Proceedings of the Fourteenth Artificial Intelligence and
Interactive Digital Entertainment Conference (AIIDE 2018)

Leveraging Cognitive Models in Planning to Assist Narrative Authoring

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Abstract

My research aims to contribute to research in the narrative authoring domain by using cognitive models in narrative plan generation. These cognitive models determine how actions and events in narrative affect the audience. My research intends to leverage these models in narrative planning and use them to provide intelligent narrative plans that are structured to invoke specific responses from audiences when they experience the narrative. This sort of approach would greatly benefit the enrich growing set of variables of narrative planning.

My research is in the nascent field of the computational modeling of narrative, work that seeks to enable computer-assisted authoring of stories by modeling the cognitive processes of both author and audience. I intend to extend work on narrative generation that uses planning algorithms to create stories that are consistent and complete (Young 2007). Previous work in narrative planning has been effective at borrowing policy planning and state-space search algorithms from AI in order to generate plot (Riedl and Young 2014). However, the majority of this work focuses on structural properties of a story (e.g., causal consistency (Li et al. 2012), intentionality (Riedl and Young 2010), conflict between characters (Ware et al. 2014)) but does not address the impact that the story has on the cognitive and affective response of its audience (e.g., tension, suspense). The goal of my work is to leverage models of author and audience to address these types of limitations.

Proposed Research

My research intends to integrate explicit models of cognitive processing into narrative planning approaches, in order to support human story writers' construction of narratives based on how they want the story to be perceived by their audiences. In my approach, planning systems will reason about the effects that story construction has on the mental state of the audience, not just upon the world state in which characters are performing actions.

This approach is important to narrative generation as perception of narrative is influenced by the mental state of the audience (Elmes and Barry 2017). Additionally, in order to generate the narrative plan catered to a cognitive response, the planner must come up with both story and discourse (Young, Moore, and Pollack 1994) to leverage the cognitive models.

I would like to direct narrative planning algorithms to consider cognitive and affective aspects of narrative experience – such as suspense, drama, humor – and provide them as crafting tools for the human story creator. Moreover, the goal of my research is to enable story creators to develop stories on a high level, and let computational planning systems complete the story creation process by searching a narrative space for stories that satisfy authorial constraints. My research plan has four stages, outlined below.

Stage 1 looks at identifying a set of relevant cognitive states experienced by audiences during narrative comprehension, and building a preliminary model of the ways that story structure prompts transitions between those states. This stage will review theory and practice around story design. I will look at the work of narrative theories regarding narrative comprehension, focusing on how readers comprehend narrative (Rimmon-Kenan 2003; Branigan 2013; Porteous et al. 2017). The field of cognitive psychology is also relevant as they propose various theories on how people perceive events and segment them (Kurby and Zacks 2008; Zwaan and Radvansky 1998; Radvansky and Zacks 2017; Zwaan, Langston, and Graesser 1995). A study of creative writing instruction and film editing would also be relevant in providing valuable information about discourse techniques to highlight certain aspects of story to invoke specific cognitive recognition and response from the audience (Magliano and Zacks 2011; Gerrig and Bernardo 1994). With help from these domains, I will develop initial models of the ways that story structure invokes audience responses like suspense, emotional engagement, and other responses from the audience (Bae and Young 2014; Cheong and others 2007). I will develop a set of procedures for manual generation of stories from partial story specifications that operationalizes these models, and use the procedures to hand-develop exemplar narratives. These narratives will then be used in a set of formative studies that will provide insight into the efficacy of the procedures for achieving targeted cognitive/affective responses.

Stage 2 will look at developing automated methods for understanding stories provided by human story creators and

reasoning with them. In this stage, I will be relying on methods drawn from natural language processing to understand the story information provided by the author. I will look at knowledge representations for narrative used in this domain (Lehnert 1981; Sanghrajka et al. 2018) and work done in narrative information extraction (Elson 2012; Schank and Abelson 2013; Goyal, Riloff, and Iii 2013). A challenge in this stage is being able to not only extract story information, but also reason with it to understand the cognitive processes the author is attempting to evoke from the audience. I would refer to other approaches in mapping narrative information to cognitive models (Cardona-Rivera et al. 2012). I would look at extracting information from the text to answer questions such as whether the author is manipulating suspense in the story, or building cognitive responses like sadness into a narrative.

