Automated negotiation among autonomous agents

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Agents, Markets, and Auctions

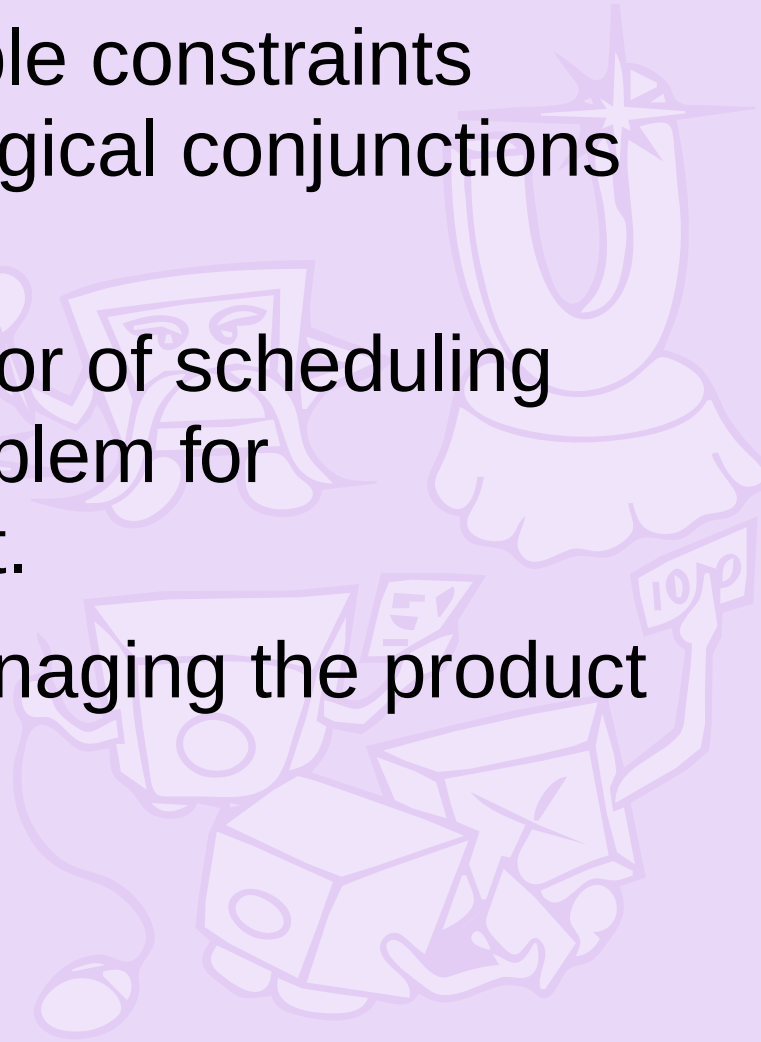
Our long term goal is to enable programs (“agents”) to do transactions on electronic markets on behalf of a user.

Why electronic markets and auctions?

- Electronic markets have the potential for reduced costs and increased access to world-wide markets.
- Auctions are a general and proven way to negotiate among rational entities.

What's Missing in Current Online Auctions

- Bids can specify only simple constraints between items, typically logical conjunctions or disjunctions.
- There is no notion of time or of scheduling constraints, which is a problem for supply-chain management.
- Methods/strategies for managing the product life cycle.



Our Solutions

MAGNET

- Introduce the use of time in auctions, and
- to combine winner determination with satisfying scheduling constraints.

MinneTAC

- Coordinate internal behaviors with activities in multiple markets.
- Strategies for managing the product life cycle.

