Designing a Massively Multiplayer Online Game / Research Testbed Featuring AI-Driven NPC Communities

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Abstract

Massively Multiplayer Online Games (MMOGs), in their aspect as online communities, represent an exciting opportunity for studying social and behavioral models. For that purpose we have developed *Cosmopolis,* a free MMOG containing several key research-oriented features. First, *Cosmopolis* consists of an outer game for larger-scale social modeling, as well as a set of subgames suitable for tightly-controlled sandbox-style experiments, all allowing a high level of data logging configuration and control by researchers. Also, *Cosmopolis's* world model incorporates configurable, AI-driven non-player character communities, as a means of researching interactions between individuals and societies.

Objective and Motivation

A 2008 study by the National Research Council entitled "Behavioral Modeling and Simulation – from Individuals to Societies" [NRC 2008] discusses how we need to expand research in modeling and simulation to include models of individual and societal behaviors, both human and AI (and hybrid). In the study, it is pointed out that a technological infrastructure needs to be developed for behavioral modeling such that we can properly develop, test and then deploy such models. The study, in fact, suggests the development of a massively multiplayer online game (MMOG) for that infrastructure. Such an MMOG can be utilized as a test bed for models of individual and group phenomena.

Cosmopolis is an MMOG we are developing for this purpose. In designing the game, we have been motivated by the need to balance the diverse interests of players and researchers: players need a fun game experience, while researchers need the flexibility to perform various experiments of their own design. To accomplish these goals, we've designed the game to incorporate specific features to work towards these ends.

Cosmopolis is centered on a world-building outer game and a collection of self-contained sub-games of any genre (action, puzzles, sports, etc.). *Cosmopolis* also contains a new approach to incorporating information channels into a game environment: dissemination of both in-game messages and real-world feeds [Zyda et al. 2010]. Previous virtual environments and their AI-based denizens do not have the ability to analyze information feeds from real-world events. We believe this ability is an important factor for effective simulation of virtualized social and organizational environments.

For researchers, *Cosmopolis* is a unique test bed and data source for studying social and behavioral models. These models can be of individual players or multiple players over time, as well as of non-player characters (NPCs), or combinations of those. The game provides various and flexible methods to facilitate these needs. These methods include administrator-produced in-game events (natural disasters, etc.), specifically designed and instantiated experiments in subgames, and AI-driven NPC communities featuring customized cultural models.

Method

The first subsection below discusses *Cosmopolis* in terms of its game design features for players, as influenced by the MMOG design guidelines mentioned in the background section. Key features covered include the outer game / subgame structure, and the game world's information channel system with its novel inclusion of real-world newsfeeds and its effects. The second subsection describes the design features of *Cosmopolis* as a research testbed. Both subsections incorporate examination of the engineering criteria used to build *Cosmopolis*, and a discussion of some ways in which AI NPC communities are incorporated into the world model.

1. Game design

As a game, *Cosmopolis* has a two-level structure: outer game and subgames. The outer game is a present-day city- and world-building simulation, including player-level and guild-level conflicts. The various subgames will be housed in any buildings or areas in the world. This two-level format supports our aim of attracting as many players and player types as possible, consequently yielding data about a wide variety of individuals in distinct populations and about the relations among them.

Currently, there are three completed or developing 3D subgames in *Cosmopolis*: WarPipe, Operation:Peace, and DungeonRun. WarPipe is a multiplayer action/shooter game for individuals or teams, featuring a detailed urban battleground and 1st/3rd person camera perspectives. Operation:Peace, a simulation designed for the United Nations Millennium Challenge, involves social interactions between players and NPCs in a demilitarized zone. DungeonRun is a single-player fantasy-themed action/adventure game with AI-controlled monsters.

