

Pharaoh: Conceptual Blending of Cognitive Scripts for Computationally Creative Agents

¹Rania Hodhod, ²Brian Magerko

¹TSYS School of Computer Science, Columbus State University, University Avenue, Columbus, Georgia 31907 USA

²ADAM Lab, Georgia Institute of Technology, 85 5th Street, Atlanta, Georgia 30332 USA

hodhod_rania@columbusstate.edu; magerko@gatech.edu

Abstract

Improvisational acting is a creative group performance where actors co-construct stories on stage in real-time based on actors' perceptions of the environment. The Digital Improv Project has been engaged in a multi-year study of the cognitive processes involved in improvisational acting. This better understanding of human cognition and creativity has led to formal computational models of some aspects of our findings. In this work, we consider enriching AI improv agents with the ability to improvise new nontraditional scenes based on existing social cognitive scripts. This paper shows how the use of Pharaoh -a context based structural retrieval algorithm for cognitive scripts- and simple blending rules can help digital improv agents to create new interesting scenes. The paper also provides an illustrative example at the end.

Introduction

Improvisational acting is a creative group performance where actors co-construct stories on stage in real-time based on actors' perceptions of the environment. We have seen in our socio-cognitive studies of improvisational actors that human improvisers often use their knowledge and past experience to co-create a new scene and that cognitive scripts are often employed in the co-creation of improvised scenes (Magerko et al., 2009; Magerko & O'Neill, 2012). Cognitive scripts are the symbolic basis for representing behavioral task and domain knowledge. They are defined as a recurrent spatial structure that gives coherence to our experience (Johnson, 1987). The question, in this conception, becomes: how can we enable AI agents to create new interesting improvised scenes?

Virtual improvisational theatre has been the focus of research in digital improv systems. The Computer-Animated Improvisational Theater (CAIT) is one example

in which users direct computer "characters" with abstract instructions and constraints. The characters worked from pre-authored narrative to improvise behaviors that follow the directions, express their personal styles, and meet other objectives (Hayes-Roth et al. 1995). In the Improv system (Sharma et al., 2010), virtual animated avatars could be scripted to enact a scenario giving the appearance of believable improvisational performances. However, none of these systems applied a deep understanding of how professional actors perform improvisation, nor have any of these systems provided the improv agents with the ability to 'independently' create new scenes, which is the focus of this paper.

As we mentioned earlier, improvisational acting requires past experience and successful retrieval of related experiences to be reused or blended in a way that enriches the current experience. This paper describes the use of cognitive scripts as social cognitive constructs and Pharaoh (a context-based structural retrieval algorithm) (Hodhod et al., 2013) to allow improv agents to recall past similar experiences and utilize them to construct new scenes.

Cognitive Scripts as Social Cognitive Constructs

A cognitive script is a schema that describes an organized pattern of thought or behavior. In fact, stories provide a good source of common social experiences that can be conceptualized in the form of cognitive scripts. Accordingly, we collected a number of stories using Mechanical Turk and used them to build a corpus of cognitive scripts. These scripts aim to provide the agent with various social experiences that can be blended to create new meaningful, hopefully interesting, scripts.

Although cognitive scripts reveal very little about how the actions of a sequence are causally chained together and do not display the roles of objects in temporal

sequences (Chen, 2004), they successfully describe a stereotyped sequence of events in a particular context (events can be linear or multi-branched) (Luger & Stubblefield, 1998). In fact, it has been shown that this temporal sequence of events provided in cognitive scripts helps in defining the context of those scripts (Hodhod et al., 2013), which can be accordingly used by improv agents to define those scripts that share similar context with each other and consequently can make use of those scripts to come up with a new blended script.

Improvisational Acting

In an improvisational act, each improviser starts to act and build an individual mental model based on how he perceives the world around him (Magerko et al., 2009) and is guided only by sets of game rules about how a scene should be functionally performed (Johnstone, 1999; Spolin, 1963). Gradually, along the scene, improv actors start to develop common beliefs forming what is known as a shared mental model (Hodhod & Magerko, 2012).