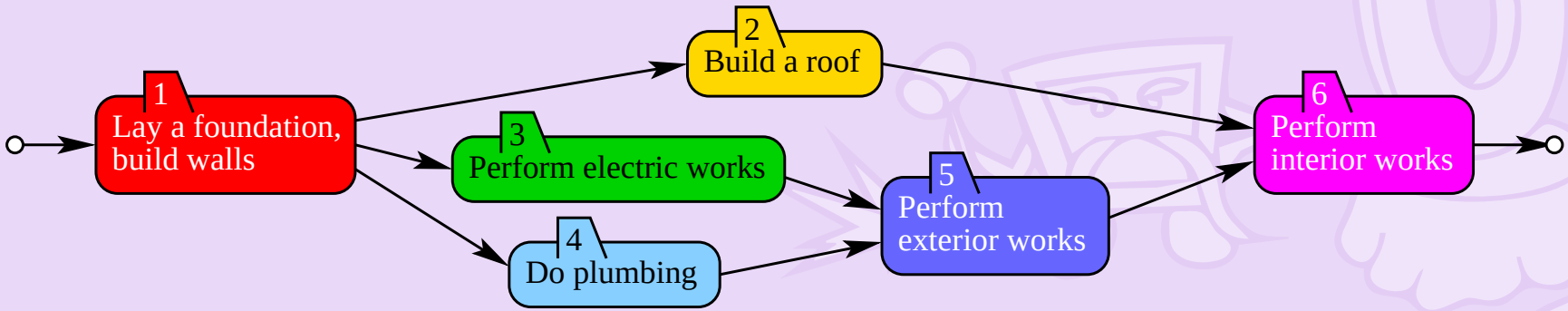
MAGNET in a Nutshell

The University of Minnesota MAGNET (Multi-AGent NEgotiation Testbed) system supports:

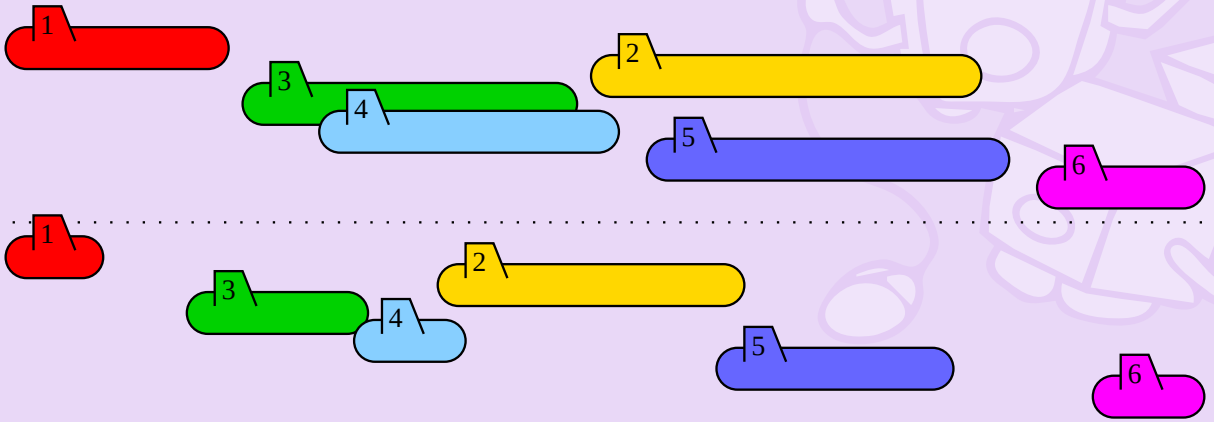
- market-mediated multi-agent interactions;
- multiple agents with different roles (customers and suppliers);
- negotiation of contracts for tasks with temporal and precedence constraints;
- automated first-price sealed-bid reverse combinatorial auctions.

Task Planning

A customer agent needs to complete a set of tasks with time and precedence constraints.

