Homework 2: Chapters 6 - 15

The following exercises are due at the beginning of class on **Thursday, November 14**. 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) In(2,4) ∧ Facing(north) ∧ ¬Dirt(2,4)

    b) ∃ x,y NearAgent(x,y) ∧ SampleAt(x,y)

    c) ∀x,c,u TakesClass(x,c) ∨ AttendsUniversity(x,u) ⇒ 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.]* Describe the properties of a multi-agent environment in which proactive result sharing would be preferred over reactive result-sharing? What about one in which reactive result sharing is preferred?

4. *[20 pts.]* Consider the following two payoff matrices:

	i defects	i cooperates
j defects	-1	2
	-1	1
j cooperates	1	-1
	2	-1

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

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

5. *[5 pts.]* Is it possible to design a symmetric, 2x2 interaction where there are four pure Nash equilibria? If so, give an example payoff matrix for such a scenario.

6. *[5 pts.]* Why are shills not a problem in Dutch, Vickrey, and first-price sealed-bid auctions?

7. *[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	20	30	20
ω_2	15	10	75
ω_3	15	15	15
ω_4	20	7	5
ω_5	50	25	25

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.

8. *[15 pts.]* Consider the following preference profile for 100 voters. The numbers in the top row represent the number of voters with a specific preference order; the column underneath each number indicates the preference order for those voters, with preferred outcomes appearing above less preferred outcomes. Thus 16 voters have preference order b>d>c>e>a.

33	16	3	8	18	22
a	b	c	c	d	e
b	d	d	e	e	c
c	c	b	b	c	b
d	e	a	d	b	d
e	a	e	a	a	a

a) Is there a Condorcet winner? If so, which candidate is it? **Hint:** You may find it helpful to create a majority graph to answer this.

b) Determine the winners according to plurality and the Borda count.

c) Calculate the Slater ranking cost for social choice ordering: $c >^* d >^* b >^* a >^* e$

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) OR ({b},3) OR ({c},5) OR ({d},3) OR ({e},2) OR ({a,c},6) OR ({b,d},4).

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.