Homework 2: Chapters 6 - 9

The following exercises are due at the beginning of class on **Thursday, November 8**. 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. ***[8 pts.]*** Do Exercise 1 from Ch. 6 in the book (p. 127).
2. ***[12 pts.]*** Consider the following two payoff matrices:

	i defects	i cooperates
j defects	5 5	0 2
j cooperates	2 0	3 1

	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 strategies (if any) are weakly or strongly dominated?
   c) Does either scenario have any Nash equilibria? If so, what are they?

3. ***[15 pts.]*** Consider the following deals that are under consideration by three self-interested agents (a_1, a_2, and a_3). Each deal is specified in terms of three numbers, each of which represents the utility of the deal to one of the agents. That is, deal $d=(d_1,d_2,d_3)$ has utility d_1 for agent a_1, d_2 for agent a_2, and d_3 for agent a_3. The fallback position (the one that occurs if the agents cannot reach a deal), has the following utilities for the agents (4, 12, 8).

   A=(10,10,12)
   B=(15,15,15)
   C=(25,0,0)
   D=(10, 20, 5)
   E=(10,40, 10)

   a) Are all of these deals individually rational for all agents? If not, which ones are irrational for which agents?
   b) Which of these deals maximize social welfare? There may be more than one.
   c) Which of these deals are Pareto efficient? There may be more than one.

4. ***[15 pts.]*** Consider a task-oriented negotiation domain in which there are two agents, the set of tasks T={a,b,c,d,e}, and the cost function is defined as follows: c({a})=4, c({b})=3, c({c})=5, c({d})=3, c({e})=2. The cost of performing a set of tasks together is simply the sum of doing the tasks individually, except that if a and c are performed together, they sum to 6 (not 9), and if b and d are performed together, they sum to 4 (not 6). Assume that in the encounter <{a,b},{c,d,e}> 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.

5. ***[15 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. $In(2,4) \wedge Facing(north) \wedge \neg Dirt(2,4)$
   b. $\exists\ x,y\ NearAgent(x,y) \wedge SampleAt(x,y)$
   c. $\forall x,c,u\ TakesClass(x,c) \vee AttendsUniversity(x,u) \Rightarrow Student(x)$

6. ***[20 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

7. ***[15 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.