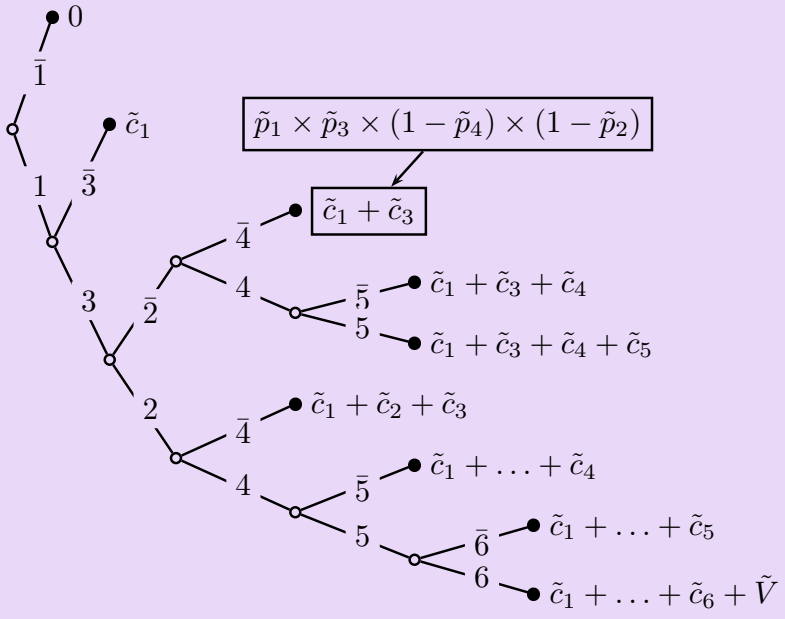


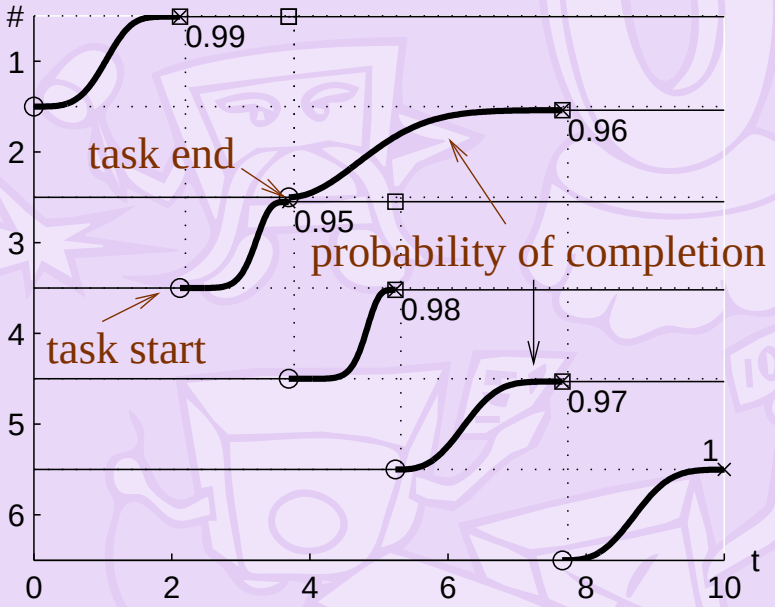
There are many ways of scheduling the tasks.



RFQ Generation

To generate a Request for Quotes (RFQ), the customer decides what ordering of tasks and durations will maximize its Expected Utility.

