Formal Models of Western Films for Interactive Narrative Technologies

Brian Magerko and Brian O'Neill
Georgia Institute of Technology
85 5th St. NW, Technology Research Bldg. #319, Atlanta, GA 30308-1030
E-mail: magerko@gatech.edu, boneill@cc.gatech.edu

Abstract

Interactive narrative technologies have typically addressed the authoring bottleneck problem by focusing on authoring a tractable story space (i.e. the space of possible experiences for a user) coupled with an AI technology for mediating the user's journey through this space. This article describes an alternative, potentially more general and expressive approach to interactive narrative that focuses on the procedural representation of story construction between an AI agent and a human interactor. This notion of procedural interaction relies on shared background knowledge between all actors involved; therefore, we have developed a body of background knowledge for improvising Western-style stories that includes the authoring of scripts (i.e. prototypical joint activities in Westerns). This article describes our methodology for the design and development of these scripts, the formal representation used for encoding them in our interactive narrative technology, and the lessons learned from this experience in regards to building a story corpus for interactive narrative research.

Keywords: interactive narrative, story corpus, improvisation, scripts, cognition

1. Introduction

The field of interactive narrative technologies (INTs), where researchers create AI-driven approaches to computer-mediated story experiences for human users, is heavily constrained by the prospect of content authoring. No matter what technical approach a particular researcher is exploring, it is typically difficult to show that a system works in a compelling fashion without a non-trivial effort in writing story content in a machine-readable form. This is due to interactive narratives containing both a formal, computational element (e.g. the programming behind getting the Holodeck to work) and an aesthetic one (e.g. the story content that has to be encoded in the Holodeck so it can involve users in story-based experiences). The work presented in this article discusses how a focus on splitting INT research into *background knowledge* for the formulation of stories and *processes* that operate on that knowledge to enable multiple agents to collaboratively create a story can be used to address this issue of authoring in a novel way.

Interactive narratives normally involve exposing a user to a *story space* (i.e. a bounded experience where multiple possible stories can be experienced) where larger story spaces mean more possible personalized user experiences and, most importantly, more content authoring by the designer. The story space can be thought of as "the space of intended experiences" for the user; in other words, the author / designer's vision (Magerko 2007a). The AI-based technology employed (normally called a *story manager*) typically serves as a guide through that space (see Roberts and Isbell 2007 for a survey of the field). "Guiding the user" could mean helping the user stay within the bounds of the story space and not executing actions that could lead to the story stopping (Young et al. 2004; Magerko 2007a). It could alternatively mean selecting story content that fits the system's perception of what would be most enjoyable to the user (Thue et al. 2007; Yu and Riedl 2012).

The most successful interactive narrative to date, *Façade,* reportedly took over five man years to author content for a relatively short work (30 minutes max for a successful story) compared to other media forms (e.g. 30-60 minute television shows, 90-150 minute films, or 40 hour digital games). *Facade* represents story content as *beats* (i.e. atomic moments of interesting narrative content), which are dynamically selected by the system as the user interacts with the characters in the story world (Mateas and Stern 2002). Other representations include planning operators, story graphs, and Proppian functions (Roberts and Isbell 2007). Each of these representations are used by the designers of systems to create the space of possible experiences for the user through the intentional authoring of story events / beats / etc. for a user to potentially experience.

The story spaces of the systems, such as *Façade*, referred to above are bounded by the content authored for the experience; in other words, the only scenes experienced by a user of such a system are the ones hand authored by the designer. While this may not be a problem itself – many systems have been built with this authoring constraint - it is a limitation of INTs that human storytellers do not have. People have the ability to draw on their personal experiences, on other stories they have heard or told, etc. and create something wholly new. Even if that new thing is an amalgam of older stories and experiences, the generative process of combining these narratives into a new one is a creative process in and of itself; very few stories told are wholly new and unique.

There is a subset of human storytelling that deals with the real-time generation of story content as a key part of the story experience for those involved. These domains (e.g improvisational theatre, Live Action RolePlay, tabletop roleplaying, etc.) often provide a similar kind of experience to those INTs attempt to provide (Flowers, Magerko, and Mishra 2006; Magerko et al. 2009). Our empirical observation of improvisational actors (Magerko et al. 2009; Baumer and Magerko 2009; Baumer and Magerko 2010; Fuller and Magerko 2011)

