

## Playable Experiences at AIIDE 2017

### Mike Treanor

American University  
treanor@american.edu

### Nicholas Warren, Mason Reed, Adam M. Smith

*Proofdoku*  
University of California at Santa Cruz  
{newarren, machreed, amsmith}@ucsc.edu

### Pablo Ortiz, Laurel Carney, Loren Sherman, Elizabeth Carré, Nadya Vivatvisha, D. Fox Harrell

*Chimeria:Grayscale*  
Massachusetts Institute of Technology, Massachusetts College of Art and Design, Harvard University  
{portiz, lcarney, lsherman}@mit.edu, ecarre@massart.edu, vvnd77@gmail.com, fox@csail.mit.edu

### Paola Mardo, Andrew Gordon

*Traveler*  
University of Southern California  
mardo@usc.edu, gordon@ict.usc.edu

### Joris Dormans

*Unexplored*  
Ludomotion  
joris@ludomotion.co

### Barrie Robison, Spencer Gomez, Samantha Heck, Landon Wright, Terence Soule

*Darwin's Demons*  
Polymorphic, University of Idaho  
{brobison, tsoule}@uidaho.edu, {gome4177, heck9873, wrig8396}@vandals.uidaho.edu

#### Abstract

This paper describes the accepted entries to the fifth Playable Experiences track to be held at the AIIDE conference. The Playable Experiences track showcases complete works that make use of artificial intelligence techniques as an integral part of the player experience.

#### Introduction

The Playable Experience track at AIIDE showcases complete works that make use of artificial intelligence. While the main track and demo session at AIIDE feature novel technology, the Playable Experience track was created to recognize and celebrate applications of AI in complete works that are intended for audiences. Because of this emphasis on audience experience, the acceptance selection process for the track is more similar to a film or game festival, than to a peer reviewed conference.

The 2017 AIIDE Playable Experiences track, chaired by Mike Treanor, features five accepted entries that span a wide range of interactive genres and technological approaches:

- **Proofdoku** extends classic Sudoku play with an argumentation mechanic and hint systems powered by the AI technology of answer set programming (ASP).
- **Chimeria:Grayscale** is an epistolary interactive narrative game that implements a models of sexism in the workplace.
- **Traveler** is a voice-controlled interactive audio narrative that exposes players to the dystopian consequences of racial profiling and warrantless border searches.
- **Unexplored** is an action roguelike. Praised for its fantastic content generation, real-time combat and surprising amount of content and depth.
- **Darwin's Demons** is an arcade style space shooter in which the player battles a population of evolving aliens encoded by digital genomes.

In the section below, each of the creators discuss their works and approaches to foster novel playable experiences.

## Accepted Submissions

### Proofdoku

Proofdoku is a puzzle game that heavily leverages the AI technology of answer set programming (ASP). By interacting with an exhaustive reasoning engine, moderate to strong Sudoku players can find new depth and clarify their thinking in a game they already **love**.

In Proofdoku, players play according to the traditional rules of Sudoku with the additional requirement that they must explain their reasoning to the game. They do this by selecting a subset of the known cells that they believe to provide sufficient evidence for the unique value of an empty cell, the conclusion. ASP is used to implement several logical inference tasks that are key to supporting gameplay. Given the player’s current argument (a set of evidence cells as premises and a conclusion cell), we responsively check the validity of the argument and update a visualization of its ambiguity. By optimizing over legal arguments, we provide hints about which part of the puzzle to argue next and how to make the argument in the most concise and general way. Through feedback and hints, the game is capable of teaching players of Proofdoku new inference patterns, even ones that have not yet been discovered and named by the Sudoku player community.

Targeting a lightweight in-browser and mobile player experience, we offload the non-trivial AI reasoning workload onto machines in the cloud. Through microservice design and a combination of local and global inference caching, we achieve a design that can support millions of active players each month while still falling entirely within the free tier of Google Compute Platform services. This architecture comes as a result of a number of experiments with alternative ASP deployment strategies that make differing demands on player device battery and data transfer usage as well as yield different response times for the various interactions in the game.

Proofdoku innovates in game design by inducing players to externalize and get feedback on the logical reasoning that is implicit in the traditional Sudoku experience. It innovates in AI applications to games by deploying a scalable architecture for centralized reasoning with ASP.

Play Proofdoku in your browser at <http://proofdoku.com/> or read about how ASP was used to power this deployed playable experience in “Answer Set Programming in Proofdoku” (Smith 2017).

