西交利物浦大學
Xi'an Jiaotong-Liverpool University

PAPER CODE	EXAMINER	DEPARTMENT	TEL
CSE304		Computer Science and Software Engineering	

2^{nd} SEMESTER 2018/2019 - Final Examination
BACHELOR DEGREE - Year 4
MULTIAGENT SYSTEMS
TIME ALLOWED: 2 Hours

INSTRUCTIONS

1. The examination paper has five questions and the total marks are 100.
2. You need to answer ALL questions.
3. To obtain full marks for each question, relevant and clear steps should be included in the answers.
4. Partial marks may be awarded depending on the degree of completeness and clarity of your answers.

THIS PAPER MUST NOT BE REMOVED FROM THE EXAMINATION ROOM.

Question 1. [20 marks]

(a) The *TouringMachines* architecture is classified as a hybrid agent architecture. If you think that this statement is true, explain why and describe the overall operations of the *TouringMachines* architecture. Otherwise, give two reasons to explain why the *TouringMachines* architecture is not classified as a hybrid agent architecture.

[7 marks]

(b) Give two examples to show how to cheat in *English Auctions*?

[3 marks]

(c) Consider a *3-by-5 cell Vacuum World* as follows:

	a	b	c	d	e
3			*		
2	H		H		
1		R	*		*

where "R" represents a robot, "H" represents a hole and "*" represents dirt.

1. Develop a set of rules (including predicates and actions) that can be used to describe the above *3-by-5 cell Vacuum World*.
2. Use these rules to instruct the robot to clean up all the dirt starting from (1,b) while avoiding falling into any hole.

[10 marks]

Question 2. [20 marks]

(a) Explain what you understand by a "BDI" architecture?

[3 marks]

(b) The following pseudo-code defines a control loop for a practical reasoning DBI agent:

```
1.  B := B_0;
2.  I := I_0;
3.  while true do
4.     get next percept ρ;
5.     B := brf(B, ρ);
6.     D := options(B, I);
7.     I := filter(B, D, I);
8.     π := plan(B, I, Ac);
9.     while not (empty(π) and impossible(I, B)) do
10.       α := head(π);
11.       execute(α);
12.       π := tail(π);
13.       get next percept ρ;
14.       B := brf(B, ρ);
15.       if reconsider(I, B) then
16.          D := options(B, I);
17.          I := filter(B, D, I);
18.       end − if
19.       if not sound(π, I, B) then
20.          π := plan(B, I, Ac);
21.       end − if
22.    end − while
23. end − while
```

With reference to the above code, answer the following four questions:

1. What should be modified in this code if the commitment protocol "Open-minded commitment" is used?
2. What should be modified in this code if the commitment protocol "Overcommitted" is used?
3. Describe the "Single-minded commitment" strategy.
4. Assume the commitment protocol "Single-minded commitment" is used in the above code, explain the meanings and outcomes of the program construct: *reconsider*(I, B) in this code.

[8 marks]

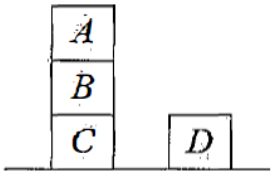

Figure 1: Initial configuration

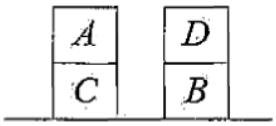

Figure 2: Goal configuration

(c) *Blocks World*: Consider the *initial* configuration in Figure 1 and the *goal* configuration in Figure 2.

1. Define a set (should be as small as possible) of predicates to describe the above two configurations.
2. Design a plan (which consists of a list of actions with "pre-condition list", "delete list" and "add list") that can be used to achieve the goal configuration, starting from the initial configuration.

[9 marks]

Question 3. [20 marks]

(a) Outline the main strengths of a *"Subsumption Architecture"*.

[2 marks]

(b) Design a subsumption architecture for the *3-by-5 cell Vacuum World* shown in Question 1.(c) and use *inhibition* to coordinate the behaviors.