In terms of engineering, *Cosmopolis* is designed to be an engaging game, with state-of-the-art graphics and effects. The game engine has been built from the ground up with the primary objective of supporting a massive, changing world seamlessly. By design, *Cosmopolis* needs to be able to support large cities and wilderness in addition to providing a cohesive experience across the subgames and the outer game. For example, the current game world has a total area of 8 km^2, and supports importing real world height data to recreate small islands, etc.

All of the action in *Cosmopolis* is handled by an event-based networking model. Each event has certain properties that define how it will be perceived in the subgame and the outer game. This approach enables us to be flexible with regards to the level of interconnectedness between the subgame and the outer game as desired by the researchers and game designers. Subgames could be designed to be completely isolated sandboxes like MMOG instances (like the DungeonRun subgame) or be seamlessly integrated with the outer game (like the Operation: Peace region-based subgame or a neighborhood basketball court). This system is also data-driven so designers can tweak the various parameters without having to ask the engineers to rebuild the game for each tweak. This also reduces the burden on the subgame engineers as they need not worry about the integration with the outer world for components like particle systems, sound, character movement and animation, etc.

In *Cosmopolis*, the in-game information system is a collection of channels through which messages flow. Channels may display news feeds from the real world or commercial advertisements; channels may publish in-game announcements publicly or regionally; channels may be configured as special chat lines between players. We aim to present messages efficiently and effectively to and between players, as well as to support the framework for the study of information spread and analysis.

For example, *Cosmopolis* features an in-game virtual economy system that has a commodity market and currency exchange market. All the commodity prices and currency exchange rates are synchronized periodically with incoming real-world rates. Using processing techniques such as keyword searches, *Cosmopolis* can extract data from information channels that may change the behaviors of NPCs (implemented as AI-driven software agents). Warnings of "terrorist attack" or "earthquake danger" may cause NPCs to flee an area. Rumors of "unrest" may coincide with NPCs behaving in a less friendly manner towards players or each other. Stock market gradients can also change the personalities of the NPCs, e.g. increasing indices make them happier, and decreasing indices make them nervous.

As *Cosmopolis*'s information system is relatively untested, it is an open question as to all the ways it will affect players. However, some speculation is possible. Players may be influenced by the game world's or NPCs' responses to certain events as described above. For example, NPCs are programmed to respond to earthquake predictions in a certain manner, and the players can learn from NPCs' actions. Another example is that players may choose to move to a region where commodities are becoming relatively more valuable. Also, there may be information channels that show players certain data (such as social networks) from the game, to see if providing such information alters player behavior.

2. Research testbed design

As a research testbed, *Cosmopolis* offers a critical degree of experimental flexibility beyond the data-logging capability of the standard MMOG. Our overall design comprises a federated model architecture: each subgame is a potential lab for a different social and behavioral model, maintaining interoperability with the outer game world model. Subgames may be added, gameplay of the outer world can be tweaked, and different NPC cultures and communities may appear, all to meet the needs of researchers who use our game to validate or collect data for their models. While all in-game events will be logged, we will be specifically providing appropriate data export, reporting, and visualization capabilities so that researchers can easily analyze the experiments that they design and conduct in the game environment. Exported data would include player and NPC characteristics and activities, relational information such as who communicated with whom, performance outcomes, geo-temporal activity sequences and so on.

From an engineering standpoint, the subgames' content and logic is completely isolated from the outer game except for a controlled data access pipeline. This enables administrators and researchers to set exactly what part of the outer world this subgame can modify, to prevent any unexpected behavior. This also means that in the event of any bug or design inconsistencies in any of the subgames, it can safely be taken down without affecting the rest of the game.

The event-based networking model enables efficient logging management, which is vital for researchers using *Cosmopolis* as a data source. The logging parameters can vary among players, NPCs, and subgames, based on the needs of different researchers. The current networking model has separate gameplay and analysis servers. The analysis server can be tasked to perform near real-time processing in addition to logging the data.

