Toward Assisted Authoring of Social Skill Scenarios for Young Adults with High Functioning Autism

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Abstract

Individuals with autism spectrum disorders (ASD) have very individualistic needs, abilities, and are surrounded by very different social contexts. Consequently, special education and therapeutic interventions often need to be adapted to a particular individual. We are interested in developing systems that can help adolescents with high-functioning ASD (HFASD) rehearse and learn social skills with reduced aide from parents, guardians, teachers, and therapists. However, we recognize that there is not a one-size-fits-all solution to social skills training for young adults with HFASD. In this paper we present a social skills learning game that utilizes techniques from intelligent tutoring systems and interactive entertainment. To overcome the limitations of generalizability, we further describe ongoing work toward artificial intelligence agents that assist parents, guardians, teachers, and therapists with the development of learning content tailored to individuals with HFASD.

1 Introduction

Individuals with autism spectrum disorders (ASD) have very individualistic needs, abilities, and are surrounded by very different social contexts. Consequently, special education and therapeutic interventions often need to be adapted to a particular individual. This makes education and intervention for ASD costly and time-consuming since it often requires working with the individual frequently on a one-to-one basis. In this paper we explore AI applications that help people – parents, guardians, teachers, therapists – help their clients and loved ones with ASD.

Specifically, we are interested in developing systems that can help adolescents with high-functioning ASD (HFASD) rehearse and learn social skills with reduced aide from parents, guardians, teachers, and therapists. We target adolescents with HFASD, because they are underrepresented with respect to applicable therapies and are more likely to have complex social skill needs. For example, an adolescent with HFASD may want to go to a movie theatre without the assistance of a parent or guardian. Can a software system help that individual prepare for that social context, and furthermore help the individual learn a set of social skills that can be successfully generalized to the actual social setting?

We recognize, for the reasons stated above, that there is not a one-size-fits-all solution to social skills training for young adults with HFASD. Our challenge is to design and develop software systems that can automatically be adapted to the particular educational and therapeutic needs of individuals with ASD. Until that challenge is overcome, systems that can help individuals with autism rehearse and learn social skills must rely on human-authored material. This phenomenon is also prevalent in non-computational social skill learning aides such as Social Stories™ [Gray, 1995], the Power Card [Gagnon, 2001], and video modeling. However, working in the domain of computer-aided instruction provides two advantages. First, individuals with autism are often drawn to computers. Indeed there is a general call for more technologies that specifically target social skills training [Putman and Chong, 2008]. Second, intelligent systems can be developed that, given different input parameters, achieve different social skill learning effects, tailored to an individual's needs and abilities.

In this paper, we have two goals. First, we describe an approach to social skills training for young adults with HFASD. Our system allows young adults with HFASD to role-play through social scenarios – such as going to the movie theatre – in a way that we believe may lead toward generalization (e.g. learning). Second, because the social skill learning system is tied to very specific scenario data, we introduce work to assist parents, guardians, teachers, and/or therapists with the authoring of new, individualized scenario content.

The paper is arranged as follows. First, we describe related work from the domains of special education, autism intervention and occupational therapy, and computer-aided education. In Section 3, we describe our scenario-based social skill learning system, provide an example walkthrough of a scenario, and describe plans for evaluation. In Section 4, we describe two intelligent scenario authoring technologies currently being investigated.

2 Background and Related Work

More than a half-century ago Kanner [1943] and Asperger [1944] first described individuals with autism spectrum disorders (ASD) as perplexing individuals. The Diagnostic and Statistical Manual, Fourth Edition, Text-Revised (DSM-IV-TR) [APA, 2000], used by practitioners and researchers in the United States, lists five subtypes of ASD under the category of Pervasive Developmental Disorders: Rhett's disorder, childhood disintegrative disorder, autistic disorder (autism), Asperger disorder (Asperger syndrome), and pervasive developmental disorder, not otherwise specified (PDD-NOS). Characteristics commonly associated with all of the disorders include deficits in the areas of communication and socialization, accompanied by restricted interests and repetitive behaviors. The complexity of the disorders included in the spectrum allow for individuals with ASD to be a heterogeneous group. It is possible for each person to present with a unique combination of characteristics with varying degrees of impairment. It is generally accepted that this population presents tremendous challenges for personnel responsible for planning educational services.

