On-Line Auctions: Theory and Practice

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Executive Summary

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Overview:

Thirty billion dollars of trade was carried out using on line auctions in 2001 alone. As suggested by the title, the aim of this track was to bring together leading theoreticians and practitioners in on-line marketplaces to discuss two complementary issues: the theory and practice of on-line auctions for the general problem of resource or task allocation in domains such as supply chains. In particular, the theory concentrated on the design of auction mechanisms and the analysis of the resulting stable bidding strategies. The practice, on the other hand, concentrated on how agent technologies can be used to implement marketplaces.

1. Navi Radjou (Forrester Research): “Building An Agent Powered Adaptive Supply Chain”

Agent technology is currently being used in Global 3,500 companies for diverse functions such as eProcurement (Deutsche Post), Manufacturing (DaimlerChrysler), Order fulfillment (Procter and Gamble) and Transportation (Southwest Airlines). The focus of Mr Radjou’s presentation was how the extant view of static supply chain can be transformed using agent technology that better represent and manage a dynamic and volatile supply network. An agent was informally defined as “a configurable, distributed software component that continually realigns disparate goals and process”. Migration to a more adaptive agent-based supply networks was motivated by not only the mismatches between supply and demand (due to accelerate outsourcing, reduced product lifecycle, and reducing demand), but also the inability of current management systems to interleave supply chain planning-execution phases. The problem is further exacerbated by the potential of error amplification in the dynamics of supply chains as well as treating nodes
within the chain as dumb that communicate to a “smart central hub”. He then proposed a multi-agent architecture composed of a set of interacting, policing, analyzing and exception handling agents. The benefit of such an agent-based adaptive supply network is a better coordinated system that is continuously senses and responds to its environment.


Living Systems (and the product Living Markets) is widely recognized to be the leading cutting edge agent technology company in the world. The company has been winner of numerous awards, most notably the Trading Agent Competition (a trading competition in the agent community) in 2001 with only one part time employee. Founded in 1996 by Christian Dannegger it now employees 120 people worldwide, bringing to reality technology that the previous presenter motivated; “adaptive solutions for business networks” that “…close the gap between planning and daily operations of through real-time information gathering, automation and instant optimization…”. Dannegger, like the previous presenter, motivated the need for not only a distributed network view of business but also the central role of unanticipated events in network dynamics. Value creation was also demonstrated to critically depend on the capabilities of agents to adapt to both negative and positive opportunities in such in-deterministic networks where agents are proactively and continuously solving a distributed optimization problem without the need for a central planner. The system architecture of Living Markets was then introduced, consisting of an agent server middleware, database models, functional primitives, business logics and the user interface layers. Finally, the application of agent technology using Living Systems was then demonstrated in two simulation scenarios. In one application complex agents were implemented for scheduling of resources in a supply network while in the other application teams of relatively simpler agents competed in the international competition RoboCup where simple stimulus response agents were used to simulate a game of football.

3. Professor Benjamin Grossof (MIT): “What’s my Deal: Contract Communication in XML Agent Marketplaces”

Professor Grossof’s research goal is to develop knowledge based technologies for representing and reasoning about meaning in communication among agents. For example, in the real world the simple act of signing a contract has a multitude of implicit context and consequences that can be accessible and understood by (most) parties. However, the digital parallel of such an act is less straightforward, because agents need to know and understand not only the meaning of what is being signed but also roles and responsibilities of the act. The solution that Grossof proposes is to represent contracts independently of the code that implements it in a structured and modular manner that can be automatically processed using agent technology. The approach, grounded in the axiomatic approaches of knowledge based system, attempts to derive meaning as entailments from the logic that supports the conclusions. The representation technology he proposes is XML that permit agent systems, representing and executing business rules, to interact and reason about the content of the communication. In addition to motivating
and detailing the knowledge base approach to the problem of contracting he also covered the state of the art in Database, Knowledge Based systems as well as industry, academic and military efforts in the field of semantic web.

Professor J. Gallien (MIT): “Dynamic Mechanism Design for On-line Commerce – A Quantitative Benchmark of Selling Methods on the Internet”

The work of Professor Gallien is grounded in a branch of Game Theory known as mechanism design. The goal of mechanism design is to design a decision rule, in this case an auction mechanism, which is efficient and elicits truthful revelation of private information from the players in the game/auction. However, the common assumption that preferences of bidders and auctioneer are static throughout the auction length is relaxed in Gallien’s work. He instead proposes a model where the auctioneer is time-sensitive. Time sensitivity is a reasonable property of most decision making. For example, for an auctioneer the value of $100 in two days is not the same as $100 today. The central question being addressed in Gallien’s work is how a seller should maximize revenue when there is time-sensitivity. To solve this problem he proposes a dynamic probabilistic discounting model that maximizes the expected discounted revenue. Assuming that the buyers arrive in a serial and random order the model can be used to not only identify the optimal selling price for fixed priced single item mechanisms but also for multi-item mechanisms. He also shows how discounting in the latter multi-item mechanism can be used as punitive incentive mechanism for ensuring bidders reveal their true valuation for the item being auctioned. Finally, the presented model was shown to be robust to errors in price setting strategies.

Professor Andreas Schulz (MIT): “Combinatorial Auctions: Theory and Practice”

Consider the resource allocation problem of an airport management system where a number of airline companies simultaneously want to maximize their value by minimizing the amount of time for unloading, loading and take-off. From the perspective of an airline certain combination of loading and take-off schedules offered by the management system are likely to be valued higher than others. Combinatorial auctions are known to be an efficient allocation mechanism to this type of problem. In contrast to single item auctions, the characteristic of a combinatorial mechanism is that agents can express a more complex preference structure (consisting of AND/OR) over a combination of goods. In fact the popularity of this mechanism resulted in congress mandating the FCC to use combinatorial auction for the sale of its upcoming spectrum. The content of Professor Schulz presentation was an introduction to and critical analysis of the field.

Professor Georgia Perakis (MIT): “Optimal Bidding in Online Auctions”

The session ended with the exciting collaborative work Professors Bertsimas and Perakis and their doctorate student J. Hawkins). The motivation of this body of research is a predictive model of the empirical observation on eBay that, contrary to economic theory, there is an increased activity before the end of a Vickrey auction (“snipping”, also deductively predicted by A. Roth). Bidding strategies in Vickrey auctions are known to
be incentive compatible, meaning that the dominant strategy of a bidder is to truthfully submit as its bid its reservation value. The authors propose that this is due to two reasons: 1) congestion; a probability $p$ the bid does not “go through” and/or 2) agents are not certain as to their valuation of the good. The goal of this research is to design decision algorithms for bidders that can compute the optimal strategy for buying a single or multiunit item(s) dynamically through information that is derived from observing the listed prices of other bidders. The model the authors propose solves the problem using a dynamic programming (DP) approach, where Bellman model is used to dynamically update and “tune” the strategy in the course of auctions. In the case of a single item auction (Palm III and stamps) the performance of DP, quantified over percentage of wins, utility to the bidder and the amount spent, was significantly better than other bidding strategies (bidding reservation value at beginning of the auction, at the end or at the penultimate step). However, where agents can participate in $N$ simultaneous auctions the exact DP method needs to be relaxed due to intractability of the approach even for two auctions. An integer programming approximation model was then introduced that outperforms DP methods on the above measure across $N$ auctions. In future the group’s goal is to extend the models to stochastically arriving auctions and trading systems using auctions.