Approaching a Player Model of Game Story Comprehension Through Affordance in Interactive Narrative

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Abstract

A growing body of work in games research, both generative and analytic, seeks to characterize the relationship between a player's understanding of an interactive narrative and her options for action within it. This paper provides several definitions that collectively serve as a basis for a model of the user's comprehension of an unfolding story in a game. Central to this approach, we define the notion of narrative affordance. In essence, a game provides a narrative affordance for some course of action when a player can imagine that course of action as part of a story that completes their current story experience.

To define narrative affordance, we draw links from cognitive models of narrative comprehension and a range of research on affordance, which we couple with planning approaches to story and discourse generation. In our approach, we view the creation of an interactive narrative that provides a high degree of agency as a discourse generation problem. We posit that an interactive narrative system must reason about the content and organization of its communication with a player in order to prompt a player's understanding about the game's story and her role in it.

This paper ends by pointing toward a research direction intended to provide insight into a range of aspects of interactive narrative, including role, genre, choice and agency.

Introduction

A growing number of research efforts have addressed the creation of interactive narratives in virtual environments and games. Much of the work in this area has focused on the composition of action sequences and their relation to *internally* coherent or well-structured narrative. In contrast, analysis of conventional narratives shows that narrative is also *externally* focused. Authors design the structure of stories to affect their readers or viewers in specific ways (Holland 1989; Bordwell 1989). The work we describe here sets out a formal model that adopts a view of interactive narrative that considers both an interactive narrative's internal structure and the way that the structure affects its player's cognitive state as the story progresses.

We view narratives as *communicative acts* between their authors and their audiences. In this sense, there is an expectation of cooperation between author and audience similar to the cooperative norms that exist between two people engaged in dialog as described by the philosopher of language Grice in his Cooperative Principle (1957). According to Grice, when people engage in dialog, they cooperate on the choices of what they say and how they say it in order to facilitate an effective exchange of meaning. The Cooperative Principle is summarized by Grice as a contract between the participants of dialog, where all participants observe the following rule: "Make your conversational contribution such as is required, at the stage at which it occurs, by the accepted purpose or direction of the talk exchange in which you are engaged" (Grice 1975).

In the case of non-interactive narrative, the communication channel that sets the context for the collaborative contract is, for the most part, unidirectional: from author to audience. The author is expected to abide by the Cooperative Principle when communicating the the story to the audience. Many literary devices rely upon this expectation for their effectiveness. For example, Chekhov's gun is a literary device in which an author introduces an element of a story early in the story's development, but waits to reveal the element's purpose until a later point. This device relies on an aspect of the Cooperative Principle, where the author and audience share the expectation that elements introduced into the story will ultimately demonstrate their relevance. [1]

In the case of interactive narrative, the collaborative contract still plays a role, but the Cooperative Principle now centers on the interaction between the game player and the system (Young 2002). We view the communication channel for interactive narratives as bidirectional, focusing on the choices that the game and player make to further the action of the story, and the ways that the game chooses to convey story dynamics to the player. What the game decides to present to the player regarding the development of the story is the game story's discourse. As part of the collaborative contract, the player relies on the game to communicate the appropriate cues or prompts indicating

[1] An author can take advantage of this phenomenon by inserting elements to purposely mislead the audience; the literary device then becomes the *red herring*.

when and how she should act. In addition, she will reason about her opportunities for action based on the discourse, her knowledge of the game world, her character's role in the story and other contextual elements. The player, in turn, is expected to behave cooperatively in the construction of the narrative through her actions in the interactive environment.

We regard cooperative player behavior as in-game behavior that furthers the story within the context of the story's genre and the player's role in it. There are two broad contexts for player behavior we deem uncooperative. The first is when players intentionally act to break the story's progression in order to subvert the story's flow. The more interesting context for our work is when players do not intend to interfere with story progression, but select actions that do. This case might arise, for instance, because a player's understanding of the story is partial or incorrect, and so she intentionally selects actions to advance a story that is incompatible with the one in which she's playing. This might arise, too, when a player lacks a clear understanding of a game's story, and so takes actions that are more exploratory in nature. In order for a player to fully engage in a game's unfolding story, we posit that she must understand the story's structure and her role in it.