Some individuals present with mild characteristics and exhibit no intellectual disabilities. These high-functioning individuals with ASD are typically identified with high-functioning autism (HFA), AS, or PDD-NOS. These individuals qualify for special education services when characteristics of their disorder interfere with learning in the general education setting.

Impaired social functioning is the central feature of all HFASD. A lack of social competency can result in significant difficulties in daily living, academic achievement, and poor adult outcomes related to employment and social relationships [Klin and Volkmar, 2003; Howlin, 2003]. Researchers and educators have attempted to develop and implement interventions that lead to social competency. However, the results of one recent meta-analysis suggest that school-based interventions were minimally effective for children with ASD [Bellini *et al.*, 2007]. Some researchers conclude that, while many of the social skills interventions promoted skill acquisition, there was little evidence that the skills generalized to other settings [Bellini *et al.*, 2007; Elder *et al.*, 2006].

Social skills training interventions are an important part of the education of children with Asperger's syndrome and high functioning autism. Due to the lack of a recognized best practice, educators use a variety of techniques, often in combination, to teach these skills. Some common non-technological interventions are Social Stories™ [Gray, 1995], the Power Card [Gagnon, 2001], and video modeling. One approach to social skill training that uses a combination of technogical and non-technological practices is the *Junior Detective Training Program* [Beaumont and Sofronoff, 2008], which consists of group social skills training, parent training, teacher hand-outs, and a computer game. The social competence that was sought was operationally defined as engaging in reciprocal positive interactions with others and responding appropriately to others' behavior. This program was tested with 44 students between the ages of 7 and 11. Parent-reported social skills of those in the treatment group improved from the clinically significant range to within normal range. These findings reinforce the importance of developing such software systems, and show that they are indeed an effective way to teach social skills.

The "I can Problem-Solve" program [Bernard-Opitz *et al.*, 2001] is a software system used to expose children between the ages of 5 and 9 to animated solutions to problem social situations. In this intervention, static and animated solutions were explained to the child by a trainer during training sessions. Children were then asked to suggest new solutions, and were reinforced with a variety of sensory or natural conditions (such as lines and spirals or a child jumping on a trampoline respectively). Children with ASD produced fewer solutions than neuro-typical children, but the number of solutions produced by children with ASD increased with repeated usage of the software.

In a review of peer-reviewed social skill interventions varying from role-playing tasks, to technology interventions, Rao et al. [2008] make several recommendations for maximizing the impact of social skill intervention. One recommendation is that social skill interventions should target children in the higher functioning range of the autism spectrum. Another important factor identified by Rao et al. is the content; Rao et al. found that a key aspect lacking in the outcome of the studies reviewed was *generalizability* of the skills being learned beyond the training setting. This is a key factor in the design of our system, as we intend to present the participants with scenarios they are likely to encounter in real life.

Other experimental technological approaches to autism intervention include virtual reality simulations, and virtual peers for language learning. Tartaro and Cassell [2008] and Bosseler and Massaro [2003] use virtual animated characters to invite language learning. Tartaro and Cassell in particular cite the advantages of using a virtual human over actual human interactors: virtual humans have the patience to interact with individuals with ASD. Parsons et al. [2004] created a virtual reality environment to familiarize individuals with autism with social settings. This work involved learning to identify roles and procedures in a social environment. Our work differs by simulating the progression through a social situation in which the individual with ASD must engage in social skills.

3 A Computer-Aided Social Skills "Game"

For our approach to computer-aided social skills education, we adopt techniques from entertainment technology research and *coached problem solving*. Coached problem solving [vanLehn, 1996] is an approach to tutoring in which a tutor and student collaborate to solve a problem. During this process, initiative shifts back and forth: as long as the student is taking correct steps, the tutor simply indicates agreement or remains silent. If the student becomes stuck or requests help, the tutor provides hints to get the student back on a correct solution path. A technology related to coached problem solving is *model tracing*, is which the system attempts to track the learner's at the cognitive level [Andeson *et al.*, 1995] according to a model of correct and incorrect executions of a target skill. A common trait of model tracing systems is *immediate feedback*, meaning that when the learner makes an error, the system will quickly let the learner know about the mistake and help him or her repair it. Generally, the student is not allowed to continue without fixing the error.

