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REVISION EXAMINATIONS

Multiagent Systems

TIME ALLOWED : Two and a Half Hours

INSTRUCTIONS TO CANDIDATES

This is a mock paper containing four questions - solutions are available.

If you attempt to answer more questions than the required number of questions (in any section), the marks awarded for the excess questions answered will be discarded (starting with your lowest mark).

1. In the following linear sequential pairwise elections, candidates are shown, and the outcomes (i.e. the candidate that would win a pairwise election) is given, where $\Omega = \{\omega_a, \omega_b, \omega_c, \omega_d\}$:

$$\begin{aligned}
\{\omega_a, \omega_b\} &\longrightarrow \omega_a \\
\{\omega_a, \omega_c\} &\longrightarrow \omega_c \\
\{\omega_a, \omega_d\} &\longrightarrow \omega_a \\
\{\omega_b, \omega_c\} &\longrightarrow \omega_b \\
\{\omega_b, \omega_d\} &\longrightarrow \omega_d \\
\{\omega_c, \omega_d\} &\longrightarrow \omega_c
\end{aligned}$$

(a) Draw the majority graph that would represent these outcomes. (**3 marks**)

(b) Give an agenda that would result in the outcome ω_a in a linear pairwise election, if such an agenda exists. If not, explain why. (**3 marks**)

(c) Give an agenda that would result in the outcome ω_c in a linear pairwise election, if such an agenda exists. If not, explain why. (**3 marks**)

(d) Define a condorcet winner. Is there a condorcet winner in this linear sequential pairwise election? If so, what is it and why? If not, why not? (**4 marks**)

(e) If you wanted to change this setting so that ω_a was a condorcet winner, what one pairwise election would you change, and why? **(2 marks)**

(f) The *Gibbard-Satterthwaite Theorem* seems to be a very negative result in social choice theory. Explain what you understand by the Gibbard-Satterthwaite Theorem and its implications, and explain the implications of computational complexity with respect to this result. **(5 marks)**

(g) *Arrow's theorem* is a fundamental impossibility result in social choice theory. Explain what you understand by Arrow's theorem, and its implications. **(5 marks)**

2. In Searle's theory of Speech Acts, a speech act consists of two components, a *performative verb* and *propositional content*. Briefly explain what the following two KQML expressions mean:

(a)
```
(ask-if
   :sender      A
   :receiver    B
   :language    OWL
   :ontology    pizza
   :reply-with  q1
   :content ( (margherita isa Pizza)
              (margherita hasTopping mozzarella) )
)
```

(4 marks)

(b)
```
(tell
   :sender      A
   :receiver    B
   :language    OWL
   :ontology    pizza
   :reply-with  q1
   :content (not (hawaiian isa ItalianPizza))
)
```

(4 marks)

The Java Agent Development Environment provides a software framework to support the development of agents, whereby each agent is created in a threaded object known as a container. Each container is registered with the main container, which provides various services, including the *Agent Management System* and the *Directory Facilitator*.

(c) Briefly describe the role of the *Agent Management System*. (**4 marks**)

(d) Briefly describe the role of the *Directory Facilitator*. (**4 marks**)

It is often useful to distinguish ontologies based on their role (i.e. how they are going to be used). Briefly describe the role of each of the following:

(e) Upper Ontology (**3 marks**)

(f) Domain Ontology (**3 marks**)

(g) Application Ontology (**3 marks**)

3. In the context of cooperative games, consider the following marginal contribution net:

$$\begin{array}{rl} a \wedge c \rightarrow 8 & \text{Rule 1} \\ b \wedge \neg a \rightarrow 5 & \text{Rule 2} \\ c \wedge \neg a \rightarrow 2 & \text{Rule 3} \\ c \rightarrow 5 & \text{Rule 4} \\ b \wedge \neg c \rightarrow 3 & \text{Rule 5} \\ d \rightarrow 9 & \text{Rule 6} \\ d \wedge c \rightarrow 4 & \text{Rule 7} \end{array}$$

Let ν be the characteristic function defined by these rules. Give the values of the following, and in each case, justify your answer with respect to the rule or rules of the above marginal contribution net:

a) $\nu(\{\varnothing\})$ **(2 marks)**

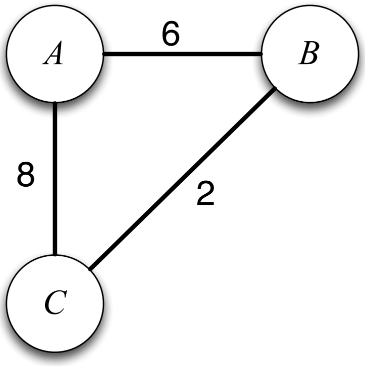
b) $\nu(\{a, c\})$ **(2 marks)**

c) $\nu(\{b, c, d\})$ **(2 marks)**

d) $\nu(\{b, c\})$ **(2 marks)**

e) $\nu(\{a, b, c, d\})$ **(2 marks)**

The following figure shows an induced sub-graph for a coalition game with agents $Ag = \{a, b, c\}$.



(f) Compute the Shapley values for the agents a, b, and c. You should show the relevant steps in your answer that are used to derive the answer. (**9 marks, 3 for each agent**)

4. Twenty three friends make plans to go to see a movie, and decide to use a Social Choice Function to decide on a genre. Each friend can be considered as an agent, such that we have $n = 23$ agents. The set of outcomes can be defined as

$$\Omega = \{\text{action, romance, comedy, drama, horror}\}$$

The preference schedule is shown below, and states how many votes are given for each preference order:

Votes	4	7	3	9
First Choice	action	romance	comedy	drama
Second Choice	drama	drama	action	horror
Third Choice	comedy	horror	drama	action
Forth Choice	romance	action	horror	romance
Fifth Choice	horror	comedy	romance	comedy

Given this preference schedule, calculate the winner (and in each case show the working) using:

a) Plurality voting **(2 marks)**

b) Alternative vote **(5 marks)**

c) The following payoff matrix (A) is for the “chicken”:

		i	
		defect	coop
j	defect	1 1	2 4
	coop	4 2	3 3

The following payoff matrix (B) is for the “matching pennies”:

		i	
		defect	coop
j	defect	-1 1	1 -1
	coop	1 -1	-1 1

The following payoff matrix (C) is for some other, unnamed game:

		i	
		defect	coop
j	defect	5 3	1 2
	coop	0 2	0 1

For each of these payoff matrices:

(i) Identify all (pure strategy) Nash Equilibria; (**6 marks**)

(i) Identify all Pareto optimal outcomes; (**6 marks**)

(iii) Identify all outcomes that maximise social welfare. (**6 marks**)