A Multi-Agent Platform for Auction-Based Allocation of Loads in Transportation Logistics (Demo Paper)

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ABSTRACT

This paper describes an agent-based platform for the allocation of loads in distributed transportation logistics, developed as a collaboration between CWI, Dutch National Center for Mathematics and Computer Science, Amsterdam and Vos Logistics Organizing, Nijmegen, The Netherlands.

The platform follows a real business scenario proposed by Vos, and it involves a set of agents bidding for transportation loads to be distributed from a central depot in the Netherlands to different locations across Germany. The platform supports both human agents (i.e. transportation planners), who can bid through specialized planning and bidding interfaces, as well as automated, software agents. Therefore, the proposed platform can be used to test both the bidding behaviour of human logistics planners, as well as the performance of automated auction bidding strategies, developed for such settings.

Categories and Subject Descriptors

I.2.11 [**Distributed Artificial Intelligence**]: Intelligent Agents
H.4.2 [**Information Systems Applications**]: Logistics.

General Terms

Management, Design, Economics, Experimentation.

Keywords

Multi-agent systems, auction platforms, electronic auctions, distributed logistics.

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1. MOTIVATION AND GOALS OF THE PROJECT[1]

Due to the dynamic and increasingly complex nature of modern supply chains, new techniques are needed in order to efficiently allocate tasks (i.e. transportation orders) between competitive parties, such that existing synergies between their supply chains are maximized.

The overall goal of our project is to build a multi-agent platform to demonstrate the feasibility of applying auction-based allocation techniques in the day-to-day transportation outsourcing activities of Vos Logistics Organizing (VLO), Nijmegen. The work was carried out in the framework of the Senter-Novem DEAL project (Distributed Engine for Advanced Logistics). The platform follows a business case proposed by Vos Logistics, thus the modeling decisions closely follow this real business scenario. Besides the practical aspects, our platform also has a scientific contribution. It allows us to test, in a realistic logistics setting, different aspects of distributed decision making in auctions, more specifically:

- Analyzing and testing the behaviour of human agents (i.e. transportation planners) taking part in distributed logistics auctions.
- Testing increasingly complex automated trading strategies that software agents can use in this setting.

Besides the demonstration of the software itself, our talk will also include a discussion of preliminary results from experiments using the platform, involving experienced Vos planners.

2. THE TRANSPORTATION SETTING

The demonstration takes its starting point in a real-world transportation case of Vos Logistics, which involves the European distribution of loads (especially across Germany), for a leading international company in its sector of activity. The platform models the way transportation loads from a depot, located in the south of the Netherlands, can be distributed across Germany. All orders used in the demonstration are fictive (i.e. randomly generated, not real orders, in order to preserve privacy), but, in order to make the system realistic, their destination postcodes,

[1] A more extended description of the proposed platform is available as a full paper at the AAMAS'08 Industry Track [1].

weight, times of delivery etc. are based on the real-world distributions of our case study (as supplied by VOS Logistics).

All outgoing orders are assumed to be delivered starting from a depot near Maastricht, while possible return freight (i.e. pick-up) orders appear at depots across Germany.

2.1 Type of auctions used for load allocation:

- Most auctions are for spot orders (i.e. loads to be delivered in the next few days). These auctions follow an ascending English auction protocol.

- For loads to be delivered further away into the future, a threshold acceptance level is set for the price, which is based on standard industry practice.

All loads are considered "by" loads (to be delivered by a certain date, where early delivery is allowed, in order to allow planning flexibility).

2.2 Types of agents in the platform:

- Human players representing carriers. In order to provide decision support during bidding, a bidding interface and a planning interface was developed. In planning the loading of their trucks, players get automated decision support and cost calculations, which helps them in formulating bids.

- Automated bidding agents. In the current, interactive demo version, automatic bidders place bids based on current industry prices; their role is to simulate the (rest of the) market and stabilize the simulated market. Other, "intelligent" (AI-inspired) bidding strategies can be added to the platform, for testing and evaluation purposes.

- The auctioneer agent. In the setting we considered, there is one auctioneer agent that distributes the transportation orders on behalf of one or more shippers (in real life, this role is played by Vos Logistics itself). We also implemented the possibility that the auctioning procedure is entirely automatic (i.e. the carrier who offers the lowest price always wins the order). However, in real life, other considerations may come into play, thus we also allow the auctioneer flexibility in deciding to whom to allocate orders.

3. OUTLINE OF HUMAN BIDDING RESULTS

A preliminary test of the platform involving 5-6 experienced Vos transportation planners was performed at Vos Logistics. In this test, planners were asked to bid against each other and against our software agents for loads, and their strategies as well as the profit they made with the acquired loads was recorded.

Results so far are preliminary, and it was agreed that another large-scale test would be performed in the following months, in order to enable us to extract empirical data. However, from the testing performed some some preliminary conclusions can already be highlighted:

- First, the bidding and planning support interfaces were considered very helpful and realistic by all the planners involved. Some participants even claimed they were superior to the planning system currently being used in everyday planning.

- The presence of automated bidders (although they currently only bid based on a randomly perturbed set of industry prices), is crucial for the stability of the market and the convergence of prices to realistic levels.

- The profit levels in the simulation do, very roughly, commensurate with the skill of the bidder. However, in order to ensure that the profit rates actually match current practice, the pricing scheme and other parameters require some further refinement.

4. DEMONSTRATION REQUIREMENTS AND SET-UP

The proposed platform is implemented entirely in Java. It is possible to provide a demonstration on a stand-alone machine or on two connected laptops (which can be brought by the presenters). This demonstration can take from 15-30 minutes and does not have any particular requirements, except for the basic facilities (i.e. power supply, table etc.).

An alternative would be to do a larger interactive demonstration, similar to the one performed with planners at Vos, in which several participants can actually bid on the laptop (using the human agent bidding interface and/or the automated bidding interfaces). This requires however, a longer time for users to get accustomed to the platform, working network connections and several willing participants with Java installed on their laptops (the actual agent code required can be easily copied on the spot).

5. ACKNOWLEDGEMENTS

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6. REFERENCES

[1] Robu, V, Noot, H., La Poutré, J.A, van Schijndel, W.J.. "An Interactive Platform for Auction-Based Allocation of Loads in Transportation Logistics". *AAMAS'08 Industry Track,* Estoril, Portugal, 2008..