Model tracing was developed for skills in which there are definite right and wrong procedures. For example, model tracing has been used in mathematics and physics tutoring systems. Model tracing cannot be applied to social skills, which are ill-defined, highly dependent on a particular context, and typically have numerous non-incorrect instantiations. However, the principles behind model tracing can be applied to social skills. A system can monitor an individual in a specific social context and attempt to assess whether an individual's actions are appropriate or not, and provide feedback and guidance through the situation. For many very specific social situations, such as going to a restaurant, going to a movie theatre, etc. the task provides a metric on whether an individual's actions are productive, unproductive, or counter-productive.

Considering model tracing as applied to social skills, paths resemble narratives, where a narrative is simply defined as a sequence of actions is a description of how a situation unfolds. All the paths taken together resemble a *branching story*. A branching story is a graph structure such that each node represents a segment of narrative and a choice point. The canonical branching story systems are Choose-Your-Own-Adventure novels. However, recent research has resulted in a spate of computational approaches to branching stories (see [Riedl et al., 2008; Roberts et al., 2008] for a review of many interactive story systems). These systems concern themselves with providing appropriate narrative content to a user immersed in an interactive, virtual story world by monitoring what the user does and responding by animating computer-controlled avatars. Our system can be considered an interactive narrative where each possible narrative is based on productive, unproductive, and counter-productive possible executions of social skills in specific contexts. However, instead of animating avatars in a virtual world, our system responds to the user by stepping through a branching picture book of still shots. Our proof-of-concept system is set in the context of going to a movie theatre.

3.1 System Description

In our system, the user – a young adult with HFASD – is tasked with completing a given situation, such as watching a movie in a movie theatre. The system presents the situation through picture book style images that correspond to the specifics of the situation. At every given step the system presents the user with two or more possible actions he or she can make and the user indicates which action he or she chooses. In response, the system updates the image to correspond to the new situation. Currently the images are still and the system flips to the new image once and action is taken. However, in future versions, we envision an animated system so that the user can see the transitions from one state in the situation to the next. At this stage we are uncertain how animation will impact our target user group; we currently take our inspiration from Social Stories™ [Gray, 1995], which uses cartoon figures and text-bubbles to represent speech. The options for action provided to the user are presented explicitly in randomized sequential order, indicating which button should be pressed to select that choice.

The picture book style was chosen for two reasons. First, visual symbols such as cartooning have been found to enhance the processing abilities of individuals with HFASD and to enhance their understanding of the environment [Hagiwara and Myles, 1999; Kuttler et al., 1998]. Effectiveness of cartooning has limited scientific verification, but there is growing support for presenting social information in smaller parts or "frames" to make it easier for students to process [Rogers and Myles, 2001]. Second, a cartoon style makes the specific environment in which the situation is taking place more abstract. We hypothesize that this will help individuals generalize social skills acquired when using the system because the contextual cues of when to apply certain skills will be more general. That is, we hope that any skills that are acquired will not be limited to only the visual environment presented in the software. Related to this, we have chosen to show the scenario from a first-person perspective, so that the user sees the environment from the same perspective as he or she might see a real environment. Further, this eliminates any confusion that could arise from seeing one's avatar from an unfamiliar perspective.

The current proof-of-concept system is written in Flash.

Errorless Learning

Choices can be "optimal," "sub-optimal," or "undesirable."[1] We follow an approach of *errorless learning*, meaning that the learner is not allowed to fail. Actions that are undesirable result in the system taking the initiative to provide feedback and to allow the user to try again (with the last choice removed). Errorless learning is often used with individuals with HFA to avoid the possibility that they acquire incorrect skills; individuals with HFA are extremely prone to repetition so it is essential to avoid reinforcing anything other than the desirable execution.

Anticipating the Unanticipated

Social situations do not always unfold as planned. It is unrealistic to only rehearse social skills in ideal environments. Consequently, for some individuals, it may be beneficial for the situation to include complications. For example, in the movie theatre experience, the movie theatre could be out of tickets for the individual's preferred show. However the fact that not all individuals with HFASD have the skills or autonomy required to go to the movies without a chaperon further motivates the need for highly customized content.

