Introduction to Multi-Agent-Programming

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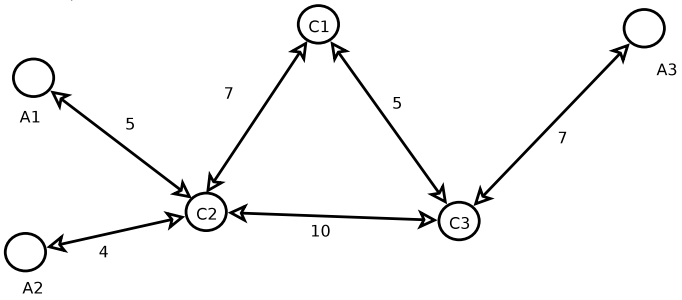
Exercise Sheet 7

Due: December 17th, 2008

Exercise 7.1 (Vickrey-Clarke-Groves auction (1.5pt; theoretical))

Consider an auction with multiple bidders $b_1 \dots b_n$ and multiple items $t_1 \dots t_m$ following the Vickry-Clarke-Groves mechanism. The bidders will be agents in a simulation environment bidding for the chance to visit a civilian, which are the items. Furthermore, the agents can be equipped with two groups of sensors being (Heat, CO_2) and (Audio, Motion). The agents A_1, A_2, A_3 (being bidders $b_1, \dots$) will be at the locations given by the graph.



Civilians $C_1, C2, C3$ will stay at the representative nodes in the graph.
Agent A_1 is equipped with both sensor groups (Heat, CO_2, Audio, Motion). Agent A_2 is equipped with (Heat, CO_2). Agent A_3 is equipped with (Audio, Motion).
Agents will assign their valuation v_{ij} (bidder i, item j) based on the new sensor readings they can get from a civilian and the costs to get there:

$$v_{ij} = u_{ij} - p_{ij}$$

Where u_{ij} will give 5 for each new sensor observation possible. If any agent has already sensed data, u_{ij} will be 0 for this component. Example: No agent has seen C_1, A_1 will have $u_{11} = 20$. If A_2 already observed C_1 in a previous round, $u_{11} = 10$. p_{ij} is the path cost to get from i's location to j's location.

(a) **Execute a VCG auction (1pt, written)** Show which agent is assigned which civilian in a VCG auction. Also give the values each agent is charged with and finally display their utility achieved under the VCG auction (i.e. their valuation - their charge).

(b) **Second round (0.5pt, written)** Now assume the agents have moved to the civilians they were assigned to and sensed data. Run a second

auction to determine, what will be the agents' next assignments, charges, and utilities. Take into account, that agents from the previous round have already sensed civilians.

Exercise 7.2 (Combinatorial Auctions)

An auctioneer is selling five items $M = \{a, b, c, d, e\}$. There are seven bids, $B_1 = (\{a, b\}, 9)$,$B_2 = (\{b, e\}, 12)$,$B_3 = (\{c, d, e\}, 10)$,$B_4 = (\{c\}, 6)$, $B_5 = (\{a, c\}, 13)$,$B_6 = (\{b, c, e\}, 16)$,$B_7 = (\{b, d, e\}, 18)$. The auctioneer wants to find the "Optimal Winners".

(a) **Branch-on-items (0.5pt, written)**
Please draw the search tree without any dummy bids; please draw the search tree with the dummy bids (each dummy bid gets the price 3).

(b) **Branch-on-bids (0.5pt, written)**
Please draw the search tree and the bid graph at each node.

(c) **Heuristic search (0.5pt, written)**
The heuristic function is

$$h(n) = \sum_{i \in A} \min_{j | i \in S_j} \frac{p_j}{|S_j|}$$

where n is a node in the search tree; A is unallocated items; S_j is the item set in a bid; p_j is the price for S_j. In addition to the defined seven bids, there are 13 extra: $B_8 = (\{b, e\}, 8)$, $B_9 = (\{c, e\}, 12)$, $B_{10} = (\{e\}, 8)$, $B_{11} = (\{a, b, d, e\}, 25)$, $B_{12} = (\{a\}, 5)$, $B_{13} = (\{d, e\}, 15)$, $B_{14} = (\{b, c, d, e\}, 20)$, $B_{15} = (\{a, e\}, 9)$, $B_{16} = (\{d\}, 6)$, $B_{17} = (\{b, c\}, 17)$, $B_{18} = (\{b\}, 7)$, $B_{19} = (\{b, d, e\}, 25)$, $B_{20} = (\{a, d, e\}, 19)$.
Use the "branch on bids" with the defined heuristic to compute the solution, please show the process (you don't need to draw a tree).

Please send your solution to dornhege and zhangd @informatik.uni-freiburg.de
*Note: We encourage you to submit the written solution in a **pdf** file. The latex template is available at the exercise web page.*