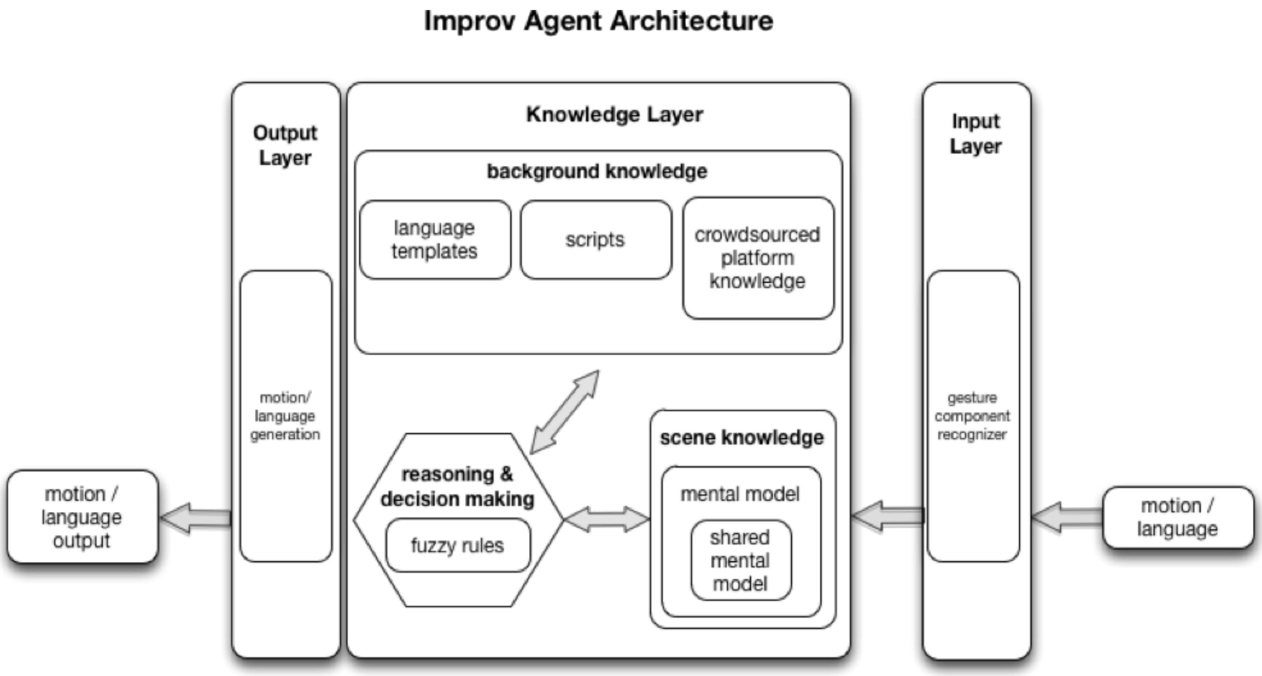

Figure 1. An architectural view of the *Digital Improv Project*. The significant components are a) the gestural / language input layer using a Microsoft Kinect, b) the background knowledge, c) the knowledge that is collaboratively constructed about the scene, d) the reasoning mechanism, and e) the gestural and language output layer.

has lead to the unsurprising conclusion that improvised stories by professionally trained actors are rarely anything close to the verbatim retelling of stories or personal experiences of the past. Rather, improvisers weave knowledge from a myriad of personal and cultural sources, in real-time, to co-create a new story with their fellow improvisers on stage. This approach to story generation is wholly different from anything seen in traditional interactive narrative technologies that rely heavily on pre-authored story spaces

As we have argued elsewhere (O'Neill et al. 2011), the notion of *story co-creation* is a particularly powerful one for INT research. Story co-creation refers to a story space that is bounded by the basic knowledge the agents involved know plus the functions they have for presenting, combining, and altering that content (much like improvisational actors do on stage) as opposed to having a centralized intelligent agent (i.e. a drama manager) that has privileged information about what the story can and cannot contain. We contend that story co-creation is an understudied, but potentially powerful stance on how to build INT systems. By taking a stance of making co-creative systems, we are placing the user in a position that has the same privileges as the computer; the user is no longer limited by only the vision of the designer and what has been encoded in the story space. This is not necessarily the only kind of interactive narrative people want (e.g. different entertainment media exist with varying amounts of user agency / control over the experience), but it is a direction for the field that is both underexplored and potentially fruitful given the plentiful examples of co-creative experiences that humans enjoy.

Based on our empirical study of improvisers (Magerko et al. 2009; Fuller and Magerko 2011; O'Neill et al. 2011), we have concluded that in order to build a co-creative interactive narrative experience, we must develop a system that has: a) similar *background knowledge* (see Figure 1) to the other agents (human or AI) in the scene, b) a model of the *scene knowledge* related to the story that is being negotiated / communicated as part of the performance, and c) the processes that operate on both knowledge sets to maintain the scene knowledge base correctly and to collaboratively construct a scene with the other actor(s). This article focuses on the first construct, background knowledge. We have focused on two main knowledge representations for background knowledge, as described in detail in this article: fuzzy concepts (based on Lakoff's *prototype theory* and fuzzy logic (1989)) and scripts (based on Schank and Abelson's seminal work on this formal psychological construct of temporal events in our daily lives (1977)).

This article briefly covers our previous research and the related work in script-based representations and improvisation in interactive theatre. It then discusses our background knowledge representation and the use of scripts as a key element in representing joint activities (i.e. what agents are doing together) in a scene. It closes with a discussion on the process we have employed in creating our story corpus and the lessons learned for building a shared repository of corpora for the interactive narrative community.