3.2 Example

Our first proof-of-concept system employing the methods described above uses the scenario of seeing a show at a movie theatre with a friend. The branching scenario starts

[1] In intelligent tutoring systems literature, these are often referred to as "green," "gray," and "red" paths.

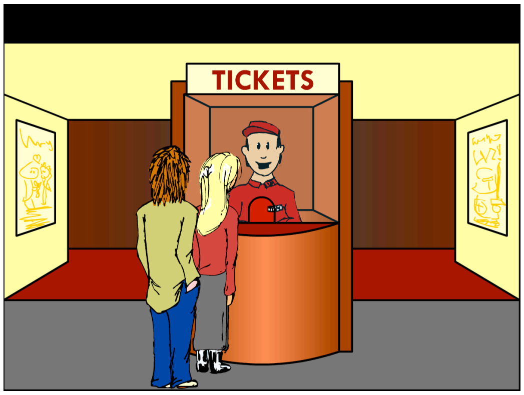

Figure 1(a). Waiting in line.

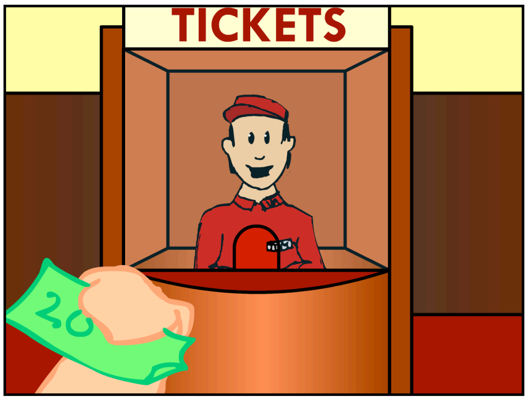

Figure 1(b). Interacting with the sales clerk.

Figure 1(c). An encounter with a security guard.

Figure 1. Screenshots from the prototype social skills learning system. These screens show what the user may see as he or she navigates through the process of going to the theatre.

with the user's avatar being dropped off by a parent or guardian at a movie theatre. The scenario progresses through several situations requiring social skills. We adopt the term *obstacles* [Bruner, 1990; Park, 2005] because these situations prevent the user from immediate goal achievement. The social skills we are most interested in are not operationalized in the traditional sense (e.g., properly responding to a greeting), but are defined by successful navigation beyond the obstacle. The first obstacle is purchasing a ticket for a movie, which involves social skills of waiting in line, asking for a ticket to a particular show, and then exchanging money. Other obstacles may involve passing through security and finding a seat. For individuals for whom practicing handling unanticipated obstacles, our proof-of-concept scenario also includes the situation in which the show of choice is sold out. In this circumstance, the user may choose between purchasing a ticket to a different show time, a different movie, or waiting to be picked up by his or her parent or guardian.

3.3 Testing the Approach

We envision our system having two applications. The first is rehearsal. Individuals with autism prefer environments with high degrees of certainty, repetition, and predictability. Dealing with others in social settings introduces a high degree of uncertainty for those with autism. It is common for individuals with HFA to rehearse for situations before hand. Unfortunately, rehearsal is not always effective as those with autism might learn cues specific to only one environment or one person [Heflin & Alberto, 2001]. Our cartoon-style approach is meant to help avoid learning of incorrect cues, but we don't yet know if they will still learn cues only appropriate to the computer system. Therefore, we need to know whether our branching scenario approach will facilitate generalization of social skills. If generalization can occur, the second application would be as a general-purpose educational framework.

To determine whether branching scenarios can be effective for learning and generalizing social skills, we have developed a pilot study in which the proof-of-concept system is used by young adults (aged 17-19) with Asperger's Syndrome, HFASD, or PDD-NOS from a nearby special-needs school. We will use the *Test of Problem Solving for Children and Adolescents (TOPS2-A)* [Griswold *et al.*, 2002], to pre- and post-test participants. *TOPS2-A* has been shown to correlate to actual problem-solving ability [Griswold et al., 2002]. Further, *TOPS2-A* tests problem-solving ability using questions involving social situations. None of the questions on *TOPS2-A* are directly related to the scenario in our proof-of-concept system. Participants will be randomly assigned to one of two groups: the active group or wait-list control group. The participants in the active group will use the computer-aided social learning system as an *intervention*. The participants in the wait-list use the computer system, but only as an additional test of system performance. That is, our experimental design allows between-group metric assessment. At the time of writing, the first experimental session has not yet been performed. Our methodological procedure is as follows.