The central problem we address in our research is the modeling of a player's comprehension process as it relates to story structure and role while she participates in an interactive narrative. Using this model, we hope to determine what game discourse management is necessary to ensure that the player understands a game story's trajectory and how she fits in the story's development.

We intend this paper to set the initial foundation for a player model that we will continue to develop in future work, which will analyze the comprehension process that takes place when players experience an unfolding story in an interactive narrative environment (i.e. game). It will also be used to generate interactive experiences that manipulate the player's understanding of how she fits into an unfolding story. Our research goal is to provide models that allow a system to:

- Manipulate a story's actions and the way those actions are communicated to a player in order to affect the courses of action – the narrative affordances – she considers available to her.
- Understand how the player views her role in the story in order to construct courses of action that support her performance in that role.
- Generate the story so that those courses of action that support a player's role are among the ones that are available to her, increasing the player's sense of agency in the story world.
- Design the story so that the player selects the course of action that most directly supports the unfolding story, increasing the player's sense of engagement in the story and her satisfaction at its completion.

In the section that follows, we present a grounding for our player model; the preliminary formalisms of our approach draw from cognitive models of story comprehension in non-interactive media and draw from a range of work concerning the concept of affordance. We subsequently present definitions for concepts that serve as a basis for our model. We also point to ways in which our definitions relate to approaches both for modeling and for prompting a player's comprehension of a game's story. We then discuss how our formalism re-contextualizes the problem of fostering player agency as a problem of generating appropriate game discourse. We end by presenting a research direction that indicates how our ideas might operationalize as our model progresses.

Background

Narrative Comprehension in Text and Film

A significant amount of research by cognitive psychologists has explored the way that people understand stories, especially in the context of written narrative. Initial evidence (Copeland, Magliano, and Radvansky 2006) indicates that the narrative comprehension process operates is a similar way in both reading, watching films and playing games. According to the constructionist analysis of cognition, readers of narrative texts engage in a process of *search after meaning* (Bransford, Barclay, and Franks 1972; Graesser, Singer, and Trabasso 1994). Zwaan and Radvansky (1998) have shown that, for readers of stories, the search for meaning involves the construction of *situation models*, mental models that track the events of a story, their causal and temporal relationships, the characters that perform them, the goals of the protagonists and antagonists in the story and other features. Those cognitive processes that are active when reading narrative have also been shown to operate across media, specifically in the comprehension of film and television narratives (Magliano, Dijkstra, and Zwann 1996; van den Broek, Pugles-Lorch, and Thurlow 1996). Further research has shown that the situation models built by readers serve to direct their expectations about unfolding action or story elements yet to come. As a story is presented, key elements serve to prompt inferences about story elements that were not explicitly communicated or that have not yet happened.

Consistent with this model is the view of *readers as problem solvers* (Gerrig and Bernardo 1994). In this view, as they read, readers work to build models of the story and its world motivated by a desire to solve the plot-related puzzles, challenges or dilemmas faced by the protagonist of the story.

While many of the ideas from work on narrative comprehension of conventional (non-interactive) media suggest parallel models for the comprehension of interactive narrative, it is clear that there are differences between the comprehension process in film and that active in game play. While many games may have clear narrative structure, an interactive narrative presents a distinct notion of coherence. Unlike characters in a film or novel, players choose their courses of action and prosecute them at their pace. Consequently, the coherence of a game's story line based on a trace of player game play may lack the kind of coherence seen in conventional media where an author controls the experience of a reader or viewer.

Affordance

The term *affordance* is broadly linked to an opportunity for action; to afford an action is to facilitate or enable it. However, the broad use of the term "affordance" in the research literature is not grounded on a generally accepted formal definition. Several researchers from different disciplines have operationalized the term into pragmatic definitions, with no clear agreement on its usage. In the sub-sections that follow, we partially trace the evolution of the term and conclude by highlighting the relevance of previous definitions to our own research. By studying affordances as phenomena in interactive narratives, we will better understand how actors develop mental models of opportunities for action in interactive environments. This knowledge is key in order to influence the creation of specific mental structures that prompt an actor to pursue her (author-intended) role in an unfolding interactive narrative.