Improv actors normally negotiate their shared mental model (i.e. shared common beliefs about the improvised world) solely through performative actions in the ongoing scene rather than with explicit communication about the model (Fuller & Magerko, 2010). Improvisers rely on their past experience to pick an appropriate script from their long term memory to improvise. Generally, this may involve swinging back-and-forth between varieties of social cognitive scripts, hence enriches the actor's current experience. Improvisers use conceptual blending to create new interesting scenes by using one or more social cognitive scripts. For example, since it is easy for human improvisers to recognize the resemblance between the dating script and interview script, they can borrow/adapt events/structures from one script and use them in another script.

In this paper, we present a two-step technique that would allow digital improv agents to exhibit creative behavior. The first step involves the use of Pharaoh (context-based structural retrieval algorithm) and the second step involves the application of blending rules to create a blended script.

Pharaoh (Context-Based Structural Retrieval Algorithm)

This work aims to use Pharaoh and cognitive social scripts to foster creativity in improvisational agents. Our aim is to allow the improv agents to make use of past experiences and come up with new experiences. Blending is one way to obtain new and/or interesting experiences. Blending

requires the presence of two input domains, in our case, the current experience (Target) and a retrieved past experience (Source). Isomorphism (one-to-one mapping) is an essential condition in the blending process as identified by Fauconnier and Turner (1996), therefore we hypothesized that the best script would be the one that holds similar events to the current script. However, isomorphism is not enough when it comes to social scripts; context is another important factor that needs to be considered in the retrieval process. For example, a 'fight' event that occurred in the beginning of a script might not hold the same context of a 'fight' event that occurred in the end of another script. Therefore, it is vital to consider the temporal occurrence of events in both scripts along in the computation of the similarity measure.

Pharaoh is a context-based structural retrieval algorithm that allows retrieval of similar cognitive scripts to a query script. Pharaoh uses the temporal links to compute the similarity between individual nodes as part of the final similarity between the two cognitive scripts under consideration. To know more about Pharaoh please refer to (Hodhod et al., 2013).

Illustrative Example

This section explains how Pharaoh provides an agent with a context similar script (Source) that it can use/blend with the current script (Target) to produce an interesting scene/act. Pharaoh computes similarities between Target and all other scripts using context, lexically-similar words and similar structure between Target and each of the scripts in the agent's memory. The most similar script (i.e. script with highest similarity) is retrieved as Source, see Table 1. For more information on how Pharaoh works please see (Hodhod et al., 2013).

Pharaoh retrieved the *interview* script as the most similar script since it has the highest similarity value to the *dating* script. Target and Source can be used now by the improv agent to construct a blended scene using projections from both scripts. According to Fauconnier and Turner (1998) projections to the blended space are partially selective; not all elements from the inputs are projected to the blend. This requires the presence of projection rules that decide on what projections stay in the blended space and what would be disregarded. In the meantime, we are using similar rules to those used in the cognitive system, Sapper (Veale & O'Donoghue, 2000), that is to keep the structure (skeleton) of one script and either move new events to that script or change some constructions of other events, such as replacing drinks with tickets in the buying event. The effect of applying this rule can be seen in Figure 2.

