

# A Testbed for Cognitively Plausibly Bartering Agents

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**Abstract.** We present an initial experimental testbed for human-AI interaction in the context of a simple bartering scenario. With pilot studies, we demonstrate the opportunity this platform provides for computational modeling of human behavior in the context of a simple market.

Demonstration can be viewed at <https://youtu.be/o5lnzMI MMt4>

**Keywords.** Game Theory, Market Theory, Human-AI Collaboration

## 1. Introduction

Bartering, the direct exchange of commodities and services without using money or any medium of exchange, is the oldest form of commerce [4] and a focus of study dating back to British economist Alfred Marshall [7]. Since that time, formal models of barter markets have been provided using the language of microeconomics and cooperative game theory [3,15,10]. Seminal work by Shapley and Scarf in 1974 [13] put forward a foundational barter model and proved that this model has a nonempty core, that is, at least one outcome that no subset of traders can improve upon. Follow-on papers have expanded upon this model and related findings in a number of ways [2,12,9,6].

In parallel, barter markets have been studied in the wild through an anthropological lens [5,11,1] as researchers seek to understand social and environmental influences on barter systems which ubiquitously defy theoretical models. Yet, computational modeling of these foundational real-world scenarios is an open challenge. We take a first step to address this gap, building *an experimental testbed for semi-structured bartering, computational modeling of human player behavior, instantiation of agent-based behavior, and ultimately, human-agent interaction in a simple market.*

## 2. System Overview

We have developed a rich and complex environment for testing agent-based bartering models with human players using the video game world of Minecraft [8] to develop agents, test problems, and tasks.

Our system is built using Spigot, a modified version of the Minecraft Java Edition [14] server software. Spigot offers performance improvements, additional configurations,

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and a rich API offering fluid control over the Minecraft environment for developers. Spigot's API enables the development of server-side plugins that take advantage of its extensive API and require no modifications to a given client connecting to the server.

Minecraft Plugins are server-side software written in Java that alter the default behavior of the game. In the Minecraft Client-Server Model, the environment exists on the Server to which all clients must directly connect via IP address. Our Minecraft server runs remotely on an ArchLinux computer. We have developed *BarterPlus* which adds several new features to the environment enabling participants to perform direct trades with each other. Our plugin collects data about each trade and stores it in a JSON file on the server. This data includes the content of the trade, start and end time, players' respective usernames and scores before and after the trade is complete. We also store metadata about each session including start date and time, winner, and the UUID, score, username, and profession of each participant.

### 3. Preliminary Experiment Design and Results

In IRB-approved pilot studies on the platform, we recruited players in groups of 5-7 to take on one of a set of fixed roles in a simple barter scenario. In each scenario, each player (trader) is assigned a profession and a corresponding set of items they need to obtain. Professions and items derive from Minecraft, e.g., farmer, butcher, fisherman. Each trader begins with a set of random items which are distributed over 3 tiers: Tier 1 items are most plentiful; Tier 3 items are most rare and valuable. All players must barter for the items they require in exchange for the ones they have to gain points. Players get points according to the Tier of the items they acquire. Points are used to determine the winner(s) of every session. Throughout the game, players can use the chat feature available in the game; they can send a public message to all or private messages to individual players. All chats during the game are saved for post-experiment data analysis. Traders can use either commands or the GUI which is a custom trade menu to enact trades.

Pilot studies have enabled us to explore social network evolution in three settings: (1) a *cooperative* setting in which players only gain a monetary bonus if all players score sufficient points; (2) a *competitive* setting where only one player receives the bonus; and (3) a *baseline* setting where any player receiving enough points can earn the bonus. Our early results indicate that the game setting influences both the level of player interaction and the amount of anti-social play.

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Figure 1.: The testbed, from the point of view of a player. Player's inventory appears at the bottom of the screen; scores are in the lower left. Five other players are in view.

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