Questionnaire for parents

Parents will fill out a brief questionnaire to let us know about their child's previous assessments, medications he might be taking, his birthday, how much time he usually spends on the computer, and so forth.

Pre-test
The TOPS2-A test will be administered to subjects individually by researchers in a quiet area. A researcher will read a passage aloud while the participant reads the same passage silently. The researcher will ask questions about the passage and instruct the participants to answer verbally.

Active group Intervention
If the participant is in the active group, he or she will interact with the computer-aided social learning system. The participant will sit at a computer that has an Internet browser, a monitor, a mouse, and headphones. He or she will participate in a training session that demonstrates how to use the computer program. The system will present a series of problems in a social setting. Possible solutions will be presented. The participant will be asked to choose the best solution. When he or she chooses an appropriate solution, the story continues. The particpant will receive points while playing. As a reward, the participant can use points earned towards playing other games on the computer. The participant will use the computer for 3 consecutive days to solve problems in 3 different stories. Each computer session will last approximately 30 minutes.

Post-test 1
A researcher will administer the *TOPS2-A* to all of the participants again. The same procedures used during the pre-test will be used during the post-test. Additionally, participants in the active group will circle ratings on a brief survey to indicate what they thought about the computer program and about being in a study.

Wait-list control group
If the participant is in the wait-list group, he or she will interact with the computer-aided social learning system *after the study is completed with the individuals in the active group intervention*. The same procedures will be used for the wait-list control group that were used for the active group.

Post-test 2
When the wait-list control group has completed the problem-solving tasks in 3 stories, the researcher will administer the *TOPS2-A* to the members of the wait-list control group again. The same procedures used in the pre-test and post-test 1 will be used.

4 Toward Overcoming the Content Authoring Bottleneck

The current proof-of-concept system has exactly one scenario: going to a movie theater. The content alone took 80 person hours to develop. This does not include time to learn Flash or the time to import the art assets into Flash. It is well-established that branching story content increases content authoring time geometrically with the number of branching points and the number of possible branches per point [Bruckman, 1990; Riedl and Young, 2006]. That is, for every point in which the user can make a decision, the amount of content that must be produced is multiplied by the number of decisions that can be made (assuming no loops). Our simple proof-of-concept scenario – going to the movie theatre – required 25 images to be produced.

For our system to be useful, we must lower the bar of content authoring to the point that parents, guardians, and teachers can produce useful social skill scenarios for the individuals with HFA that they care for. In the case of our computer-aided social skill learning system, there are several complications with regard to authoring content:

- Animation – we cannot assume that our target authors have the necessary artistic abilities.
- Authoring branches – we cannot assume that our target authors will be able to set up sufficiently complicated scenarios with branching structures required to step through all the necessary permutations of situations. Further we cannot assume that our target authors will be able to create equally compelling (or error-free) content for all branches
- Pedagogical correctness – we cannot assume that our target authors know how to create scenarios that are pedagogically appropriate (for example, using errorless learning).
- Skill correctness – we cannot assume that our target authors can correctly represent the social skills that they desire others to learn

In the next sections we discuss two artificial intelligence technologies that can be used to assist with the authoring of scenario content.

4.1 Branching Scenario Authoring Assistance

The primary data structure of our system is a graph, such that each node in the graph is a situation that corresponds to an image. Directed arcs between nodes represent decisions that the individual with HFA can make at each node.