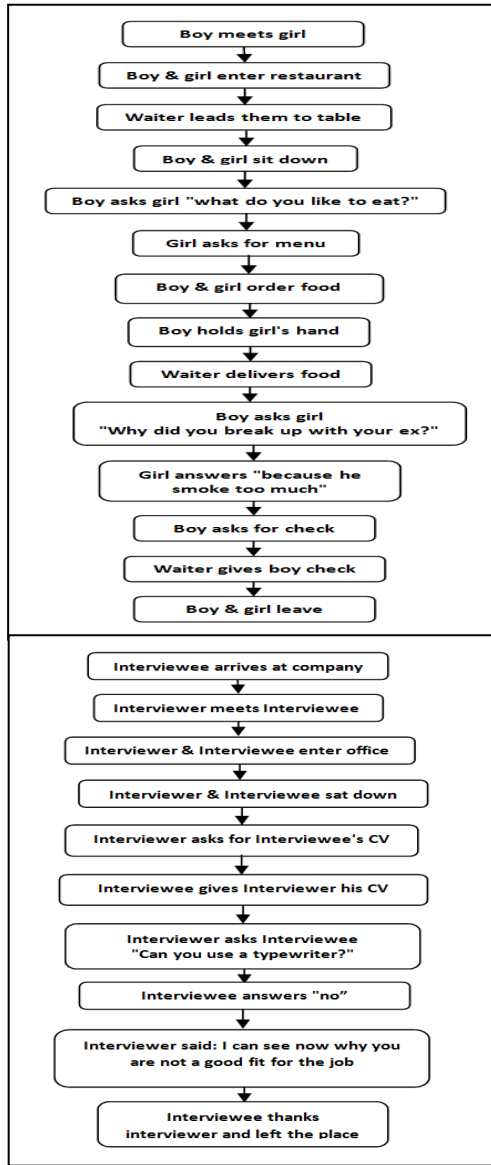


Fig.1: Linear paths from the dating and interview scripts

The blend in Figure 2 tells the following story: couple goes to the restaurant; boyfriend asks girlfriend “what do you like to eat”; girlfriend asks for the menu; boyfriend holds girlfriend’s hand; boyfriend asks girlfriend “can you use a typewriter?”, girlfriend: “no”, boyfriend: “I can see now why you are not a good fit for the job”, girlfriend thanks boyfriend and left.

What actually happens in the new script is that the agent decided on when to start the blend by looking for a least common parent node between Target and Source (in this case, the ‘sat-down’ event). All the events below this node are transferred to Target, but with the substitution of the mapped attributes in those events. For example,

‘interviewee’ is substituted by ‘girl’ and ‘interviewer’ is substituted by ‘boy’. Further blending can take place by setting the new blend as Target and look for another Source that can be used to extend the script, if needed.

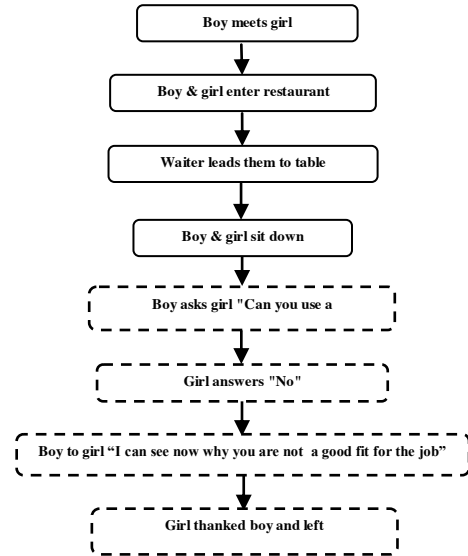


Fig.2: Blended scrip

Discussion

Imagine an improvised scene in which two improv actors adopt two different scripts and each actor is following his script (i.e. they are not on the same page yet). In order for the actors to achieve consensus, a conceptual change is required in which one actor needs to agree with the other actor via adopting his script. Such conceptual change depends on two factors: first, the extent to which the two relevant scripts differentiate from each other; and second, what kinds of cognitive mechanisms are available for eliminating these differences (Chen, 2004). Pharaoh can successfully handle the first factor. Pharaoh is able to provide the similarity values for each script in the corpus and the query script, in addition to mapping corresponding events. The second factor proposed by Chen is addressed via the use of repair strategies that allow the actors to get rid of the current divergence and reach cognitive consensus (Fuller & Magerko, 2010; Hodhod & Magerko, 2012; Magerko et al., 2011). Allowing improv agents to possess those capabilities would be considered a big step not only in field of interactive narrative, but more broadly in computational creativity.

The challenge in retrieval of cognitive scripts appears in the temporal precedence information held in them and which should be considered in the retrieval process in order to preserve the social context of the scripts. Retrieval of similar cognitive scripts is the first step in achieving a computational blending model for social constructs.

Studies and analyses of blending have been carried out in areas such as sign language (Liddell, 2000), music theory (Zbikowski, 1999), cinema (Veale, 1996), humor (Coulson et al., 2006), design (Ribeiro et al., 2003), and poetry (Harrell, 2007). However, blending studies is underestimated in the improvisation domain. This paper presents two-step blending methodology that can be used in the digital improvisation domain.

Conclusion

Digital improvisation is a complex and challenging domain where many mental processes are involved as such understanding and negotiation of mental models, recalling of past experiences and blending two or more of them to produce/use in a new scene/situation. Enriching digital improv agents with mental capabilities, such as blending has not been investigated before.

The work done in this paper helps to gain a more comprehensive understanding of the practical construction of cognitive social scripts and the blending process might occur on them as well as draw attention to techniques worthy of further examination.