Affordance in Psychology Gibson coined the term affordance as an element of his Theory of Direct Perception (Gibson 1979). For Gibson, affordances relate to perception. We perceive an object, we do so by perceiving its affordances. Vera and Simon (1993) put forth a theory of affordances based on physical symbol systems (Newell and Simon 1976): affordances revolve around mappings we make between a declarative representation of the world to actions. Affordances, they proposed, "are in the head, not in the external environment, and are the result of complex perceptual transduction processes" (Vera and Simon 1993).

Affordance in Design Gaver (1991) leveraged Gibson's formalism of affordances as a framework for studying complex tasks of computer users. To that effect, Gaver introduced two concepts that are relevant to our research. *Hierarchical* affordances are encapsulations of smaller affordances that are grouped in space. An example put forth by McGrenere and Ho (2000) is a word processor application, which affords document editing, but editing is done through affordances for text modification, font selection, and others. *Sequential* affordances are affordances that reveal information about other affordances, intended to be grouped in time. An example, also put forth by McGrenere and Ho (2000), is a drop-down menu which at first affords clicking, and upon clicking, subsequently affords selection.

Whereas Gibson discusses an object's affordance independent of whether or not the actor perceives it, Norman proposed that what is really important is what is perceived to be possible, rather than what really is possible (Norman 1999; 2002). For Norman, there are three independent manipulable entities when dealing with affordances:

- *real* affordances - what actions are possible with an object
- *perceived* affordances - what actions actors perceive as possible to do with an object
- *feedback* - perceptual information used to advertise the *real* affordance in the hopes of eliciting an accurate *perceived* affordance

This formalism admits that a real affordance might be poorly advertised through the interface so that no adequate perceived affordance is possible. Gaver treated an object's affordance and the presence of adequate feedback (perceptual information) as binary in his work. He plotted the space of interactions between adequate/inadequate feedback versus real/non-existent affordance in a graph similar to that presented in Figure 1 (Gaver 1991). Norman concluded that a designer should try to live up to her end of an unspoken design contract by providing adequate feedback to an actor so as to maximize the probability that her perceived affordance of an object matches the object's real affordance.

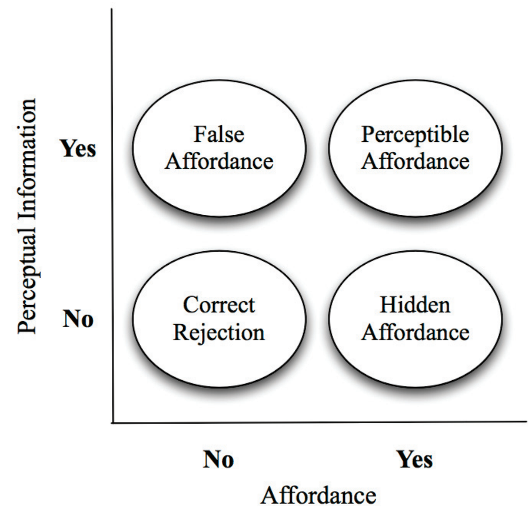

Figure 1: A re-creation of a graphic presented in Gaver's (1991) work on affordances. Gaver distinguished between perceptual information and affordance to explain the space of possible interactions between actors and objects in a computer environment.

Affordance in Interactive Narratives Mateas (2001) referenced Norman's vision of affordances as a way to approach the task of designing an interactive narrative that allows players to experience agency – the feeling of empowerment that comes from being able to take actions in the world whose effects relate to the player's intention. Mateas analyzed interactive narratives as having two types of affordances. *Material* affordances are opportunities for action that are presented (either directly by prompting action or indirectly by allowing it) by the game to the player. *Formal* affordances provide motivation to perform one particular action out of all actions that are offered. Mateas posits that "a player will experience agency when there is a balance between material and formal affordances."

Narrative Affordance Affordances have traditionally been associated with intuitive properties of artifacts that entail certain types of operation due to their outward appearance. However, our use of the term affordance is not in the context of artifacts that require operation, but rather in the context of artifacts (specifically, story events) which prompt mental structures that allow players to envision intuitive outcomes to the current story. We are interested in what players perceive the current story *narratively affords* them to pursue as completions to their current game experience. A game provides a narrative affordance for some course of action when a player can imagine that course of action as part of a story that completes their current story experience.