2. Related Work

Previous Research

Our work on the *Digital Improv Project* has led us to build interactive narrative technologies that are based on a formal study of the socio-cognitive processes employed by improvisational actors (Magerko, Fiesler, and Baumer 2010; Magerko, Dohogne, and DeLeon 2011). We have built formal models of how actors negotiate the details of a scene as part of a real-time performance without any agent necessarily having any privileged knowledge about the story (though this is possible in certain improv games) in a system called *Party Quirks* (Magerko, Dohogne, and DeLeon 2011) and are currently modeling how improvisers establish the *platform* (i.e. the introductory details about what characters are in the scene, where they are, and what they are doing together) in a game called *Three Line Scene* (O'Neill et al. 2011). *Party Quirks,* based on the real-life improv game of the same name, involves a party host who has three guests with previously assigned "quirks" (e.g. is a robot or is a pirate who is afraid of treasure) that the host has to guess during the scene. This game rarely involves story and is more focused on the representation and communication of character, which is why we focused on it as our first major system.

In terms of building a complete interactive narrative work, we have reasoned that building the platform should be our first major task in narrative co-construction before moving to the middle and conclusion sections of an improvised scene. Our most recent INT effort, *Three Line Scene* (also inspired by a real-life improv game), builds on our work in *Party Quirks* to enable an AI and a human to establish the platform of a scene based in the Old West (i.e. involving cowboys, bandits, gunfights, etc.). The nature of *Three Line Scene* is to establish the details of a scene within three lines to quickly and solidly get the platform agreed on so the scene can progress. Our future work will address other processes related to the co-creation of novel improvised stories, such as how the *tilt* (i.e. the main conflict) in a scene is negotiated and resolved (Brisson, Magerko, and Paiva 2011) and how conceptual blending is employed during performances to create new knowledge structures in the scene.

Scripts

Schank and Abelson argue that people use scripts to represent and navigate well-known situations (1977). Specifically, these scripts are a predetermined series of actions that define those situations, typically built from a person's experiences in those situations. While these scripts are malleable to the specifics of a situation (such as what food is ordered in a restaurant), the overall sequence and content of a script (how to behave in a restaurant) is rarely altered. In Schank's model, a script represents a causal chain. Actions early in the script explicitly enable the latter elements, and the scripts themselves may have preconditions before they can be retrieved and applied to a situation. The inference capabilities of humans allow us to recognize and apply scripts based on a small number of observed events. People may need to be able to recognize a ten step script based solely on the first and last events encoded in that script. In addition to telling us how to act in a given situation, scripts allow us to understand stories that others tell us. We use these scripts to fill in the gaps of a story when details are omitted. When such information is left out, we can assume that the omitted details happened according to the script. Finally, in Schank's model of scripts, two or more people in the same situation may operate from different scripts. For example, at a restaurant, a customer, a waiter, and a cook would all operate from separate scripts. Thus these scripts are tailored to a typical experience from a single perspective.

Orkin developed plan networks as a means of displaying collections of pathways through a given scenario (2007). Orkin sought to learn the common interactions between a customer and a waiter in a typical restaurant scenario. He observed thousands of interactions between players in a virtual environment known as *The Restaurant Game*. Players were tasked with acting as either a customer or a waiter, and each interaction between players represented a new plan in the network. Orkin visualized these plan networks as directed graphs, where each node was a discrete event and a directed edge indicates that one event immediately followed another in one or more of the observed interactions. With a large enough number of observations, any individual path through the plan network graph can be seen as a valid interaction.

While plan networks and Schankian scripts both aim to describe the typical behavior in a common interaction, plan networks model the behavior of all parties involved, as opposed to the Schankian approach which takes a single perspective to the interaction. Additionally, plan networks focus on the temporal sequence of events and ignore the issue of causality. However, plan networks do allow for an understanding of multiple pathways through a scenario, unlike Schank's model of scripts. This feature of having multiple paths has mapped well onto our formulation of genre-specific scripts for improv theatre, as described in the next section, and heavily contributes to our formulation of background knowledge of improv actors.

Co-creation in Interactive Narrative

Co-creation has been sparsely applied in interactive narrative systems. Co-creation is closely related to the concept of *agency*, which has been described as the impression a user has of how much control they have in a story (Thue et al. 2010). Co-creation refers to the actual generation of content in a story; in other words, the amount of co-creation in an experience is related to how much of a scene is built on elements that were introduced in the scene as opposed to being pre-authored. Co-creation, therefore, depends heavily on procedural definitions of story creation.

