Homework 2: Chapters 6-8, 11-12, 14-15

The following exercises are due at the beginning of class on **Tuesday, November 15**. 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. Note, there are problems on both sides of the sheet.

1. ***[10 pts.]*** Translate the following first-order predicate logic sentences into KIF. You may wish to refer to **http://logic.stanford.edu/kif/dpans.html** for details on KIF's syntax.
   a) $\text{In}(2,4) \wedge \text{Facing}(\text{north}) \wedge \neg\text{Dirt}(2,4)$
   b) $\exists\, x,y\ \text{NearAgent}(x,y) \wedge \text{SampleAt}(x,y)$
   c) $\forall x,c,u\ \text{TakesClass}(x,c) \vee \text{AttendsUniversity}(x,u) \Rightarrow \text{Student}(x)$
2. ***[10 pts.]*** Using the KQML language, describe how you would implement the Contract Net protocol. Specify the syntax of the performatives used (via templates or examples) at each step of the protocol. For details on the language, you may wish to refer to: **http://www.cs.umbc.edu/kqml/kqmlspec/spec.html**
3. ***[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

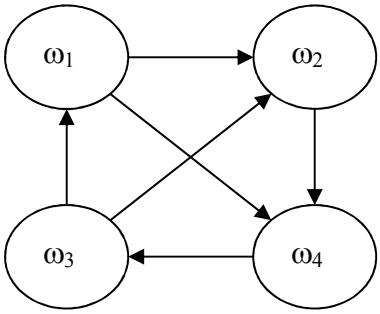
   a) Which of these outcomes maximize social welfare? There may be more than one. Show your work.
   b) Which of these outcomes are Pareto efficient? There may be more than one.
4. ***[20 pts.]*** Consider the following two payoff matrices:

	i defects	i cooperates
j defects	3 3	4 2
j cooperates	2 2	7 3

	i defects	i cooperates
j defects	5 8	3 4
j cooperates	2 2	7 3

   a) For each scenario, what is each agent's preference ordering for the outcomes?
   b) For each scenario, which strategies (if any) are weakly or strongly dominant?
   c) Does either scenario have any pure Nash equilibria? If so, what are they?

5. ***[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.
6. ***[5 pts.]*** Why are shills not a problem in Dutch, Vickrey, and first-price sealed-bid auctions?
7. ***[5 pts.]*** Consider a one-shot, open-cry, second-price auction. Assume that the agents have to reveal their bids in a random order. Give an example where an agent would be best off if it bid insincerely
8. ***[15 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: $\omega_3 >^* \omega_1 >^* \omega_2 >^* \omega_4$

9. ***[15 pts.]*** Consider a task-oriented negotiation domain in which there are two agents, the set of tasks T={a,b,c,d,e} are initially allocated as <{a,b},{c,d,e}>, and the cost function is c = ({a},4) ORMIN ({b},3) ORMIN ({c},5) ORMIN ({d},3) ORMIN ({e},2) ORMIN ({a,c},6) ORMIN ({b,d},4). Here an ORMIN bid works like an OR bid, but instead of choosing the value of the maximum covering bid, we choose the value of the minimum covering bid. This makes more sense in this context because agents want to do less work, as opposed to bids for goods, where agents want greater value.

   a) Is the deal <{a,c,e},{b,d}> individually rational for both agents? If not, which agents is it irrational for? Show your work.

   b) Suppose we are using the monotonic concession protocol and agent A_1 has proposed deal δ_1=<{b,d},{a,c,e}> and agent A_2 has proposed deal δ_2=<{b,d,e},{a,c}>. If both agents are using the Zeuthen strategy, which agent should concede on the next round? Show your work, including the cost and utilities of both deals to the agents, as well as the measure of each agent's willingness to risk conflict.