Narrative Affordance and Its Role In Our Model of Player Comprehension

To formally define narrative affordance, we must first present formal definitions for other story-related elements of a game. These definitions form the initial part of our player story comprehension model which will be expanded upon in future work. We use these definitions to characterize a player's search for narrative meaning and the way that his or her expectations about a game's story affects her choices for action. To model this reasoning effort, we rely on planning-based approaches to serve as proxies for the cognitive processes involved in the comprehension of a game's plot-based structure and the deliberation involved in a player's selection of a course of action within a storyline.

In this work, we leverage previous approaches to the use of plans and planning algorithms to model aspects of the process of reasoning about tasks, stories and the discourse about them (Riedl and Young 2010; Christian and Young 2004; Jhala and Young 2010). In brief, we represent a story's narrative as a (possibly partial) plan composed of *steps* (the actions that occur in a story), ordering constraints (pairwise temporal constraints between two steps indicating when one step precedes another), causal constraints (indicating when one step establishes some condition in the world needed by a later step to successfully execute), binding constraints (indicating when variables in the schematic action representations are instantiated by constants designating objects in the game world) and hierarchical constraints (indicating when a set of actions form a sub-plan for a more abstract step).

We adopt a typical model of individual steps in our approach. Following a STRIPS representation (Fikes and Nilsson 1971), each step is identified by a unique label or name, an action type (e.g., RUN, PICK-UP, RELOAD), a set of preconditions and a set of effects. Preconditions are atomic terms indicating the conditions that must hold in the game world immediately prior to an action's execution in order for the action to succeed. Effects are atomic terms indicating all the ways that the successful execution of an action will change the game world. We use an extended version of the DPOCL knowledge representation and planning algorithm; for a full description of this algorithm, see (Young, Pollack, and Moore 1994).

Model Elements and Their Definitions

A player forms a mental model of the unfolding action of a game based on knowledge of his or her own actions, direct observations about the world state, communication with other game characters/players and inferences that she makes about the game world. We model the beliefs of a player about the game level using a *domain model.*

Domain Model: A *domain model* $\mathscr{D}$ is a tuple $\prec \mathscr{I}, \Lambda, \Delta, \mathscr{G}, \Gamma \succ$ where $\mathscr{I}$ is a set of terms describing the player's beliefs regarding the intial state of the game level, Λ is a set of action operators available in the world, Δ is a set of action decompositions available in the world, $\mathscr{G}$ is a set of goals for the final state of the level and Γ is a set of action decompositions indicating *genre*, such that $\Gamma \subset \Delta$.

Action operators in Λ are tagged as either primitive or composite. Primitive actions are those that are directly executable in the game world (e.g., PICK-UP, DROP, JUMP). Composite actions are abstractions of action sequences (e.g., DESTROY-BASE, CAPTURE-FLAG) that must be refined into more primitive actions for execution. The decomposition operators in Δ and Γ hold specifications for means to refine composite actions. Decomposition operators map a composite action to a sequence of more-primitive actions that act as the subplan to achieve the composite's effects. Decompositions can be partial, in that they need not specify every aspect of a subplan.

Where a domain model represents the player's beliefs about a game level at the start of the game, the player also accumulates new beliefs about a game level as play progresses, e.g., about the actions that have occurred since the start of the game level. We represent these beliefs as a *chronology*.

Chronology: A *chronology* is a tuple $\prec \mathscr{D}, S, B, O, L_c, L_D \succ$, where $\mathscr{D}$ is a domain model, S is a set of steps, B a set of pairwise ordering constraints over elements of S, L_C is a set of causal links between elements of S and L_D is a set of decomposition constraints between elements of S.

We say a chronology is *consistent* just when a) its bindings are logically consistent (i.e., no variable is bound to more than one object constant) and b) its ordering constraints are temporally consistent (i.e., no step required to come before (or after) another may also come after (or before) that same step).

We say a chronology is *complete* just when it contains no plan flaws (Penberthy and Weld 1991), that is, when all preconditions of all steps are satisfied by causal links, no causal links are threatened by other steps that undo their causal conditions and all composite actions in the chronology have the decomposition links that specify sub-plans for their execution.

Chronologies are required to be *consistent* but need not be *complete*. [2]

Chronologies represent the beliefs that a player holds about the unfolding action in a game level *so far*. Aside from the specification of the level's initial state, a chronology has no explicit indication of state, either at the player's current moment or at earlier points after the start of the level. It's fairly direct, however, to compute state at any point by

[2]While it is possible (or even likely) that players will hold inconsistent models of a game world at times, we defer the representation of explicitly inconsistent models for future work.

