Creating an Artificially Intelligent Director (AID) for Theatre and Virtual Environments

(Doctoral Consortium)

Christine Talbot
Game Intelligence Group
University of North Carolina at Charlotte
ctalbot1@uncc.edu

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1. BACKGROUND

Historically, most virtual character research focuses on realism, interaction with humans, and discourse. The majority of the spatial positioning of characters has focused on one-on-one conversations with humans or placing virtual characters side-by-side when talking. These rely on conversational space as the main driver (if any) for character placement.

Robotics is more of a physical representation of characters and by its nature relies on spatial positioning of objects. Research in this area has involved providing directions to robots or robots providing directions to humans. The main concern is how to describe the spatial positioning of objects with respect to other items in the environment [5, 16]. Some robotics research has worked on incorporating robotics into the theatre, but its purpose has been around pre-recording humanistic movements for replaying in other scenarios [9].

Psychologists have spent a lot of time digging into the meanings behind key prepositions that describe spatial concepts, such as *in*, *on*, *near*, and *far* [4, 7]. This is useful in helping us to understand spatial instructions given by humans or within play-scripts for characters in theatre. Research has also been performed around comfortable conversational space, grouping of people in conversation, and what may trigger someone to change position or move [6, 10].

Movies and games rely on motion capture (mocap) files and hardcoded functions to perform spatial movements. These require extensive technical knowledge just to have a character move from one place to another. Other methods involve the use of Behavior Markup Language (BML), a form of XML which describes character behaviors. BML Realizers take this BML and performs the requested behavior(s) on the characters. This too requires a fair amount of low-level detail and knowledge to write.

Theatre, movies, and television all utilize a form of play-scripts, which provide detailed information on what the character must do and when for a particular scene. These involve annotations, in addition to the speech, which identify scene setups, character movements, and entrances/exits.Many game writers have a background with play-scripts, plus they are created in standard natural language, so these become a great front-end for specifying character movements. Theatre also provides some useful rules of thumb for actor placement onstage which provides good positioning for a scene [2].

With this research, we focus on creating an AI Director to spatially position characters in a virtual theatre or other virtual environment, utilizing psychology's spatial preposition research findings, natural language processing, robotics influenced work, play-scripts, and theatre rules.

2. PREVIOUS WORK

In our previous work [12], we utilized play-script annotations to place virtual characters onstage in the right place at the right time. These annotations, along with some basic natural language processing, saved us over four hours of explicit directions encoding by eliminating the need to write low-level Behavior Markup Language (BML) code to describe the movements of the characters. It provided the ability to position characters correctly on average 75% of the time, per our baseline of Sir Gielgud's Broadway production of Hamlet in 1963 [3]. The remainder of the time the characters performed their own interpretation of the annotations and applied basic theatrical rules to their performance.

That work was followed by the introduction of a rules engine for the AI Director. This rules engine incorporated theatrical rules, conversational rules, character grouping rules, and general rules. The inclusion of the rules engine increased our performance for character positioning to 89% accuracy [15] with our existing baseline of Hamlet. The main outlier from this work appeared to be due to one actor's interpretation, or whim, during the performance.

This led us to conjecture that perhaps there is something in what the character is saying which caused the actor to perform this "extra", unannotated movement. We took the entire Hamlet [11] play-script and captured all the movements performed within the play. Using several standard machine learning techniques, we attempted to learn if certain phrases would result in a specific movement, or even just a movement in general [13]. Unfortunately, we were unable

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to learn any of this information from what the characters were saying, partly because of the nature of Shakespeare's writing (iambic pentameter), and partly because of our approach's inability to effectively capture the relationships between the words. We were encouraged by this work because it indicated that these unannotated movements may not be in what is being said, but due to introducing a human.

3. CURRENT WORK

Currently, we are working on incorporating force-directed graphs for appropriately positioning characters onstage as a result of a human-controlled character's position. Force-directed graphs have been used to visualize graph data in many different disciplines, including social networks. They provide a symmetrical layout of the nodes of the graph based on both attractive and repellent forces which play off of each other. New applications and approaches for these graphs continue to be pursued, especially for very complex graphs.

Our use of these algorithms focuses on the symmetry that comes with their use, as well as the ability to adjust the forces based on information within the graphs. We approach the layout of the characters on the stage, along with their connections to their marks and any props onstage, as individual nodes within the graph. Each character, prop, audience, and mark is connected to their relevant node, each with a different force based on the relationship between them.

Character to character relationships are based on the closeness or friendliness of the two characters with each other. Relationships between a character and its mark are based on how long it has been since the character was instructed to move to that point. Ties from each character to the audience are maintained for helping to ensure visibility of every character onstage based on their position (i.e., no character occludes visibility to another character). Finally, a centralized node is utilized to help organize the character groups of three or more characters into a more circular shape and acts as a centroid for the group. This creates a more natural shape to the spatial arrangement of characters.

These provide us with a dynamic and more human-consistent way of adjusting characters due to a human-controlled character's movements onstage, regardless of whether they are in-line with the play-script, missing the mark, or not moving at all. Since we do not have annotations on what the human-controlled character will do at any particular time, and we cannot just move the human character where we want them to be, we need these adjustments to be dynamic to ensure appropriate blocking of the play onstage.

4. FUTURE WORK

Next steps in this research will focus on camera and audience visibility optimizations in conjunction with our prior work on spatially locating characters onstage. The vantage point of several cameras or locations in the audience will be chosen as the "best seats in the house" and will focus on providing ideal visibility and layouts from those vantage points. Upon completion and evaluation, we will next pursue several user studies to evaluate the effectiveness of our entire architecture for an AI Director to block a play versus a real director's blocking of the same play. Evaluations from the theatre departments, as well as theatre-goers will be instrumental in determining our success.

Once completed, this work will be useful in assisting directors, game writers, and other virtual environment authors with placing virtual characters within their environment, whether it is a stage or a more general virtual environment.

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