Procedural representations of story creation in interactive narrative (as opposed to drama management techniques) are not commonplace in the field. One particular system of note, Fairclough's *OPIATE*, attempted to procedurally represent Propp's functions from Propp's formal analysis of Russian folktales (Fairclough and Cunningham 2004). This allowed the system to recognize when a situation matched the conditions for a function and allow it to dynamically assign roles to characters, plot elements to be instantiated, etc. While this system represented a procedural set of rules that was both heavily restricted to a particular domain (Russian folktales) and was not necessarily conducive to modern expectations of interactive narrative experiences (Tomaszewski and

Binsted 2007), it was a significant work in the exploration of procedural definitions for INT systems. OPIATE could only essentially involve the user in Russian folktales, but the story space was defined by the knowledge in the world plus the definitions for how to apply that knowledge; in other words, story elements were not concretely pre-authored beforehand. While this work may have suffered from an over-constraining story domain, it did create a precedent for authoring story knowledge in a procedural form that removed the computer from the privileged role it normally assumed in INTs and attempted to create a more open-ended, less specifically defined story space for the user to explore and contribute to. Other notable systems include Swartjes' improv theatre-inspired investigation of object creation (Swartjes 2010) and Zhu's representation of status in the domain of real-world interactive theatre (Zhu, Ingraham, and Moshell 2011).

We contend that this focus on procedurality in interactive narrative systems is one that has significant potential for the future of the field. In order to build such a system, however, we need to arrive at a clear understanding of how to represent the knowledge an agent will employ and the processes that will operate using that knowledge. We refer to the knowledge that is used by processes in a co-creative experience as *background knowledge*, which is described in the next section.

3. Background Knowledge for Improvisation

Fuzzy Concepts

If agents are going to improvise together, they need to be able to refer to similar story constructs during improvisation – just like in any kind of collaboration or conversation. This requires agents to have significant enough overlap in their knowledge base – before the scene begins – to have anything sensible to say to each other. As mentioned earlier, we have worked on a system that constructs the platform (i.e. initial details) of a scene. Our initial work focused on how to formally represent the *character prototypes* (Magerko, Dohogne, and DeLeon 2011) that improvisers employ and how those prototypes are physically communicated on stage (e.g. a pirate taking a swig from a bottle of rum). This work has subsequently been extended to cover the major elements of scene platforms: character, location, and joint activity (Sawyer 2003).

Our main formalism for representing knowledge in this framework has been inspired by Lakoff's *prototype theory* (1989) and the corresponding subfield in logic known as *fuzzy logic*. Prototype theory suggests that we have shared cultural constructs that describe elements of our world (e.g. tables, superheroes, puppies, etc.). These constructs (prototypes) are not easily expressed in Boolean logic; tables are not *always* made of wood and superheroes do not *always* wear capes. Rather, prototypes are described as having degrees of memberships in different categories (e.g. superheroes have a strong, but not 100% membership in the category *wears capes* because not all superheroes wear capes, though many do). We refer to *degrees of association* as a bidirectional degree of membership (e.g. *pirates* are associated with *peglegs* strongly and vice versa). We have found that this epistemological theory fits very well with our data collected on human improvisers (Magerko, Dohogne, and DeLeon 2011). Fuzzy logic is a representation that affords exactly this kind of relation between knowledge and categories. Elements are described as having degrees of membership (DOM) to each set in the world. For example, *superhero* would have a degree of membership in *wears cape*, *made of wood*, *eats spinach*, and any other set that is included in our world state.

We use the above formalism for describing prototypes in the platform for an improvised scene. As shown in Figure 2, we have relationships between the gestural **M**otions performed by an agent or human improviser (via a Microsoft Kinect interface) and the semantic **A**ctions that those motions could represent. For example, waving your hand in the air could be strongly associated with the *saying hello* set, medium with the *dancing* set, and close to 0 for the *bandaging a wound* set. Actions have associations with **C**haracters (e.g. *bandaging a wound* would be highly a member of the *doctor* set and perhaps medium for *pirate*) and **J**oint **A**ctivities (e.g. bandits are highly associated with the *robbing bank* activity). These different sets of DOM values, as shown in Figure 2, can be used to infer new knowledge from a gestural input, to scene elements, to finally an output entailed by the new scene knowledge that has been inferred (e.g. seeing the other actor point their hand → they are pointing a gun → cowboys point guns, so perhaps they are a cowboy → bandits are in

