Homework 2: Chapters 6 – 14

The following exercises are due at the beginning of class on **Thursday, November 17.** Some of these problems may take a while to solve, so I recommend that you work on this assignment over the course of multiple days.

1. ***[15 pts.]*** Imagine a multi-agent system in which all agents use the KQML communication protocol and understand the KIF language, but the agents do not all necessarily understand the same ontologies. Also, agents do not know ahead of time if other agents understand the same ontologies they do. However, there is a single translator agent (known to all agents) that can translate KIF content using symbols from one ontology into equivalent content using symbols from another ontology. Describe a protocol that would allow all agents to exchange messages and (eventually) understand the message they receive. You should describe what performatives are needed, the format of the content of these messages, and the procedure agents use for determining which messages to send. For details on KQML you may wish to refer to: http://www.cs.umbc.edu/kqml/kqmlspec/spec.html
2. ***[15 pts.]*** Consider the pursuit task, in which four predators attempt to surround and capture a prey. Assume that the predators and prey live on a 100x100 grid, and that each can only move one square in one of the four compass directions on each round. Only one animal can occupy a square at any given time. Each predator can only see up to three squares away from it (but can see in all directions). The predators can broadcast messages to each other, regardless of distance. A prey is captured when a predator moves into its square. Describe an appropriate coordination mechanism for the predators. Explain the rationale for your choices. You do not need to implement your solution, but it should be described at a sufficient level of detail that it could then be easily implemented by a competent programmer who is familiar with multi-agent systems.
3. ***[10 pts.]*** In "Towards Flexible Teamwork," Milind Tambe uses decision trees to calculate when an agent should communicate. Show the derivation of his formulas for communicating both under the conditions of Fig. 7 (p. 102) and under those of Fig. 8 (p. 103). Hint: Start with EU(**C**) > EU(**NC**), substitute and simplify.
4. ***[20 pts.]*** Use the following two payoff matrices to answer the questions on the reverse of the sheet.

Scenario I	i defects	i cooperates
j defects	3 3	4 2
j cooperates	1 1	2 4

Scenario II	i defects	i cooperates
j defects	-1 -1	2 1
j cooperates	1 2	-1 -1

a) For each scenario, what is each agent's preference ordering for the outcomes?

b) For each scenario, which non-mixed strategies (if any) are dominant for the players?

c) Does either scenario have any Nash equilibria? If so, what are they?

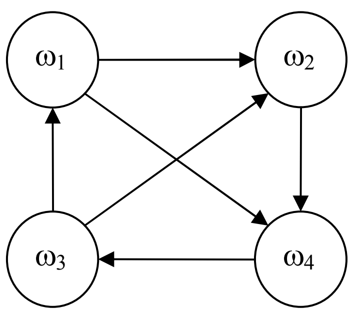
5. ***[10 pts.]*** Consider the following five possible outcomes for three self-interested agents a_1, a_2, and a_3 with utilities $u_i(\omega)$:

ω	**$u_1(\omega)$**	**$u_2(\omega)$**	**$u_3(\omega)$**
ω_1	10	10	12
ω_2	15	15	15
ω_3	25	0	0
ω_4	10	20	5
ω_5	10	40	10

a) Which of these outcomes maximize social welfare? There may be more than one. Show your work.

b) Which of these outcomes are Pareto efficient? There may be more than one.

6. ***[10 pts.]*** Consider the following majority graph:



a) Is there a Condorcet winner? If so, which candidate is it?

b) Design an agenda that will make ω_2 the winner.

c) Calculate the Slater ranking cost for social choice ordering: $\omega_2 >^* \omega_3 >^* \omega_1 >^* \omega_4$

d) Calculate the Slater ranking cost of social choice ordering: $\omega_3 >^* \omega_1 >^* \omega_2 >^* \omega_4$

7. ***[10 pts.]*** Under what conditions will the auctioneer receive a higher price for a good if they use a Vickrey auction as opposed to a first-price sealed-bid auction? For this problem, assume that the auctioneer does not lie and the bidders do not collude.

8. ***[10 pts.]*** Consider the following bid: $\beta_1 = (\{b,c\},3)$ XOR $(\{b,c,e\},4)$ XOR $(\{c,d\},5)$

a) Calculate $v_{\beta 1}(\{b\})$

b) Calculate $v_{\beta 1}(\{c\})$

c) Calculate $v_{\beta 1}(\{d\})$

d) Calculate $v_{\beta 1}(\{a,b\})$

e) Calculate $v_{\beta 1}(\{a,b,c,d,e\})$