References

- Chen, X. 2004. Scripts and Conceptual Change. In P. Li, X. Chen, and H.X. Zhang (Eds.). *In Science, Cognitive, and Consciousness*, Nanchang (pp. 96-117).
- Coulson, S., Urbach, T. P., & Kutas, M. 2006. Looking back: Joke comprehension and the space structuring model. *Humor-International Journal of Humor Research*, 19(3), 229-250.
- Fauconnier, G., & Turner, M. 1996. Blending as a central process of grammar. In Goldberg, A. E. (Ed.). *Conceptual structure, discourse, and language*. Stanford, CA: CSLI Publications (pp.113-131)
- Fauconnier, G., & Turner, M. 1998. Conceptual integration networks. *Cognitive science*, 22(2) (pp. 133-187).
- Fuller, D., & Magerko, B. 2010. Shared mental models in improvisational performance. *Proceedings of the Intelligent Narrative Technologies III Workshop*, INT3'10 (pp. 1-6). Monterey, CA: ACM.
- Harrell, D. F. 2007. GRIOT's Tales of Haints and Seraphs: A Computational Narrative Generation System. In N. Wardrip-Fruin and P. Harrigan (Eds.). *Second Person: Role-Playing and Story in Games and Playable Media*. Cambridge, MIT Press.
- Hayes-Roth, B., Sincoff, E., Brownston, L., & Lent, B. 1995. Directed improvisation with animated puppets. *Proceedings of CHI 95 Conference Companion* (pp. 79-80).
- Hodhod, R., & Magerko, B. 2012. Reaching Cognitive Consensus with Improvisational Agents. *Proceedings of the 8th Annual AAAI Conference on Artificial Intelligence and Interactive Digital Entertainment*. Palo Alto, CA.
- Hodhod, R., Magerko, B., & Gawish, M. 2013. Pharaoh: Context-Based Structural Retrieval of Cognitive Scripts. *International Journal of Information Retrieval Research (IJIRR)*, 2(3) (pp. 58-71).
- Johnson, M. (1987). The body in the mind: The bodily basis of imagination, reason, and meaning. *The body in the mind: the bodily basis of imagination, reason and meaning*. Chicago: University of Chicago Press.
- Johnstone, K. 1999. *Impro for Storytellers* (1st ed.). New York: Routledge.
- Liddell, S. K. 2000. Blended spaces and deixis in sign language discourse. *Language and gesture*, 2, Cambridge: Cambridge University Press (pp. 331 - 357).
- Magerko, B., Dohogne, P., & Fuller, D. 2011. Shared Mental Models in Improvisational Digital Characters. *Proceedings of the 2nd International Conference on Computational Creativity* (pp. 33-35). Presented at the ICC3 2011, Mexico City, Mexico.
- Magerko, B., Manzoul, W., Riedl, M., Baumer, A., Fuller, D., Luther, K., & Pearce, C. 2009. An Empirical Study of Cognition and Theatrical Improvisation. *Proceeding of the Seventh ACM Conference on Creativity and Cognition* (pp. 117-126). New York: ACM.
- Magerko, B., & O'Neill, B. 2012. Formal Models of Western Films for Interactive Narrative Technologies. *the LREC 2012 Workshop on Computational Models of Narrative*. Istanbul, Turkey.
- Ribeiro, P., Pereira, F. C., Marques, B., Leitao, B., Cardoso, A., Polo, I. I., & de Marrocos, P. 2003. A model for creativity in creature generation. *Proceedings of the 4th Conference on Games Development (GAME ON'03)* (pp. 170-175).
- Sharma, M., Ontanon, S., Mehta, M., & Ram, A. 2010. Drama management and player modeling for interactive fiction games. *Computational Intelligence*, 26(2), (pp. 183-211).
- Spolin, V. 1963. *Improvisation for the theater: A handbook of teaching and directing techniques*. Northwestern Univ Pr.
- Veale, T., & O'Donoghue, D. 2000. Computation and Blending. *Cognitive Linguistics* 11, 3(4) (pp. 253-282).
- Veale, T. 1996. Pastiche: A Metaphor-centred Computational Model of Conceptual Blending, with special reference to Cinematic Borrowing. *Manuscript.[Available from <http://blending.stanford.edu>].*
- Zbikowski, L. M. 1999. The blossoms of 'Trockne Blumen': Music and text in the early nineteenth century. *Music analysis*, 18(3) (pp. 307-345).