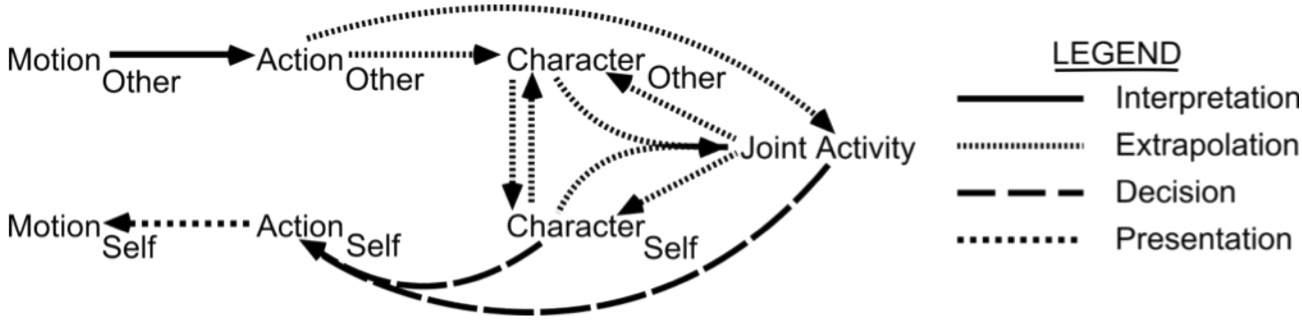

Figure 2. A depiction of the knowledge involved in reasoning about platform. Each arrow represents a table of degree of associations between the two sets. For example, all actions have degrees of associations with all characters. Therefore, if the Other actor executes an action, the Self agent (the one going through this thought process) can entail possible characters the Other may be portraying based on the degree of association values.

scenes with cowboys → I am a bandit → bandits also point guns → I should make the *gun pointing* motion and say "Reach for the sky!"). This process is described in more detail in (O'Neill et al. 2011).

While our fuzzy representation has worked well in the improv systems we have built so far, we quickly found during our design of *Three Line Scene* that there is a major issue with using fuzzy logic to represent one particular aspect of a scene's platform: joint activities. Joint activities (JAs) do have DOM associations with other scene elements (e.g. *bandits* are highly associated with *robbing a bank*), so having a fuzzy representation as part of the way we describe JAs makes sense. However, JAs also have a decomposition that needs to be observed; in other words, a joint activity like *robbing a bank* can actually be decomposed into multiple actions. Furthermore, these multiple actions are temporal in nature. In the *robbing a bank* joint activity, the bandit should not leave with the money before he says "Stick 'em up!" to the banker. While decomposition could be encapsulated by DOM values (i.e. the actions in a joint activity are highly associated with that activity), temporality cannot. Therefore, we have introduced a second formalism into our architecture, as shown earlier in Figure 1: scripts.

Scripts for Improvisation

For the purposes of our *Three Line Scene* system, we have focused on an Old West domain, which has definable genre characteristics (e.g. has cowboys, gunfights, saloons, etc.) and was deemed a large enough story space to allow for interesting improvised scenes without being too large (i.e. untractable) or too small. We identified typical joint activities by watching canonical Old West. Once we had selected our set of joint activities, we re-watched relevant scenes from the films and listed the pertinent actions in the joint activity. We asked multiple people to watch the same scene and then cooperatively authored scripts from these lists of events to build a corpus of script information about Old West stories.

We considered crowdsourcing approaches for identifying Old West joint activities and building the scripts. Crowdsourcing can give a good set of responses, but setting the problem up for such an approach can be cumbersome. Orkin was able to crowdsource typical restaurant interactions, but doing so required thousands of interactions in a virtual environment (2007). We considered asking people to build scripts using Amazon Mechanical Turk, but we only would have been able for the next event at any given time, rather than the whole script. We quickly became dissatisfied with the time and complexity requirements for collecting scripts from the crowd and opted for the lower cost option of mining genre examples for script information instead.

As suggested earlier, we represent scripts using a modified form of Orkin's plan networks. These plan networks allow scripts to be represented as a collection of possible sequences of discrete events. Each network is represented as a directed graph, where nodes represent individual events and arcs connect events to other events that could potentially occur next. Each node in the script structure contains information about the specific action, what character the improviser is portraying, and what other objects or characters are involved in the action. Additionally, nodes that could potentially be the first or last event in a script are tagged as such. Arcs only represent possible successors -- no assumptions can be made about causal relationships between events whether or not they are connected by an arc.

Cycles are permissible in plan networks. For example, in a *bar* script, one could imagine returning to an earlier point in a script after finishing a drink in order to order a new one. However, it is often possible for cycles to exist in a network that stop making sense if repeatedly traversed. In a *Western shootout* script, a cycle may exist between two characters drawing their guns. This cycle exists so that either character may draw first. The