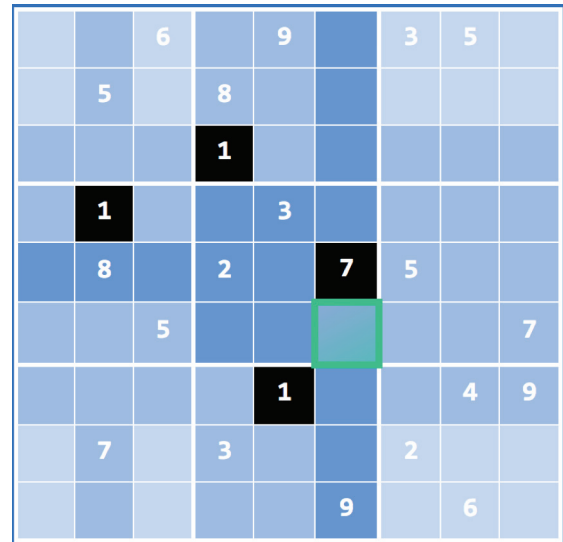


Figure 1: Proofdoku gameplay

### Chimeria:Grayscale

Chimeria:Grayscale is an epistolary interactive narrative game modeling phenomena related to sexism in the workplace. Users browse through and respond to notes/messages via an interface resembling a streamlined, aestheticized email client. Chimeria:Grayscale leverages the affordances of Chimeria, a social identity modeling engine and interactive narrative authoring platform, to implement a social science model of ambivalent sexism. This model of sexism undergirds the system’s dynamic theme and event variability based on the user’s choices within a story of a Human Resources manager’s probationary period at a sexist workplace.

While many people recognize and deplore individual acts of social ills such as sexual harassment, perceiving issues like institutionalized sexism requires a more nuanced understanding of systems of discrimination. Chimeria:Grayscale models ambivalent sexism, a framework that posits that sexism has two components: benevolent sexism and hostile sexism. The model is well-structured enough to be modeled computationally and has been empirically shown to be consistent and reliable across cultures and time (Glick and Fiske 2011). We believe that modeling social systems through videogames may help foster critical awareness and even conceptual transformation with respect to social ills. Prior work in interactive storytelling provides some support for this hypothesis (Matthews, Gay, and Doherty 2014)(Hernandez, Bulitko, and Spetch 2015)(Tanenbaum and Tanenbaum 2015)(Domínguez et al. 2016). While users cannot digitally gain the physical-world experiences of others, systems like Chimeria:Grayscale can

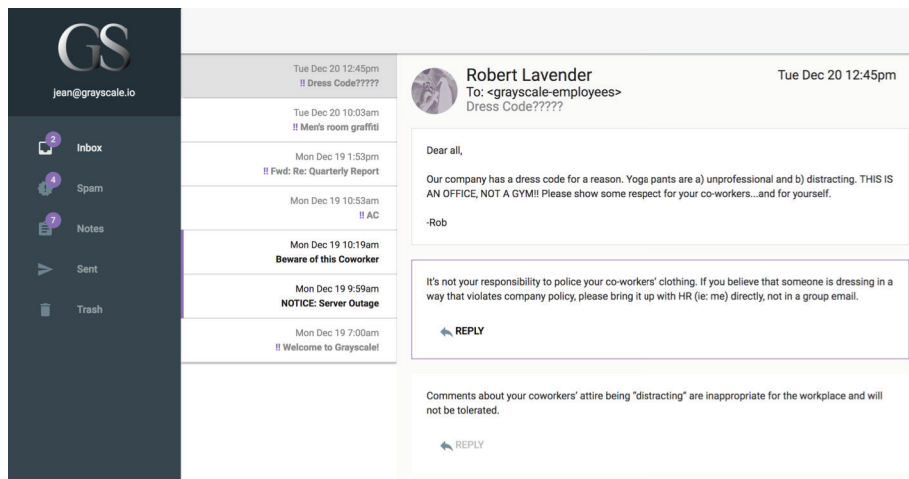


Figure 2: Screenshot of gameplay from *Chimeria:Grayscale*

help convey systematic patterns of experience as it relates to social ills like sexism.

Chimeria (Harrell et al. 2014)(Harrell et al. 2014; Harrell, Kao, and Lim 2013) is a system that supports the simulation of physical-world identity phenomena in virtual identity systems by modeling complex social identity phenomena and providing tools for authoring expressive systems that demonstrate such phenomena. The underlying engine can model agents with multiple social category memberships, gradient memberships, fluctuating memberships, etc. These affordances supported us in simulating nuances of workplace sexism.

Chimeria:Grayscale players take the role of a Human Resources Manager and must negotiate tensions between ethical behavior and career advancement. Players interact through a naturalistic email interface designed to increase player immersion and engagement with the underlying model of sexism. When important emails arrive, players must select a response to proceed. These selections affect the structure and content of the narrative, and thereby the narrative's theme, as the player character's social category membership changes based on the ambivalent sexism model (Glick and Fiske 1996)(Glick and Fiske 2011). Chimeria:Grayscale selects and customizes narrative events that simulate aspects of ambivalent sexism based on the player character's current and trajectory of category memberships.