How can artificial intelligence be used to assist in the authoring of branching structures for social skill training? Anecdotally, we know that people can write non-branching narratives, but that branching structures tend to cognitively overload the human author. However, if one can describe the behavior of the system with a few number of non-branching narratives – in this case, descriptions of prototypical theatre experiences – an AI system can use this information to generate branching structures. Riedl and colleagues [Riedl *et al.*, 2003; Young *et al.*, 2004; Riedl and Young, 2006; Riedl *et al.*, 2008] describe a technique, called *narrative mediation*, for automatically generating branching narrative structures. Specifically, Riedl et al. [2008] describe an adaptation to narrative mediation in which a single prototypical non-branching narrative is provided as input to an AI algorithm that produces possible alternative branches based on a similarity metric.

Overview of Narrative Mediation
In narrative mediation, non-branching narratives are represented as partially- or totally-ordered plans. Planning has been demonstrated to be a practical technology for generat-

```
BUILD_TREE (root_plan, problem_info)
  tree ← {root_plan}
  agenda ← {root_plan}
  WHILE agenda is not empty AND max depth is not reached DO
    branches ← GENERATE_BRANCHES(first(agenda), problem_info)
    tree ← tree ∪ branches
    agenda ← (agenda - {current}) ∪ branches
  RETURN tree

GENERATE_BRANCHES (plan, problem_info)
  branches ← ∅
  threats ← CAUSAL_THREATS(plan, user_actions(problem_info))
  FOREACH interval in plan DO
    FOREACH threat in threats that affects interval DO
      b ← GENERATE_BRANCH(plan, threat, interval, problem_info)
      IF b ≠ nil THEN DO
        branches ← branches ∪ {b}
  RETURN branches

GENERATE_BRANCH (plan, threat, interval, problem_info)
  FOREACH g in negative_outcomes DO
    bad_plan ← PLAN(g)
    IF bad_plan ≠ nil THEN DO
      RETURN EXPLAIN(bad_plan)
  RETURN REPLAN(plan, threat, interval, problem_info)
```

Figure 2. The algorithm for identifying branching points and generating branches, given a prototype narrative.

ing narrative content (c.f., [Meehan, 1976; Lebowitz, 1987; Young, 1999; Riedl and Young, 2004]). Operators in a narrative plan are events in the narrative and links represent causal relationships between events (i.e., there is a link if one event is causally necessary for a temporally successive event to take place). In narrative mediation, an AI system automatically analyzes the causal structure of the narrative plan, looking for points at which a user's actions can undo causal relationships. This amounts to a set of "what-if" experiments in which the AI system proposes "what if the user were to perform action *a* at time *t*?" If the answer is that the original narrative plan could not continue, the AI system invokes a planning-based narrative generator to determine whether the narrative can be restored *if* the user were to take the hypothetical action. This alternative narrative plan is a branch designated for handling the contingency of the user's action. In Riedl et al. [2008], repaired narratives are preferred that are as similar to the original as possible. The process is recursive: each new narrative is inspected for points in which branching can occur until no new branching points are identified or until a depth bound is reached.

Authoring with Narrative Mediation

Narrative generation (c.f., [Meehan, 1976; Lebowitz, 1987; Turner, 1992; Riedl and Young, 2004]) is in its relative infancy. However, for social skills training, the goal is not to achieve dramatic effects, but to demonstrate pedagogical and skill correctness. In that respect, the desired outcome state is the successful completion of a social skill and a planner must achieve the outcome state. Our AI system requires (a) one or more prototypical narratives, (b) a description of the world in which the scenario takes place and a favorable outcome state, and (c) an operator library that enables a planner to solve social scenario goals from a range of state configurations. For now we assume that this knowledge can be engineered and may or may not include case descriptions of common ways in which social situations unfold. Scenarios are individualized by incorporating knowledge about the client – a young adult with HFA – into the world description. This forces the narrative generator to take such individualistic elements into consideration. The action template library may also be customized to account for individual abilities.

With narrative mediation, we can leverage a linear manual process of describing one or more prototypical social scenarios, and produce an exponential number of ways in which a social scenario can unfold. If the human author creates multiple linear descriptions of ways a scenario can unfold, we can create a tree with prefix matching. That is, we merge two linear narratives until an event occurs that does not match. Once we have fleshed out the tree of branching scenario paths using narrative mediation, the human author can then inspect the branching structure for errors; it is easier to edit a branching scenario than to author one from scratch. To facilitate editing, each complete narrative – a path from the initial state to the outcome state found by traversing the branching scenario graph – can be presented linearly. The process of transforming a branching narrative into *n* non-branching narratives is straightforward.