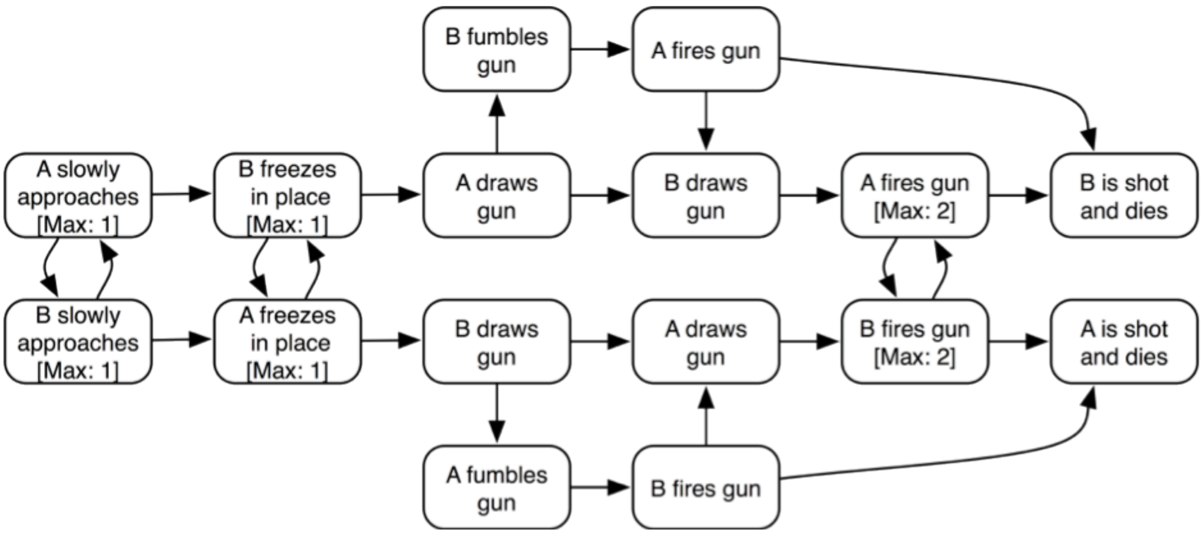

Figure 3. A script representation of an Old West shootout. The two characters described here, denoted as A and B, approach the shootout, and possibly draw and fire. Note the loop counters in the nodes representing each character entering the shootout, freezing, and firing their weapons. The two left-most nodes are tagged as acceptable starting points for the script, while the nodes representing a character getting shot are tagged as possible endpoints for the script.

consequence of such a cycle, unfortunately, is that both characters may repeatedly draw their guns. We have two approaches to managing and preventing these possibly infinite cycles. The first approach is the incorporation of "loop counters" in our representation of plan networks. Each node in such a cycle is tagged with the maximum number of times that it can be traversed. Our second approach is the separation of paths through the plan network so that there is no cycle. Separating the cycle into multiple paths allows us to enforce consequences to a specific order of events. For example, in the *Western shootout* script shown in Figure 3, each character drawing a gun has been separated into multiple nodes. In addition to preventing a character from drawing his gun multiple times, this approach further allows us to restrict who shoots first based on who drew first.

In the *Three Line Scene* system, we have a script for each joint activity in our knowledge base. There are two circumstances in a scene that require script retrieval. In the first, one of the improvisers believes he knows the joint activity in the scene. Each joint activity has only one script, so the script can easily be retrieved. In the other case, an improviser is trying to determine the joint activity (and the relevant script) based on the actions he has observed from the other improviser. Our *Three Line Scene* knowledge structure relates joint activities to individual actions that an improviser might take (as shown in Figure 2). Therefore, based on a particular action, an improviser can find one or more relevant scripts that may apply. The improviser can then apply further information from the scene so far to narrow the field (e.g., the characters that the improvisers are playing), or if no other information is available, choose a script to follow for the time being until confirming or conflicting information is presented.

Our background knowledge for joint activities is a hand-authored corpus that is comprised of a set of plan networks like the gunfight one illustrated in Figure 3. While this corpus is currently not especially large, it is sufficiently large enough for us to conduct the *Three Line Scene* project on platform establishment and informs us about knowledge authoring and representation issues for the future. This corpus, which is available from the authors to the academic community by request, is one that we intend to a) use as a knowledge base for our current *Three Line Scene* project; b) retain as a corpus of background knowledge for future, more complex improv agents; and c) continue to refine and augment to build a corpus that includes more genre-specific scripts as well as scripts from other genres that could be blended with the Western scripts as part of the improvisational process of creating new stories.

4. Discussion

This article has described how we as a research group have generated our own corpus of scripts to serve as background knowledge for an interactive narrative technology based on improvising scenes. This process has involved the hand authoring and peer reviewing of scripts compiled from genre examples in Western films. It would be an incredible boon to our work – and other projects in the INT field, undoubtedly – to have a pre-existing story bank that already had multitudes of genre scripts (and other platform elements) for us to rely on (Finlayson 2011). Such a story bank would allow us to move our efforts away from knowledge representations / background knowledge and focus more heavily on the procedural knowledge involved in improv (i.e. how to negotiate scene elements, how to computationally blend background knowledge with scene to create new story elements, etc.). However, our experience in authoring for *Three Line Scene* has encouraged some reflection on the concept of a story bank and how the idiosyncrasies of INT research projects may not fully benefit from such an effort without careful deliberation and awareness of the field.

The particulars of our knowledge representation (i.e. scripts and the fuzzy mappings illustrated in Figures 2 & 3) are not commonly used in other interactive narrative projects. As mentioned earlier, other systems rely on planning operators, beats, complete plans, story graphs, or Proppian functions to logically encode story elements (Roberts and Isbell 2007). As we have observed earlier, story representation in an INT is directly related to the affordances of the system for the AI involved (Magerko 2007b). In other words, what story representation is used in a system influences what the AI in that system can and cannot do. This has a direct relevance on the potential use of a story bank for INT research. If a particular AI-based approach does not map well to the affordances of the representation used in a story bank, then, best case, that approach necessitates its own story knowledge and cannot make use of a story bank, and worst case, that approach falls out of favor because it is inconvenient given the particular representation used in a story bank. We call this issue the *AI affordance problem*.

