

# IAGO: Interactive Arbitration Guide Online (Demonstration)

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## ABSTRACT

Automated negotiation between two agents has been the subject of much research focused on optimization and efficiency. However, human-agent negotiation represents a field in which real-world considerations can be more fully explored. Furthermore, teaching negotiation and other interpersonal skills requires long periods of practice with open-ended dialogues and partners. The API presented in this paper represents a novel platform on which to conduct human-agent research and facilitate teaching negotiation tactics in a longitudinal way. We present a prototype demonstration that is real-time, rapidly distributable, and allows more actions than current platforms of negotiation.

## General Terms & Keywords

Experimentation; Human Factors; Negotiation; Human-Agent Interaction; Virtual Humans

## 1. INTRODUCTION

Negotiation, specifically multi-issue bargaining, is an important topic in social cognition and interpersonal skill-development [7]. However, most automated negotiation platforms are fine-tuned to attempt to achieve Pareto Optimality (or peak efficiency) among two perfectly rational agents. These platforms therefore do not lend themselves readily to teaching negotiation to human students, nor do they adequately represent a research space for understanding negotiation in the wild.

Human-human negotiation has been studied extensively and found to contain myriad signals beyond simple offer exchanges, from emotional display, to favor-and-ledger-related patten [4], to complex natural language dialogue. Within the agent community, simulating these behaviors is a first step toward developing realistic agents, as well as teaching valuable negotiation skills.

We have developed a platform upon which human-negotiating agents can be adequately developed. Previous efforts have spurred interest and novel research by allowing agent-agent negotiations competitions to be conducted, including at AAMAS. However, recent interest in *human-agent* negotiation requires a new platform that contains features that are necessary for the new domain. Such a platform must also meet practical research goals of being both readily deployable and easy to extend to the particular needs of the study or simulation. IAGO, our Interactive Arbitration Guide Online platform addresses these points. Specifically, IAGO was designed with the following principles in mind:

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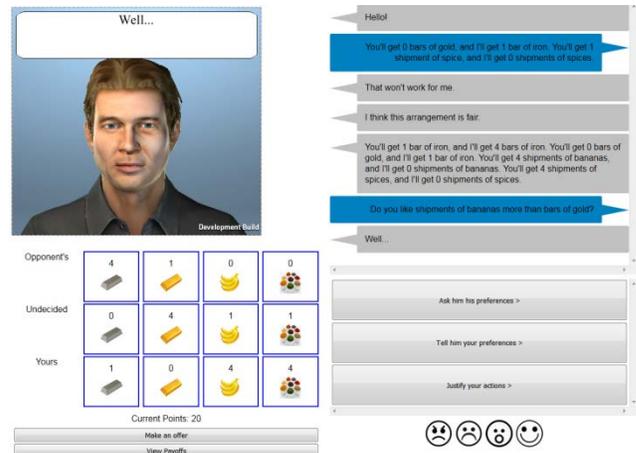


Figure 1: IAGO Screenshot

1. Must support current web-standards and require little to no installation of complex support software on a user's machine.
2. Must deploy a well-defined API that allows both agent designers and negotiation game designers to easily create and specify behaviors for the purposes of competition/research.
3. Must support currently unexamined aspects of human-human negotiation in a human-agent context. Specifically, this must include partial offers, visual representation of emotional signals, and relative preference elicitation/revelation.

## 2. BACKGROUND

### 2.1 Human-Human Negotiation Features

The authors have compiled a detailed corpus of human-human negotiation data, including recorded negotiations and annotated transcripts. Several features of human-human negotiation have been examined that are believed to be critical to examine in any negotiation context. Complex forms of signaling intent, such as through emotional reactions to offers or messages, are of critical importance to negotiations [1].

Whereas many negotiation platforms rely on complete offers, many human-human negotiations rarely include complete offers until late in the negotiation. Complete offers represent a full assignment of all items in the multi-issue task to either one party or the other, whereas partial offers omit one or several issues to focus on the remaining issue(s). Furthermore, partial offers are rarely seen as binding until late in a negotiation.

Finally, while preference elicitation remains a core feature of many agent-agent platforms, human-human negotiation contexts (and therefore, human-agent) often showcase relative preferences and utilize natural language to express subtly different meanings. Often, these meanings may be used to hedge and avoid revealing critical information (or often result in outright lies).

Although there are additional features that have been shown to be important to human-agent negotiation, these core features are the focus of IAGO and are, to the authors' knowledge, largely not formalized in human-agent negotiation platforms to date.