Errorless Learning Branches

The AI process we have described so far does not consider errorless learning. To account for errorless learning, we need to generate "optimal," "sub-optimal," or "undesirable" branches. The techniques described above can only generate "optimal" and "sub-optimal" narrative branches, but does not classify those branches.

To classify generated branches, we observe whether the new branch is a novel sequence for achieving the desired outcome, or whether the new branch is a minor variation of the narrative of the parent branch. Minor variations are "sub-optimal" but not "undesirable." One can think of the branch as a *repair* to the originating branch in the sense that the user has performed an action that is not the most effective for reaching the desired outcome, but is not harmful. Each "sub-optimal" branch begins with a special action that explains, with text, the reason why the action that was taken is not the best choice. Currently, we require the human author to write the explanation. However, in future work, we may be able to automatically generate the explanation by comparing the branch to the original path.

To generate "undesirable" branches, our system must do extra work. Because narrative mediation is based on planning, it only results in paths – narratives – that successfully achieve the desired outcome state. For the purpose of assisting with the authoring of social skills scenarios, we extend narrative mediation to generate undesirable branches. The modified algorithm is shown in Figure 2. Given a set of *undesirable* outcome states and for each branching point identified, we generate a plan that achieves one or more undesirable outcome states. For example, in the theatre scenario, and undesirable state would be going home without seeing a movie. For each plan found that achieves an undesirable outcome state, we provide an opportunity for explanation for why the action leading to the branch is undesirable and allow the user to try again. In the user interface, the choice leading to the undesirable branch is disabled. Again, for now, these explanations must be manually authored, but in future work we believe these explanations can be automatically generated from the undesirable branch information.

4.2 Animation Assistance

At first glance, the problem of assisting authors with animation does not seem challenging. Let us suppose that there is an authoring interface in which the human author can select from scenes and characters templates. It is not unreasonable to assume that a human content author can use such an interface to create an image to correspond to a non-branching scenario. However, because of the combinatorial explosion that comes with branching scenarios, asking a human to manually produce images for each possible narrative branch is unrealistic. However, the selection and composition of graphical templates can be automated. Elson and Riedl [2007] describe a system – Cambot – that, given a description of a scene and dialogue, selects characters, locations, and camera angles for the composition of 3D animated movies.

Cambot treats input –a script consisting of actions and dialogue with possibly incomplete location, blocking[2], view, and scene specifications – as a set of constraints that must be satisfied in order to find a sequence of shots that cover all the beats. In this case, the script is the event sequence in a narrative branch and blocking, view, and scene specifications are derived from plan operator metadata. The input constraints define a search space comprised of compatible locations, blockings, and shots. Cambot uses a combination of breadth-first search and dynamic programming to search this space to find the highest-scoring combination of locations, blockings, and shots that cover each beat. Score is computed relative to the degree of satisfaction of user-provided (or default) aesthetic constraints. The result of this process is a sequence of shots, blockings, gestures and dialogue acts, along with precise timing information, that can be sent to a visualization engine for final rendering. We envision a version of this technique for the automated graphical rendering of situations described by the human author or generated by the narrative generator. The system would be constrained to produce only first-person perspective shots with no camera movement, effectively producing the still image we currently desire for our prototype.

Conclusions

The population of young adults with high functioning autism spectrum disorder (HFASD) is growing. Many of these individuals can function effectively and autonomously, but need assistance to handle the complexities of society. We propose an approach combining intelligent tutoring with branching narrative graphs in a system for (a) rehearsal of social situations, and (b) learning to generalize non-operationalized social skills and problem solving. However, in doing so, we run into a challenge that is also common to other intervention and therapy strategies with regard to large-scale distribution: customization and individualization of interventions, therapies, and educational content does not scale. Specifically, this material must be manually configured, and it often must be administration manually. In this paper we also explore artificial intelligence approaches that may eventually lower the manual authoring burden to the point where customization and administration of interventions, therapies, and instructional materials can be handled by parents, guardians, and teachers.

[2] *Blocking* refers to the positioning and orientation of actors on a stage or movie set.

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