Ultimately, the work is intended to be useful to AI researchers and game developers aiming to spark critical social thought.

## Traveler

Traveler is an online playable experience in the form of an interactive audio drama, with voice input and produced

audio output. In *Traveler*, players take on the role of Dr. Ramon Pineda, an American physician returning from an international conference in Germany. His homecoming takes a turn for the worse when passing through immigration at LAX airport, where he is whisked away by border agents for questioning and held alongside other travelers affected by increased border security measures. *Traveler* uses interactive narrative to expose players to the dystopian consequences of racial profiling and warrantless border searches, and challenges to them to consider what their own actions might be if put in similar situations. *Traveler* is innovative in its use of natural language input (voice) as the means of narrative interaction, which forces players to take an active role in determining the fate of the protagonist. Immersion in the fictional storyline is furthered by presenting the scenario as a series of produced audio clips, with sound effects and voice actors adding to the protagonist's own audio narration of the fictional events. *Traveler* is playable online at the following website: <http://dine.ict.usc.edu/traveler.html>

*Traveler* follows the familiar design of branching storylines like those of the classic Choose-Your-Own-Adventure books (Packard, 1979), where fixed narrative content is presented to players as outcomes of their decisions. However, *Traveler* uses two natural language processing technologies that support a greater degree of immersion and interactivity than seen in text-based interactive fiction. First, *Traveler* uses automated speech recognition to allow players to express their intentions aurally as natural language narrative sentences, rather than typing or choosing from a menu of options. For this, *Traveler* uses the high-accuracy large-vocabulary speech recognition technology built into recent desktop versions of Google's Chrome browser, affording a completely hands-free interactive narrative experience. Second, *Traveler* uses an un-

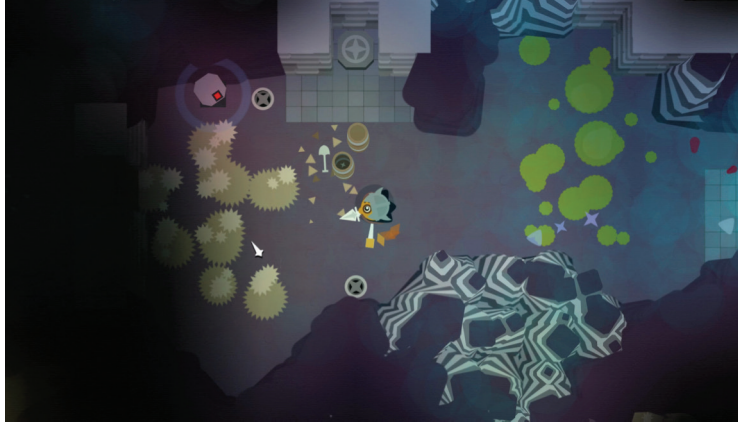


Figure 3: A screenshot from Unexplored.

supervised text classifier to automatically select the most appropriate outcome of a player's intentions from among the fixed set of pre-authored possibilities. For this, we compare the input words that are identified via automated speech recognition with the text of the first words of each possible outcome, selecting the one that ranks the highest on a similarity equation, where the pairwise word similarity function is the cosine distance between each word's latent Word2Vec representation (Mikolov, T.; Sutskever, I.; Chen, K.; Corrado, G.; and Dean 2013).

$$AvgMaxSim_W(I, O) = \frac{\sum_{i=1}^{Len(I)} \max_{1 \leq j \leq W} Sim(I_i, O_j)}{Len(I)}$$

This approach capitalizes on the ability of distributed word vectors to encode the overlap between semantically similar words, allowing novel and unanticipated player input to be routed to coherent responses in most cases. Furthermore, each outcome is paired with authored-written examples of the sorts of input that they are intended to handle, which serve as additional targets when ranking the similarity of each outcome.

Traveler demonstrates how AI advances in natural language processing can enable new forms of interactive digital entertainment. In particular, Traveler explores a design that increases players' immersion and engagement through natural language interaction without abandoning the traditions of storytelling and media production of the entertainment industry.

## Unexplored

Unexplored follows the classic roguelike premise: explore the Dungeon of Doom in search for the Amulet of Yendor

and escape with it. However, the game is played in real-time and focuses on puzzling and exploration as much as on combat. To support this type of gameplay the level generator of Unexplored expands on the traditional generative techniques typically found in roguelike games.