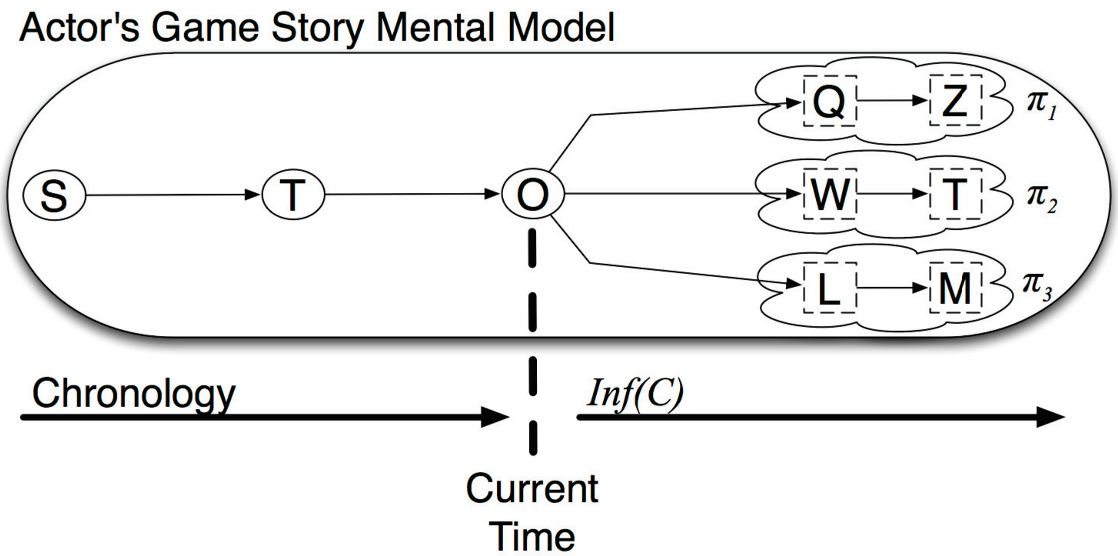

Figure 2: A visual representation of a player's comprehension of a game's story. Circles represent actions, dotted-squares represents actions that are envisioned in a player's projection and arrows represent causal links. The left-to-right direction of the arrows represents an ordering constraint between two actions (e.g. S happens before T). *Current Time* represents the progress in the player's Chronology thus far. From the current *Chronology*, the player makes a projection $\Pi = \{\pi_1, \pi_2, \pi_3\}$ which is informed by knowledge of the game's genre Γ. A course of action $\mathscr{A}$ encapsulates one or more actions and is said to be narratively afforded when it appears in at least one projection π_i. In the above figure, we can say Q is narratively afforded (because it appears in π_1), whereas K (which does not appear) is not.

progressing forward in time from the initial state, updating the state model as indicated by the effects of each step in in the chronology, ordered according to the chronology's ordering constraints.

Chronologies are implicitly indexed at a given time in the player's progression through a game world. In contrast, a *projection* of a chronology is intended to model the player's inferences about the extension of that chronology into the future, leading towards the end of the level, where all the level goals have been established.

Projection: A *projection* π of some chronology $C = \prec S, B, O.L_C, L_D \succ$ towards goal state G is a tuple $\prec S', B', O', L'_c, L'_D \succ$, where $S \subset S', B \subset B', O \subset O', L_C \subset L'_C$ and $L_D \subset L'_D$.

A *complete projection* π_c is a projection in which every precondition for each step in π_c has a causal link that establishes it, no causal link in π_c is threatened, every composite action in π_c has a sub-plan and every goal in G is established by some causal link in π_c

Player Model: A *player model* $\mathscr{M}$ is a tuple $\prec C, Inf(), Pr() \succ$ where C is a chronology believed by the player to have occurred in the story so far, $Inf()$ is a function that maps chronologies and domain models to sets of projections and $Pr()$ is a preference function describing the player's preferences over action sequences.

A genre Γ provides context for the player inferencing function $Inf()$, and constrains Π to sequences of actions built from patterns in Γ. In our approach, we consider that players will reason about potential courses of action, informed by their knowledge of the game world and the interactive narrative's genre, to imagine plan fragments describing possible future action sequences. A game provides a narrative affordance for some course of action when a player can imagine that course of action as part of a story that completes their current story experience.