The affordance issue suggests that a general corpus or story bank should have malleable guidelines for representations. Rather than having a pre-defined logical representation, some initial core representation should be decided on which, in turn, can be added to in time with the needs of new projects coming to light. This could be designed with a decentralized (i.e. conventions agreed upon by the group of users) or centralized (i.e. a governing body reviews proposals for alterations / additions and formally agrees on new modifications) organizational mindset. Regardless of the approach, some intentional design in the governance of the representation used in a story bank needs to be taken to incorporate the myriad different logical approaches used in INT research and ones that are yet developed. A corpus needs to be as nimble and adaptive as the field using it, else it may either fall into disuse or bias the field towards the representational status quo.

A second issue with a general corpus for interactive narrative research is the nature of subjectivity in even the simplest story elements. When developing our earlier improv system, *Party Quirks*, that focused on representing and communicating character prototypes, we found very quickly during user testing that our hand authored prototype information rarely directly matched with our users' background knowledge. In other words, the *subjectivity problem* is reflected in how our conceptualization of character prototypes did not reflect everyone's view of the same prototypes.

This observation forced us to reconsider how we were authoring data about prototypes. Rather than rely on hand authoring, we opted for crowdsourcing our character prototype information. We created tasks on Amazon Mechanical Turk that allowed us to get a large amount of data fairly quickly about how strongly / weakly associated each of our character prototypes were for each of the possible actions in the world. We have employed this process again in the development of *Three Line Scene*, creating a separate crowdsourcing task for each connection (except **M**otion → **A**ction) seen in Figure 2. This process has allowed us to build a sizeable dataset that represents the views of a much larger population than our research lab in terms of the degrees of association between prototypes in an Old West story world. That dataset is then probabilistically sampled by our intelligent agents at the beginning of a scene to create a unique actor with background knowledge that is drawn from the particular views of our crowdsourcing subject pool.

Our crowdsourcing solution is one potential way to address the subjectivity problem. Whether it is with crowdsourcing or some other approach, the subjective nature of stories (e.g. the affect of a scene, what the definition of a prototypical character is, what the theme of a story was, etc.) need be captured to fully represent story elements as viewed by potential observers. If a corpus only intends to capture the typically non-subjective aspects of stories (e.g. the occurrence and ordering of events) then this issue may be avoided, though it will be decidedly sparse and, in some cases, non-subjectivity of content may be difficult to agree upon without getting data from an outside population anyway.

Our work on the *Digital Improv Project* is intended to serve as an exemplar of the kinds of research in interactive narrative technologies at present that are directly related to the collection of logical representations of stories. Our particular representation is decidedly different from those in other systems, but none are proven to be the absolutely correct formalism. There is potential for interactive narrative systems to be bootstrapped enormously with access to a large body of knowledge about stories (Gordon and Swanson 2009; Yu and Riedl 2012). However, if we as a community intend to collaborate on such an effort, we need to keep in mind issues like the affordance and subjectivity problems to develop a tool that helps our work in the future and reflect the variety of approaches used at present.

5. Acknowledgements

We would like to thank all of the members of the ADAM Lab at Georgia Tech who have put their hard work into the *Digital Improv Project* effort, including Chris DeLeon, Peter Dohogne, Joshua Faubel, Daniel Fuller, Rania Hodhod, Jonathan Pelc, Andreya Piplica, Matthew Postema, Mark Riedl, Dannielle del Rosario, and Emmy Zhang. This work was funded by NSF grants: IIS 0757567, 1036457, 0929326, 1037711, 1127359, 0840122, and 1129840.

6. References

Baumer, A., and B. Magerko. 2009. Narrative Development in Improvisational Theatre. In *Proceedings of 2nd International Conference on Interactive Digital Storytelling*, 140–151. Guimarães, Portugal.

———. 2010. An Analysis of Narrative Moves in Improvisational Theatre. In *Proceedings of 3rd International Conference on Interactive Digital Storytelling*. Edinburgh, Scotland.

Brisson, A., B. Magerko, and A. Paiva. 2011. Tilt Riders: Improvisational Agents Who Know What the Scene is About. In *Proceedings of 11th International Conference on Intelligent Virtual Agents*, 35-41. Reykjavik, Iceland.

Cavazza, M., F. Charles, and S. J Mead. 2002. "Character-based interactive storytelling." *IEEE Intelligent Systems*, 17 (4): 17–24.

Fairclough, C., and P. Cunningham. 2004. "A Multiplayer OPIATE." *International Journal of Intelligent Games and Simulation*, 3 (2): 54-61.

Finlayson, M.A. 2011. Corpus Annotation in Service of Intelligent Narrative Technologies. In *Proceedings of the 4th Interactive Narrative Technology Workshop at the Seventh Artificial Intelligence and Interactive Digital Entertainment Conference*, Palo Alto, CA.