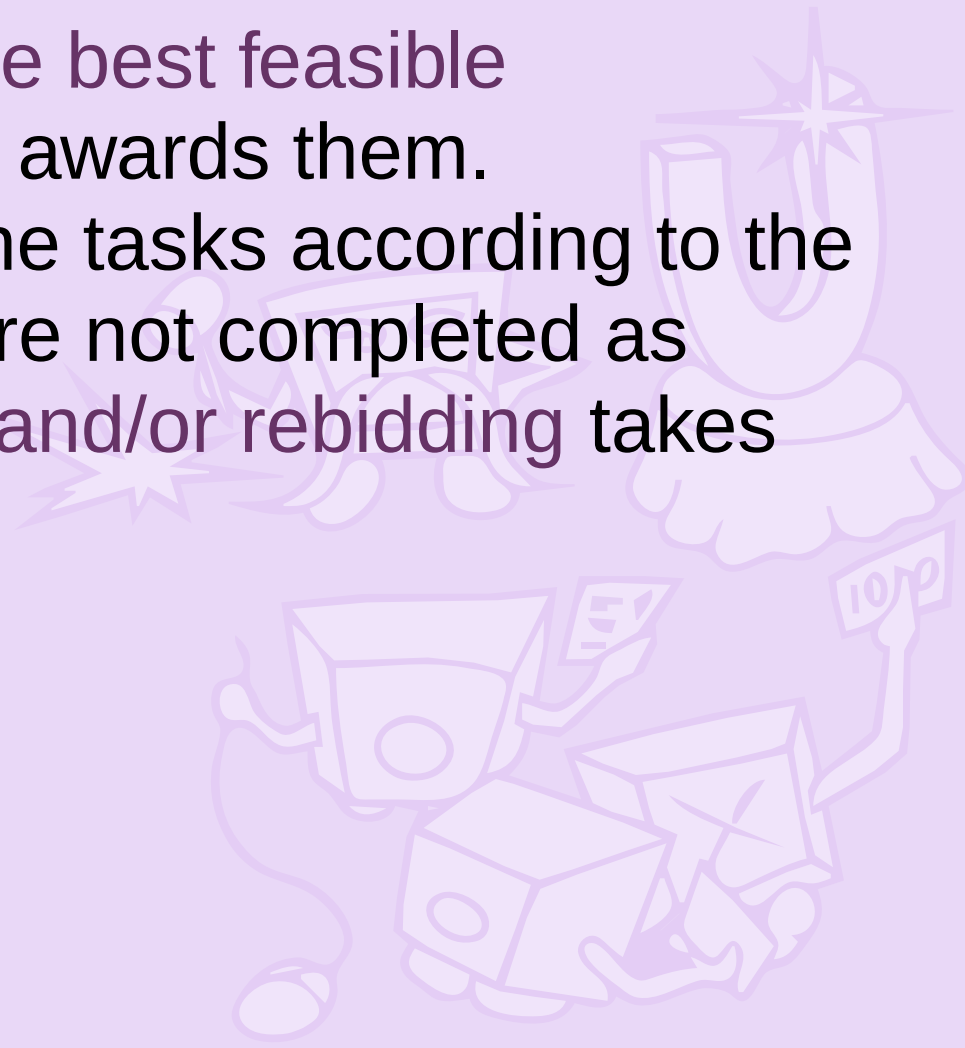




Event tree corresponding to an optimal schedule. The outlined event corresponds to the failure of tasks 2 and 4 after successful completion of tasks 1 and 3.

Winner Determination

The customer selects the best feasible combination of bids and awards them.
The suppliers execute the tasks according to the awarded bids. If tasks are not completed as expected, rescheduling and/or rebidding takes place.