Stage 3 involves using planning methods to design the narratives described in Stage 1, using the results obtained from Stage 2 to guide these methods. This stage will involve building on existing narrative planning algorithms by adding new knowledge representations that characterize the cognitive aspects of author and audience. An important contribution of the planning methods that I will propose is that these planning methods will be taking the audience models into consideration. Recent work has contributed to tracking the audience's perceived knowledge at different points in the narrative (Robertson and Young 2018). Narrative planning algorithms incorporate more features that are commonly observed in narrative, such as failing actions (Thorne and Young 2017), conflict manipulation (Ware et al. 2014), possible worlds (Shirvani, Ware, and Farrell 2017), and intentionality (Teutenberg and Porteous 2013). My research will aim to build off on these algorithms to incorporate cognitive information about how actions in the plan will affect the audience as well. This will be the core challenge of my research in this step.

Stage 4 will build upon the work proposed in Stage 3 to develop a real-time computer-assisted story authoring system. This aspect of the work aims to support mixed-initiative story authoring by providing story creators suggestions for narrative plans that they can adopt in their story tailored to the cognitive responses they are attempting to invoke from their audiences. This stage will consist of user studies to test the hypothesis of my research goals. The studies will monitor the various cognitive states that users experience in a narrative and verify them against the generated narrative plans' intended cognitive responses.

Current Work

As an undergraduate, I developed the LISA system (Sanghrajka et al. 2017), addressing the related problem of narrative information extraction – the use of natural language processing methods to identify events and other features of a story from a story text. LISA's design extends previous work (Valls-Vargas 2016) to use logical reasoning to make inferences about events in a textual story. During a subsequent internship at Disney Research, I extended this work by proposing a theoretical model for knowledge extraction and reasoning of movie scripts (Marti et al. 2018; Sanghrajka et al. 2018), and integrated these methods into an intelligent scriptwriting tool for scriptwriters being developed by Disney. While this approach has shown promise, the work focused on representations of story structure rather than discourse structure. Current research in this domain still needs to extract both story and discourse from narrative text, and use that information towards understanding the cognitive reactions the author wants to invoke from audience. My plan is to use narrative planning to create stories tailored to invoke specific cognitive and affective responses from audiences.

Currently, I am working on the implementation of a narrative planner called HeadSpace (Thorne and Young 2017; Young 2017), which allows for characters in a narrative to create plans based on a perceived world state which may not be the same as the real world state. This leads to characters coming up with possibly flawed plans which could fail. The planner also allows characters to reevaluate their knowledge when their actions fail, and come up with a new plan to achieve their goals. The planner also allows for characters to form multiple plans to achieve the various intentions that they may have, and the actions performed by these characters are performed strictly in order to meet one or more of their intentions.

Working on HeadSpace is a significant step for my research because it not only gives me experience working with narrative planning and the challenges associated with it, but also adds more richness and depth to the narratives generated by planners. This richness in the plans generated will allow me to further develop plans that can manipulate these variables for different cognitive responses. For example, HeadSpace's ability to represent different world state beliefs among the characters and the real world state allows me to monitor inconsistencies in the characters' knowledge about the world, and that difference can be manipulated the cognitive responses, such as amount of suspense felt by the audience (Gerrig and Bernardo 1994).

Significance

I believe that storytelling is a universal: it is important to be able to craft, tell, understand and effectively respond to stories in order to successfully communicate one's thoughts. While my work proposes the use of intelligent planning algorithms to provide stories that factor in the audience's reactions, these algorithms may be useful beyond telling a story to an audience. Results from research on AI and robotics is moving at a tremendous pace to enter into the daily lives of people; as a result, it's critical that this technology can understand the people it interacts with, and restructure its actions based on the reactions of its users, especially with social bots like Microsoft Research's Tay (Taylor and Schweitzer 2018). Machine enculturation is only possible if people feel comfortable interacting with machines. To truly become part of society, machines must structure their goals following social and moral behavioral standards. Understanding the cognitive and affective reactions of users to actions can teach robots and agents to behave appropriately and structure their actions according to social standards in the society.

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