Course of Action: A *course of action* $\mathscr{A}$ grounded in chronology C is a tuple $\prec S, C, B, O, L_C, L_d \succ$, where S is a set of steps not in C, B is a set of variable binding constraints for the free variables in the steps in S, O is a set of ordering constraints between steps in S well as constraints requiring every step in S to occur after the latest steps in C, L_c is a set of causal links either between steps in S or links where the source step is in C and the destination step is in S, and L_d is a set of decomposition links for sub-plans of composite actions in S.

Narrative Affordance: A game can be said to provide a *narrative affordance* for a course of action $\mathscr{A}$ to a player model $\mathscr{M} = \prec C, Inf(), Pr() \succ$ just when $Inf(C)$ yields a set of projections Π where $\mathscr{A}$ appears in at least one $\pi_i \in \Pi$.

Our model adopts Simon and Vera's perspective of affordances being symbol structures. We classify affordances as both *real* and *perceived*; our research focuses on providing the right *feedback* (which in our context translates to game discourse) to the player in order to elicit the player's correct perception of what the story is inviting her to do. Affordances can be hierarchical, which maps well to the planning data structures we are adopting from the DPOCL knowledge representation (Young, Pollack, and Moore 1994). Affordances can be sequential, which justifies us considering narrative affordances as sequences of actions which could potentially be of length one or greater.

Discussion

Unification of Previous Work

A significant amount of existing work sets the computational stage for the definitions described in the section above. As mentioned above, we are using a STRIPS-style knowledge representation for actions within a game, augmented with a representation of composite actions and hierarchical plans developed by Young, Pollack and Moore (Young, Pollack, and Moore 1994). Using these definitions, we suggest that the content of a player's domain model can be formed as follows:

- An initial state description $\mathscr{I}$ can be formed from default or stereotype templates (Rich 1979) describing typical knowledge about a game world.
- Level goals $\mathscr{G}$ are often provided explicitly to game players and so may be specified by designers; however, future work may also seek to infer player-formed goals from the observation of game play (Mott, Lee, and Lester 2006).
- Models of Λ and Γ, the game-world actions available to a player – and, significantly, their misconceptions about those actions – can be obtained by observing player action-sequences and matching those sequences to templates from a taxonomy of misconception types (Thomas and Young 2011).

In order to build a model of a player's chronology C, we assume that the game environment is instrumented in a way that the system can map from actions that players observe during play to a characterization of those actions in the system's declarative representation. To generate a set of projections Π from a chronology C, we exploit approaches to plan-space planning (Kambhampati, Knoblock, and Qiang 1995), where C and its domain model $\mathscr{D}$ form the basis of a partial plan that serves as the root node in a space of plans computed by a planning algorithm. Here the planning algorithm serves to compute $Inf()$ and the set of complete plan nodes in this space corresponds to the set of projections Π.

These planning elements serve as the starting point for the knowledge representation used in our player model. There are at least three elements that are missing from our characterization, however. First, as described above, the player's model of the story's genre plays a role in constraining the space of projections that she considers at any given point in game play. We've provided only a preliminary model of genre here. Second, the player's model of her role in the story influences her selection of one course of action over another (under an assumption of cooperativity). We have yet to specify any model of role. Finally, a model of the player's preference over types of game play is critical to our model's ability to effectively characterize player choice. Again, we have made no commitment towards a representation of preference other than to indicate that it is needed.

One strength of this model is that we will be able to gauge its efficacy, in part, by its predictive power. For example, if we are given an accurate player model for a player in a given game, it should be possible to compute the projections supported by the game's chronology and then probe the player experimentally to determine if the player is considering some or all of those projections. This is an approach towards validation taken in previous computational work on predicting inferences during narrative (Niehaus 2007) and in the generation of inferences (Niehaus and Young 2010), suspense (Cheong and Young 2006) and surprise (Bae and Young 2010) during the reading of automatically created stories.

In addition to the model's predictive power, we hope also to demonstrate its contribution as a generative tool. Given our planning-based approach to the implementation of this model, the task for a narrative generation system using it is to create a chronology that supports a desired course of action via its narrative affordances. In this regard, the challenge is one that spans the generation of both plot (what actions happen in the game) and discourse (what elements of the plot are communicated to the player). The system must compose a plot and a selection of communicative acts about that plot whose resulting communication will establish the desired mental state (beliefs about the chronology) in the mind of the player.