## 2.2 Negotiation Platforms

There have been several different platforms that attempt to facilitate negotiation for various purposes. The GENIUS platform [3] allows a variety of multi-issue bargaining tasks to be completed rapidly between two agents. It has been used in negotiation competitions held at AAMAS and elsewhere for several years<sup>1</sup>. However, as part of its optimization for these types of negotiations, it does not include several key features of human-agent negotiation, such as partial offers, complex preference spaces, non-final offers, favors, and other features. Additionally, the NegoChat agent [6] has attempted to address some of these concerns in a different domain, allowing purely free natural-language information with a chat agent as part of a negotiation.

In IAGO, we create a platform on which future negotiating agents (such as the one implemented by NegoChat) can be built for use in future negotiation competitions. IAGO supports a wide variety of features that have been shown to be critical to realistic human-agent communication. These include partial offers, preference elicitation statements, a customizable set of natural language argumentation phrases (currently based on work by Keenan and Carnevale) [8], and an expressive virtual human agent. The interface also features a full conversational history, the ability to feature non-linear utility structures, and a customizable graphic interface. IAGO exposes a simple API that allows games and agents to be customized with a single template Java class.

## 3. PLATFORM DESIGN

### 3.1 Web-Based Interface

IAGO is built to be easily deployed. Human-agent negotiations may be conducted wherever study requirements demand. As IAGO is completely web-based, remote subject platforms such as Amazon's Mechanical Turk may be used as well as traditional methods. No installations are required for IAGO to function; the platform is delivered through HTML5 and OpenGL. JavaScript is used to create web socket communication to the back-end, which is Java-based. Because of these features, IAGO is able to be used on a wide variety of common web browsers with little to no visual distortion. IAGO is also, notably, fully asynchronous. Humans or agents may both choose to take any action at any time and these decisions will be represented in real-time through the interface.

We use under-development aspects of the Virtual Human Toolkit<sup>2</sup> to create the virtual character on screen and simulate the animations, expressions, and backchannels. Users familiar with the VHT can substitute their own models to change the appearance of the virtual human, though IAGO does not require this setup if the standard male agent is acceptable.

### 3.2 Easy-to-use API

IAGO allows the rapid development of agents by simplifying the communication between agents through a set of pre-specified Events. A core set of Events is listed below:

1. SEND\_EXPRESSION – allows for an agent to send or receive an expression from a preset list defined by the

game structure. These include prototypical expressions such as Anger, Surprise, Happiness, and Sadness.

2. SEND\_MESSAGE – allows for an agent to send or receive a string to be displayed in the chat log. The game can expose the preset list of legal messages that the human can use, simplifying the assumptions if natural language is not the focus of the competition or study.
3. SEND\_OFFER – the core of any negotiation, this allows an agent to send or receive an offer (partial or full) that represents some ordering of the issues at hand. An offer will move the items in the offer grid to the desired positions, while a message affects the chat log.
4. TIMING\_PROMPT – this allows agents to easily record periods of idleness from their partner, waking after a specified amount of time to take another action (such as reiterating a message, or relenting on a previous offer).

The release version of IAGO will include open-source samples of agents, as well as full documentation of the API.<sup>3</sup>

### 3.3 Logging Features and History

One critical feature of this system is its ability to provide large amounts of data about the history of the negotiation. This is important both for the users of the system, who will often wish to verify offer or message history, and also for researchers, who require a more detailed description of the logs of a negotiation.

IAGO logs all events along with a timestamp and user identification number, and exports much of its data to files/databases. On the visual side, the full offer history is always available to the user through a scrolling window, as are user preferences and past emotional displays.

### 3.4 Demonstration Features

The demonstration we have prepared<sup>4</sup> is intended to showcase the core features of IAGO. We have prepared an agent created using the IAGO API that can conduct a simple multi-issue bargaining task featuring four issues at five different levels. The agent utilizes the fixed list of utterances that the human may use, although it has its own set of responses. Our agent attempts to gain the most value for itself in the negotiation by employing several human-negotiation techniques, such as appealing to the principle of fairness by utilizing a fixed-pie lie [1].

The authors anticipate that IAGO will demonstrate the value of a flexible negotiation framework that allows researchers to examine facets of negotiation primarily found within human-agent domains. It will also be a platform upon which human-agent negotiation competitions can be conducted in order to determine which agents are most successful when negotiating with humans—a domain that has not been explored as extensively as the agent-agent competition domain.

## 4. ACKNOWLEDGMENTS

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<sup>1</sup> See information on ANAC, <http://web.tuat.ac.jp/~katfujii/ANAC2015/>

<sup>2</sup> See <https://vhToolkit.ict.usc.edu/>. Some components of VHT are open source.

<sup>3</sup> Please contact the first author for access to development software/documentation.

<sup>4</sup> A short video is available at [https://youtu.be/WFs\\_4YdK5UM](https://youtu.be/WFs_4YdK5UM)

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