Winner Determination

For m items and n bids

minimize $\sum_{i=1}^{n} c_i x_i$

subject to $x_i \in \{0, 1\}, i = \{1 \ldots n\}$ i.e. Bid Selection

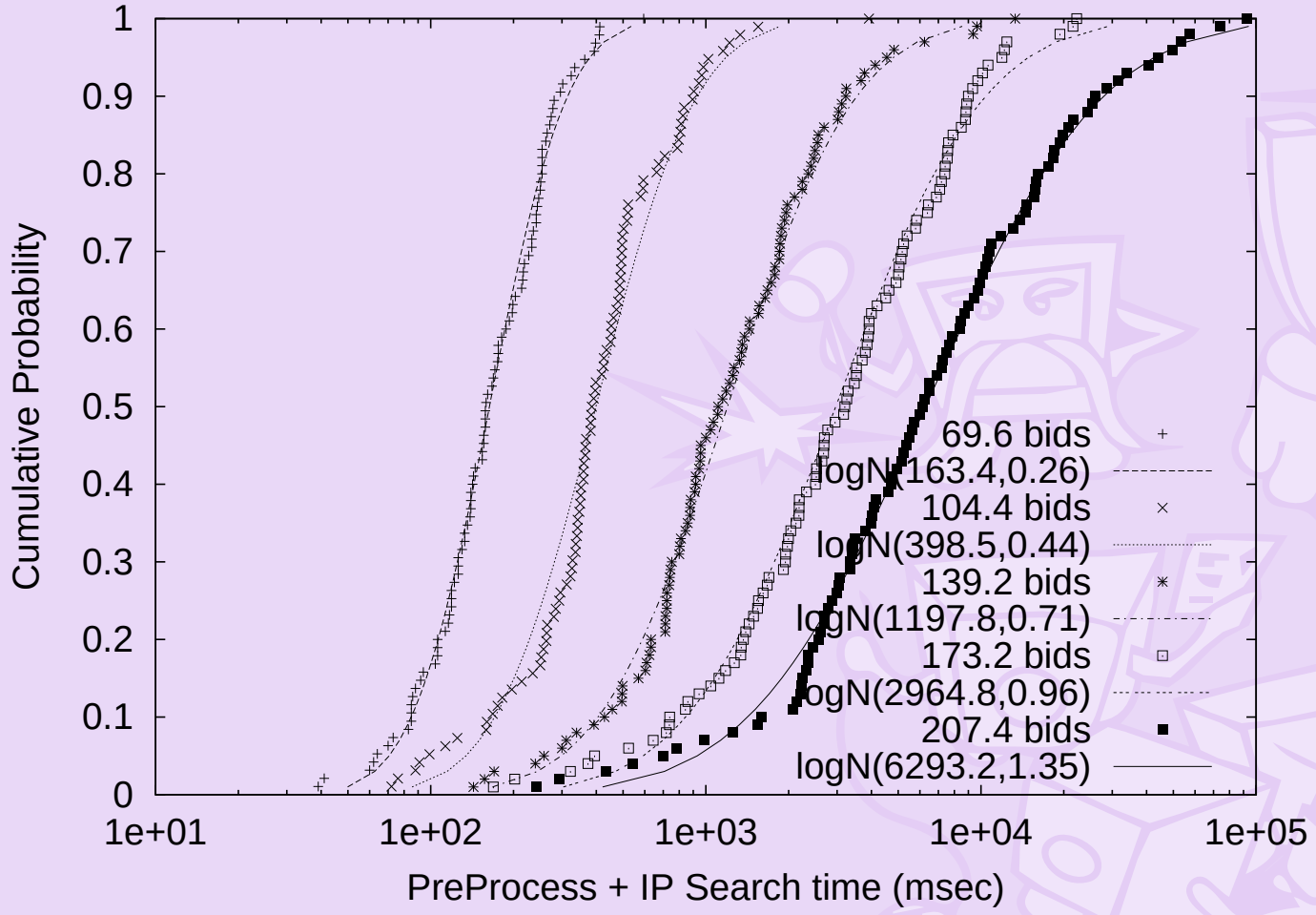
and $\sum_{i:s_j \in \mathcal{S}_i} x_i = 1$, for each $s_j \in \mathcal{S}_r$ i.e. Coverage

and Local Feasibility

where c_i is the bid price for bid b_i, $\mathcal{S}_i$ is the set of items in bid b_i. $i : s_j \in \mathcal{S}_i$ is the set of all i such that task s_j is in the set of tasks $\mathcal{S}_i$ in bid b_i.

