PAPER CODE NO. **COMP310**	EXAMINER : Michael Wooldridge DEPARTMENT : Computer Science Tel. No. 7790

UNIVERSITY OF LIVERPOOL

MAY 2007 EXAMINATIONS

Bachelor of Science : Year 3
Master of Science : Year 1

Multiagent Systems

TIME ALLOWED : Two and a Half hours

INSTRUCTIONS TO CANDIDATES

Answer **four** questions.

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).

Question 1

a) Briefly define and explain, with examples where appropriate, the properties you would expect an intelligent agent to exhibit.

[10 marks]

b) Briefly explain what you understand by the *intentional stance* and an *intentional system*, and explain the role that the intentional stance plays in the *agent-oriented programming* paradigm, as typified by the `AGENT0` programming language.

[5 marks]

c) The issue of telling an agent what to do (without telling it how to do it) is a central problem in multiagent systems. A number of approaches to this problem have been proposed, chief among them being the following:

– utility functions over states;

– utility functions over runs;

– predicates over runs;

– achievement tasks;

– maintenance tasks.

Explain what you understand by each of these approaches, making clear the relative advantages and disadvantages of each and how these approaches relate to one-another. Illustrate your answer with examples as appropriate.

[10 marks]

Question 2

The following pseudo-code defines a control loop for a practical reasoning ("BDI") agent.

```
B := B_0;
I := I_0;
while true do
    get next percept ρ;
    B := brf(B, ρ);
    D := options(B, I);
    I := filter(B, D, I);
    π := plan(B, I);
    while not (empty(π) or succeeded(I, B) or impossible(I, B)) do
        α := hd(π);
        execute(α);
        π := tail(π);
        get next percept ρ;
        B := brf(B, ρ);
        if reconsider(I, B) then
            D := options(B, I);
            I := filter(B, D, I);
        end-if
        if not sound(π, I, B) then
            π := plan(B, I)
        end-if
    end-while
end-while
```

With reference to this pseudo-code:

a) Characterise the level of commitment that the agent has with respect to its intentions and its plans. (When does an agent reconsider its intentions? When does it reconsider its plans?) Illustrate your answer with examples where appropriate.

[10 marks]

b) The $options(\cdots)$ function takes beliefs and intentions as arguments. Explain the intuition behind this function, and why it takes these arguments.

[5 marks]

c) The $filter(\cdots)$ function takes beliefs, desires, and intentions as arguments. Explain the intuition behind this function, and why it takes these arguments.

[5 marks]

d) Consider the $reconsider(\ldots)$ function: explain what properties this function should have, and the situations in which it can be assumed to be functioning optimally.

[5 marks]

Question 3

a) A *coalitional game with transferable payoff* is a structure $\langle Ag, v \rangle$. Explain what each of the components in the structure are, what they are intended to represent, and what the computational issues are if such structures are to be used for reasoning about multi-agent systems.

[5 marks]

b) *Weighted voting systems* are one type of coalitional game that is widely used and studied. Define what a weighted voting system is, and explain the extent to which a weighted voting system overcomes the problems you identified in part (a).

[5 marks]

c) A key issue in *coalition formation* is that of *stability*. Explain what you understand by this issue, and how the *core* tries to capture stability. (A pass mark in this question may be obtained with an informal answer, but full marks can only be obtained with the formal definition of the core.)

[5 marks]

d) Another key issue in coalition formation is that of *fairly distributing coalitional value*. Explain what you understand by this issue, and how the *Shapley value* tries to capture a fair distribution. In your answer, you should clearly explain the properties that the Shapley value satisfies. (A pass mark in this question may be obtained with an informal answer, but full marks can only be obtained with the formal definition of the Shapley value.)

[10 marks]

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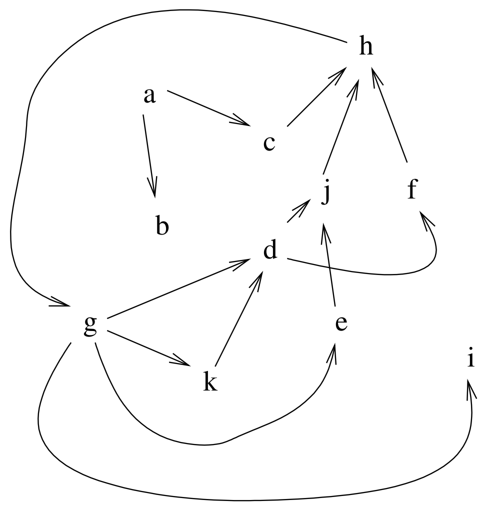
Question 4

a) The following figure shows an abstract argument system.



Compute the *grounded extension* of this argument system, giving the status (*in* or *out*) of the following arguments:

$$a \quad b \quad c \quad d \quad e \quad f \quad g \quad h \quad i \quad j$$

[2 mark each]

b) Define the notion of a *preferred extension* in an abstract argument system, and state potential advantages and disadvantages of preferred extensions as a model of justifiable positions.

[5 marks]

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Question 5

The following is the payoff matrix for the “game of chicken”.

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

With reference to this payoff matrix:

a) Define the notion of a Nash equilibrium strategy pair, explain why the concept of Nash equilibrium strategies is so important, and identify with justification which (if any) strategy pairs in this payoff matrix are in Nash equilibrium.

[10 marks]

b) Define the notion of a Pareto optimal outcome, explain why the concept of Pareto optimal outcomes is so important, and identify with justification which (if any) outcomes in this payoff matrix are Pareto optimal.

[10 marks]

c) Define what it means for an outcome to maximise social welfare, and identify with justification which outcome(s) in this payoff matrix maximise social welfare.

[5 marks]