Authorial Intent, Choice, and Agency

Murray defined agency as "the satisfying power to take meaningful action and see the results of our decisions and choices." (Murray 1998) The results of the agent's choices must bear relevance to the agent's intent; action satisfies the desire for agency only when contextualized by an agent's intent. A game should therefore be carefully designed so as to allow a player to develop the intention to shape the game's underlying story through choice of action in the game environment. Furthermore, the game should support player actions through which the player can participate in the development of the game's story. These ideas are what Wardrip-Fruin et al. defined as agency: "a phenomenon involving both game and player that occurs when actions players desire are among those they can take as supported by an underlying computational model." (Wardrip-Fruin et al. 2009)

One way of providing this computational model (which is the focus of our research) is to encode all story-relevant communication as discourse that presents game-supported opportunities for meaningful player choice, where the player both is aware of the consequences of her in-game choices and can perceive either that there is no one else to fill the player's role or that the protagonists' goals (i.e. their own) would fail without their action.

When a player plays a game, they willingly adopt a cooperative attitude by expecting that game communication and action will revolve around a story line. Therefore, when a game provides a narrative affordance, the game is essentially giving a player a sense of what courses of action are enabled by the story. From this perspective, agency is determined by the overlap of narrative affordances in a story space and the player's choice.

This allows us to cast player agency as a discourse generation problem, where we must decide:

- what discourse content to present that allows the player to perceive specific narrative affordances, and
- what discourse content to present that motivates the player to pursue a particular course of action

Regarding the former, a game's author must ensure that the game presents narrative affordances aligned with what the author wants the player to experience. This is reminiscent of the work by Nelson et al. (2006) that focuses on authoring interactive narratives with respect to an author evaluation function. This evaluation function declaratively encodes the game author's judgement of a narrative's quality. In our research, game authors might annotate certain narrative affordances as more desirable than others. The game would then automatically structure the game discourse to serve the purpose of prompting desirable narrative affordances in the player's head.

Regarding the latter, a player's perceived role and personal preferences will guide her to make a choice. The game must consider both of these aspects in order to prompt discourse to pursue a course of action that the game's underlying computational model knows is available.

When an author's intended narrative affordance $\mathscr{A}$ appears in at least one of a player's projections Π of how the player believes the chronology C will unfold, and the player intends to carry out the course of action $\mathscr{A}$ due to a combination of the player's preferences $Pr()$ and perceived role at the moment the player inferred the projections, we posit a phenomenon takes place where the player experiences agency and the story moves forward at the same time. This contrasts with Church's characterization (1999) of traditional role-playing games, where he describes them as games that alternate between game mechanics and story, with players being able to form intentions, take actions and see consequences only outside of story progression. In our research, the story is a game mechanic, and through it the player makes meaningful choice which allows her to experience agency.

Future Work

This paper describes initial work on the development of a model of a player's comprehension process during an interactive narrative. The work that will follow from the ideas described here will proceed along three lines: formal, cognitive and computational.

The formal work that remains will most directly focus on those aspects of our current model that are most clearly approximations of more complex representations. One area will involve the development of a more formal definition of material and formal affordances in the context of interactive narrative. The other two areas that are most immediately suggested are more accurate representations of role and genre.

Future cognitive work will explore the key differences between narrative comprehension in games and narrative comprehension in interactive narrative media. As we mention above, the parallels between narrative in texts and narrative elements in games suggests that we may be justified in borrowing representations from non-interactive narrative comprehension in games (experimental evidence reported by Copeland, Magliano and Radvansky (2006) provides support for this expectation). However, it seems likely that a player's differing expectations about the coherence of their experiences in games may change the way that they construct situation models. A greater understanding of the narrative comprehension process in games will give us greater confidence in the leverage of previous psychological models.

Finally, future computational efforts will work towards the development of a generative system that reasons over the trajectory of a player's experience to create and adjust the narrative discourse in order to influence the player model over the course of game play. By modeling a player's perception of the direction of the unfolding narrative by treating narrative experiences as afforded to her by the story, we hope to leverage narrative and communicative principles to guide the creation of discourse content in order to procedurally create such experiences.

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