To separate the account management from gameplay logic, *Cosmopolis* uses web services to perform authentication and initiate game connection. This also paves the way for enabling researchers to control different parameters of the game from the browser. For example, they could add buildings, move objects, change the weather, or alter the default friendliness of an NPC community towards outsiders.

One experiment in progress, based on the concept of knowledge dissemination, involves communities of NPCs in *Cosmopolis'* Operation: Peace subgame. Facts and beliefs will be spread through NPC communication networks of various configurations. One set of the social network configuration parameters is the physical layout of the NPCs and their walking routes/speeds. Another set of parameters will determine how trusting the community is of information introduced by a player character or a newsfeed. In other words, how far and with what degree of confidence would such information spread, and how would belief/disbelief of that information affect the NPCs' behavior?

Discussion

MMOGs are widespread and popular online communities; *World of Warcraft* alone boasts millions of player characters. The significance of *Cosmopolis* is its uniqueness as an MMOG designed specifically as a research testbed for social and behavioral models, with a correspondingly high degree of researcher control over experiments performed in and data gleaned from the game world. A few of the key features that *Cosmopolis* incorporates are a system of nested subgames, a world-development mechanic, a channel-based information system, and interactive AI communities. While these features help to make the game novel and fun, they also have specific applications for scientists opting to use *Cosmopolis* as a research platform: subgames are a way for researchers to conduct isolated experiments; the modifiable nature of the world allows for events to occur that may dramatically alter the main game environment, providing fodder for scientists interested in the evolution of online communities; the information broadcasting systems will allow different messages to be broadcast to different portions of the community to help manage experiments conducted on the entire player community; and, configurable communities of NPCs allow for validation of various social and behavioral models involving AI principles and techniques. Furthermore, ready access to a high-fidelity data set means that researchers will have an easier time determining the impacts of different treatments on the community in *Cosmopolis* than do researchers of more closed gaming environments. Also, all *Cosmopolis* interactions are eminently documentable, and may be used to explore the mappings between game world and real world societies.

It is impossible for one MMOG to be considered the definitive online game, and *Cosmopolis* is not intended to be that. But it is an important step in opening up game environments for use by researchers, and one that will help support the work of many scientists interested in studying game environments and how different phenomena manifest within them. At present we are designing and running our own first experiments within *Cosmopolis*. We hope that the demonstration of the feasibility of *Cosmopolis* will encourage other researchers to look to game environments -either *Cosmopolis* or their own more specialized platforms- as avenues for research into human and AI character-based interaction.

Bio

Michael Zyda is the Founding Director of the USC GamePipe Laboratory, and a Professor of Engineering Practice in the USC Department of Computer Science. At the USC Viterbi School of Engineering, he founded the Games cross-disciplinary degree programs and dramatically increased the incoming undergraduate enrollment of the Computer Science Department. From Fall 2000 to Fall 2004, he was the Founding Director of the MOVES Institute located at the Naval Postgraduate School, Monterey and a Professor in the Department of Computer Science at NPS as well. From 1986 until the formation of the MOVES Institute, he was the Director of the NPSNET Research Group. Professor Zyda's research interests include computer graphics, large-scale, networked 3D virtual environments, agent-based simulation, modeling human and organizational behavior, interactive computer-generated story, computer-generated characters, video production, entertainment/defense collaboration, modeling and simulation, and serious and entertainment games. He is a pioneer in the following

fields - computer graphics, networked virtual reality, modeling and simulation, and serious and entertainment games. He holds a lifetime appointment as a National Associate of the National Academies, an appointment made by the Council of the National Academy of Sciences in November 2003, awarded in recognition of "extraordinary service" to the National Academies. He is a member of the Academy of Interactive Arts & Sciences. He served as the principal investigator and development director of the America's Army PC game funded by the Assistant Secretary of the Army for Manpower and Reserve Affairs. He took America's Army from conception to three million plus registered players and hence, transformed Army recruiting. The creation of the America's Army game founded the serious games field.

References

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