Flowers, A., B. Magerko, and P. Mishra. 2006. "Gamemasters and interactive story: A categorization of storytelling techniques in live roleplaying." *Futureplay*, London, Ontario.

Fuller, D., and B. Magerko. 2011. Shared Mental Models in Improviational Theatre. In *Proceedings of 8th ACM Conference on Creativity and Cognition*. Atlanta, GA.

Gordon, A., and R. Swanson. 2009. Identifying personal stories in millions of weblog entries. In *Third International Conference on Weblogs and Social Media, Data Challenge Workshop, San Jose, CA*.

Lakoff. 1989. Cognitive models and prototype theory. In *Concepts and conceptual development*, ed. Ulric Neisser, 63-100. CUP Archive.

Magerko, B. 2007a. "Evaluating Preemptive Story Direction in the Interactive Drama Architecture." *Journal of Game Development* 2 (3): 25-52.

———. 2007b. "A comparative analysis of story representations for interactive narrative systems." *Proceedings of Third Annual International Artificial Intelligence and Interactive Digital Entertainment Conference*, Palo Alto, CA.

Magerko, B., P. Dohogne, and C. DeLeon. 2011. Employing Fuzzy Concepts for Digital Improvisational Theatre. In *Proceedings of the Seventh Annual International Artificial Intelligence and Interactive Digital Entertainment Conference*. Palo Alto, CA: AAAI Press.

Magerko, B., C. Fiesler, and A. Baumer. 2010. "Fuzzy Micro-Agents for Interactive Narrative." *Proceedings of the Sixth Annual International Artificial Intelligence and Interactive Digital Entertainment Conference*. Palo Alto, CA.

Magerko, B., W. Manzoul, M. Riedl, A. Baumer, D. Fuller, K. Luther, and C. Pearce. 2009. An Empirical

Study of Cognition and Theatrical Improvisation. In *Proceeding of the Seventh ACM Conference on Creativity and Cognition*, 117–126. Berkeley, CA.

Mateas, M., and A. Stern. 2002. “A Behavior Language for Story-Based Believable Agents.” *IEEE Intelligent Systems* 17 (4): 39-47.

O’Neill, B., A. Piplica, D. Fuller, and B. Magerko. 2011. A Knowledge-Based Framework for the Collaborative Improvisation of Scene Introductions. In *Proceedings of the 4th International Conference on Interactive Digital Storytelling*. Vancouver, CA.

Orkin, J.D. 2007. Learning plan networks in conversational video games. MsC Thesis in Media Arts and Sciences Thesis, MIT Media Laboratory.

Roberts, D. L, and C. L Isbell. 2007. Desiderata for managers of interactive experiences: A survey of recent advances in drama management. In *Proceedings of the First Workshop on Agent-Based Systems for Human Learning and Entertainment (ABSHLE 07)*, Honolulu, Hawaii.

Sawyer, R. K. 2003. *Improvised dialogues: Emergence and creativity in conversation*. Ablex Publishing Corporation.

Schank, R.C., and R.P. Abelson. 1977. *Scripts, plans, goals and understanding: An inquiry into human knowledge structures*. Vol. 2. Lawrence Erlbaum Associates Hillsdale, NJ.

Swartjes, I. 2010. Whose Story is it Anyway? How Improv Informs Agency and Authorship of Emergent Narrative. Ph.D. thesis, University of Twente, Enschede, The Netherlands.

Thue, D., V. Bulitko, M. Spetch, and T. Romanuik. 2010. “Player agency and the relevance of decisions.” In *Proceedings of Third International Conference on Interactive Digital Storytelling*: 210–215, Edinburgh, Scotland.

Thue, D., V. Bulitko, M. Spetch, and E. Wasylishen. 2007. Interactive storytelling: A player modelling approach. In *Proceedings of Third Annual International Artificial Intelligence and Interactive Digital Entertainment Conference,* Stanford*, CA*.

Tomaszewski, Z., and K. Binsted. 2007. The limitations of a Propp-based approach to interactive drama. In *Intelligent Narrative Technologies: Papers from the AAAI Fall Symposium*. Arlington, VA.

Young, R. M, M. O Riedl, M. Branly, A. Jhala, R. J. Martin, and C. J. Saretto. 2004. “An architecture for integrating plan-based behavior generation with interactive game environments.” *Journal of Game Development* 1 (1): 51–70.

Yu, H., and M. O. Riedl. 2012. A Sequential Recommendation Approach for Interactive Personalized Story Generation. In *Proceedings of the 11th International Conference on Autonomous Agents and Multi Agents Systems*. Valencia, Spain.

Zhu, J., K. Ingraham, and J. Moshell. 2011. “Back-Leading through Character Status in Interactive Storytelling.” *Proceedings of Fourth International Conference on Interactive Digital Storytelling*: 31–36. Vancouver, Canada.