Multiagent Systems

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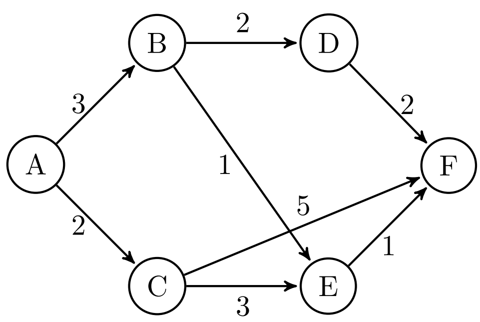
Exercise Sheet 10

Due: Friday, July 25, 2pm

Important: Each exercise sheet is to be solved in groups of **two students**. Thus, please note your names on each solution sheet and, if applicable, in the source code (as a comment on top of each source file). The solutions are to be handed in as pdf or plain text files (UTF-8 encoded) using the SVN. We strongly suggest the use of LaTeX for typesetting your solutions.
As always so far, you might solve the exercises in English or German.

Exercise 10.1 (VCG mechanism, 1+2+2 points)

Consider the problem of buying the shortest path in a transportation network (see Shoham and Leyton-Brown, p. 281). The transportation network is given by the following directed graph:



The numbers on the edges of this graph denote the agents' costs c for traversing the edge from one node to the other in the given direction. Thus, an agent's utility is $-c$ if a route involving the edge with cost c is selected, and zero otherwise. In other words, the agent "sitting" on the edge would be paid the amount c for traversing its edge.
The cheapest route to get from A to F is clearly $ABEF$ with a total cost of $3 + 1 + 1 = 5$. But how much would we have to pay each agent according to the VCG mechanism?
An example: The agent AC (owning the edge between the nodes A and C) is not pivotal to the shortest/cheapest path $ABEF$. Taking his declaration $c(AC) = 2$ into account leads to a cost of -5 for the other agents, because the path does not involve him anyways. Likewise the shortest/cheapest path without AC's declaration has cost -5. Thus, agent AC has not to pay (or gains) nothing, as $(-5) - (-5) = 0$.

(a) Which of the agents are pivotal and how is each of them to be paid? Explain your calculations step by step for each agent.

(b) The edges BE and EF both incur a cost of 1. However, the corresponding two agents do not receive the same amount of reward according to the VCG mechanism. Explain what that means.

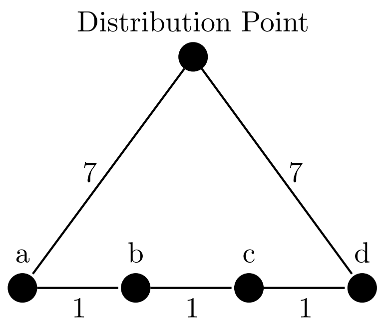
(c) How would the situation change, if the edge EF had a cost of 4 instead of 1? Calculate all payments of all agents again and discuss your result.

Exercise 10.2 (Bargaining, 1+4 points)

Consider the following Task Oriented Domain:

Description: Agents have to deliver sets of containers to warehouses, which are arranged on a weighted graph $G = G(V, E)$. There is no limit to the number of containers that can fit in a warehouse. The agents all start from a central distribution point. Agents can exchange containers at no cost while they are at the distribution point, prior to delivery.
Task Set: The set of all addresses in the graph, namely V. If address x is in an agent's task set, it means that it has least one container to deliver to x.
Cost Function: The cost of a subset of addresses $X \subseteq V$, i.e., $c(X)$, is the length of the minimal path that starts at the distribution point and visits all members of X.

We now consider a concrete example:
The reachability between warehouses a, b, c, d together with their reachability costs are given by the following undirected graph:



Two agents A_1 and A_2 start at the delivery point and both have to deliver boxes to warehouses a, b, c and d.

(a) Which value would A_1's utility have, if A_2 agreed to also take A_1's boxes to the warehouses? Explain.

(b) Apply the Zeuthen strategy for both agents as the negotiation strategy and explain the outcome as compared to the maximum overall utility.