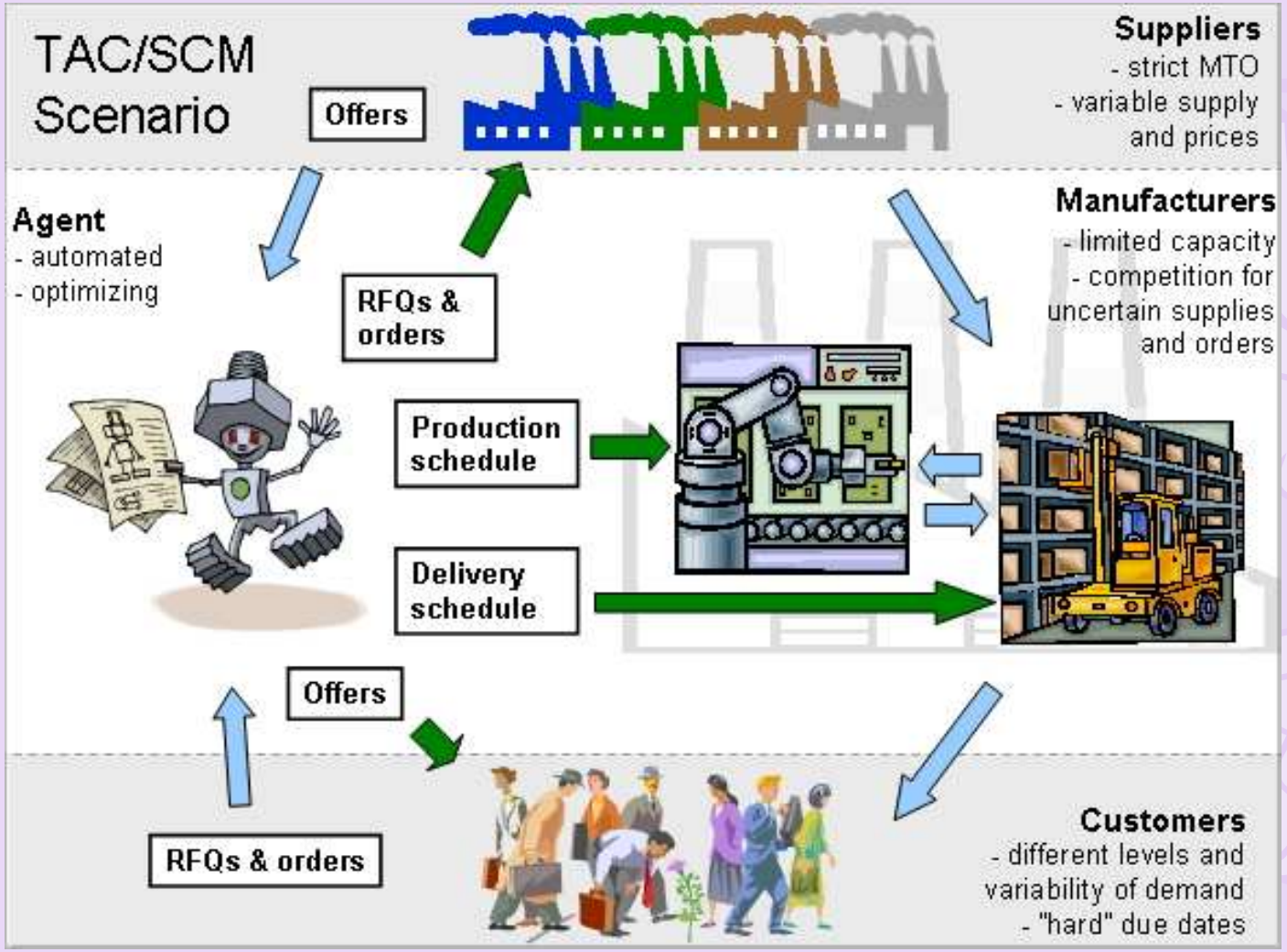
Estimating Solution Time

Learn to estimate the negotiation time line.



Observed and inferred runtime distributions for different numbers of bids, with 20 tasks and $\approx$ 7.3 tasks/bid.

Trading Agent Competition - Scenario



Trading Agent Competition - Analysis

Results for game 1807@tac5.sics.se http://tac5.sics.se:8080/tac5.sics.se/history/1807/

Result for game 1807@tac5.sics.se played 2003-10-18 16:22:00

Player	Revenue	Interest	Costs			Margin 1	Margin 2	Result
			Material	Penalty				
bravo	134 101 352	624 538	70 890 095	233 131	0%	47%	47%	63 602 664
alpha	128 960 111	1 226 772	76 884 575	318 106	0%	40%	41%	52 984 202
delta	117 144 262	418 112	86 936 149	479 968	1%	26%	26%	30 146 257
charlie	113 374 995	362 187	87 039 094	562 563	1%	23%	23%	26 135 525
Dummy	88 322 143	-2 242 042	65 031 470	62 219 168	49%	26%	-46%	-41 170 537
Dummy-2	82 196 450	-2 585 505	60 818 566	65 783 761	52%	26%	-56%	-46 991 382

Download game data here

Player	Orders	Utilization	Deliveries (on time/late/missed)	DPerf
bravo	7723	83%	7692 / 6 / 25	100%
alpha	7895	80%	7838 / 31 / 26	99%
delta	7129	74%	7058 / 28 / 43	99%
charlie	6758	73%	6685 / 17 / 56	99%
Dummy	6135	54%	150 / 3252 / 2733	2%
Dummy-2	6474	50%	376 / 2847 / 3251	6%

Margin 1 *is the margin excluding bank interest and penalties while* ***Margin 2*** *includes bank interest and penalties.*
DPerf *is the delivery performance.*

Conclusions

- Broad study of electronic markets.
- Ability to automate the negotiation process.
- Strategies for online supply chain management

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