Unexplored utilizes a multi-step transformation process where a series of products are produced before final levels are generated. This builds on the ideas of Model Driven Engineering and has several advantages. The first main product of the generator is a dungeon plan that outlines the layout of the 20 floors in the dungeon, including what bosses, enemies and items are to be spawned, and which themes to be activated for each individual floor. This allows the game to create quests that span multiple floors, foreshadow hazards to be encountered, and prepare the player for boss battles. In fact, the first thing added to the plan is random choice of one of eight dragons, which in each activates particular themes, enemies, and magic items.

Taking full advantage of the model transformations that are the core of Unexplored's content generation, each individual floor is created in multiple steps as well. The initial steps of this process focuses on the level structure. Using graphs to represent the layout of the dungeon, the game uses cycles as the core structural feature of any level. Instead of creating a branching, tree-like structure, cyclic dungeon generation creates two paths between any two points it wants to connect in the dungeon. The advantage is these cycles create a much better flow and easily accommodate many common level design patterns.

Lock and key mechanics are common in Unexplored. In order to create varied and unique puzzles, the level generator of Unexplored can use many different types of items as lock and key mechanisms based on the current theme for a level. In addition, Unexplored generates a number of code based puzzles where the correct 'code' (which object to

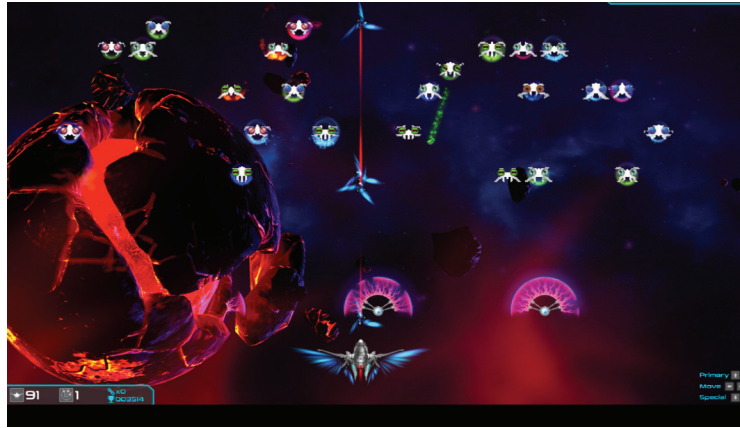


Figure 4: A player battles the third generation of Proteans using the “Beagle,” one of over 30 customizable ships that are unlocked through gameplay.

place or remove from a particular spot) can be cut up in several pieces and communicated through different means (direct hints, special decorative patterns, revealed under specific conditions). These puzzles seamlessly integrate with the explorative and generative nature of the game.

### Darwin’s Demons

Darwin’s Demons is a classic arcade style game that pits the player against a population of enemies that use biological evolution to adapt to the player’s strategy. These enemies, called the “Protean Swarm”, are encoded by a digital genome of 38 diploid loci. These genes determine the game traits of the Proteans, such as their morphology, projectile type, and defensive shields. The Protean swarm also feature a simple form of evolved, dynamic decision-making that governs their movement. Protean movement is based on the location of the player’s ship, player projectiles, and is modulated by gene values. Decisions regarding whether to fire at the player are governed in a similar way.

The fitness function in Darwin’s Demons is comprised of two components – Aggression and Accuracy. Aggression fitness is earned when a Protean moves lower on the screen (toward the player). If Protean moves past the player, it is destroyed and the player loses a life. The Protean receives a fitness bonus if this occurs. Accuracy fitness is accrued when a Protean fires a projectile, and scales negatively with impact distance from the player. Experiment Mode (as opposed to Arcade Mode) allows the player to adjust many of the game parameters.

At the end of a generation (analogous to a wave in traditional arcade style games), parents are selected through tournament selection using a discrete time model of evolution. This form of evolutionary computation sets the basis for adaptation in the game. The default settings of the game feature a population size of 65 per generation, and

the default tournament size is 20. Once parents are identified, a new creature is instantiated with one recombinant chromosome from each parent. Mutation is applied to each chromosome using a Gaussian distribution with parameters that depend on the game’s difficulty setting. Once the next population is created, the next generation begins. Over time, this model leads to adaptation of the Protean population, which is a form of procedural content generation responsive to player strategy.

The full version of Darwin’s Demons was released on Steam on February 13th, 2017 (the day after Darwin Day).

### Conclusion

The Playable Experiences track at AIIDE is intended to be a home for complete experimental works that might have a hard time being recognized solely for their technical contribution, but are still innovative and interesting audience experiences. This year’s selections showcase a broad range of interactive genres and technological approaches. Our hope is that the works accepted into this track will inspire novel applications of artificial intelligence to create innovative audience experiences.

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