[6 marks]

(c) Tom can play I, II, III or IV, and Mary can play V or VI. Consider the following *payoff matrix*:

	V	VI
I	7,4	6,4
II	5,3	5,4
III	4,3	6,3
IV	6,5	7,6

Determine if either player has any dominant strategy and justify your answer.

[3 marks]

(d) A *Pareto Optimum* cannot be a *Nash Equilibrium*. If the statement is true, explain it. Otherwise, give a counter-example.

[3 marks]

(e) Consider a two-player cooperative game with the following *payoff matrix*:

	x	y	z
a	10,10	15,9	4,0
b	0,15	0,0	1,0
c	0,4	0,1	5,5

Answer the following three questions:

1. Identify with justification, if any, the pairs that are in *Nash equilibrium*.
2. State whether any outcomes are *Pareto optimal* and justify your answer.
3. Identify with justification, if any, the pairs that maximize the social welfare.

[6 marks]

Question 4. [15 marks]

(a) Briefly describe the *Core* of a coalitional game and the *Shapley value*.

[3 marks]

(b) Consider the coalitional game with agents $Ag = \{a, b, c\}$ and characteristic function ν defined as follows:

- $\nu(\varnothing) = 0$
- $\nu(\{a\}) = 0$
- $\nu(\{b\}) = 0$
- $\nu(\{c\}) = 0$
- $\nu(\{a, b\}) = 1$
- $\nu(\{a, c\}) = 1$
- $\nu(\{b, c\}) = 1$
- $\nu(\{a, b, c\}) = 1$

State whether the *Core* of the above coalitional game is empty (with justifications).

[3 marks]

(c) The XJTLU table tennis team has three members: x, y, z and one coach: C. The university has suggested them to do the team training on every Tuesday. In order to reach an agreement, the coach and three members vote. If the coach agrees or if at least two of the three members agree (i.e., the team training on every Tuesday), then it passes. Consider the above-mentioned as a coalitional game with a set of players $\{C, x, y, z\}$, where the value of "the team training on every Tuesday" is 1. Answer the following two questions:

1. Let ν be the characteristic function defined by the above coalitional game, give the values of ν.
2. Calculate the *Shapley values* of the players. You are required to show the relevant steps in your answers on how you have obtained the values.

[9 marks]

Question 5. [25 marks]

(a) The XJTLU football team is asked by the club manager to vote among four possible club filming days: W (April 1), X (April 2), Y (April 3), and Z (April 4). The preference schedule is shown below:

Number of voters	4	6	7	8	12
1^{st} choice	Z	Y	X	X	W
2^{nd} choice	Y	W	Y	Z	Y
3^{rd} choice	X	Z	W	Y	X
4^{th} choice	W	X	Z	W	Z

With reference to the above preference schedule, answer the following four questions with justifications:

1. How many votes are needed for a majority?
2. Explain what you understand by a *Plurality method*?
3. When is the club filming day if the club manager uses the plurality method to count the votes?
4. Explain what you understand by a *Condorcet candidate* and identify the Condorcet candidate in the above vote (if there is any)?

[8 marks]

(b) An election is to be decided by the *Borda count method* to select one of five candidates: Albert, Boby, Chuck, Danny or Ebby. There are 1000 voters. If candidate Albert gets 2581 points, candidate Boby gets 1473 points, candidate Chuck gets 1888 points, and candidate Danny gets 3838 points, how many points does candidate Eddy get? Who wins the election?

[4 marks]

(c) A *Condorcet candidate* is also a *majority candidate*. If you think that this is true, explain it. Otherwise, give a counter-example.

[3 marks]

(d) The *Contract Net Protocol (CNP)* is one of the most widely used task allocation protocols in the multiagent systems world. It is quick, flexible and has low communication costs. However, it is quite limited in some issues and has shortcomings if the setting for task assignment is more complicated. Describe the five main phases of the *CNP* and what issues may arise in practice. Give also an example of the *CNP*.

[10 marks]

END OF PAPER