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 2017/2018 - Final Examination
BACHELOR DEGREE - Year 4
MULTIAGENT SYSTEMS
TIME ALLOWED: 2 Hours

INSTRUCTIONS

1. The examination paper has five questions.
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) Explain what you understand by a *hybrid agent architecture*. With the aid of an example, briefly describe the characteristics of the hybrid agent architecture including the overall operations and its layer interactions.

[7 marks]

(b) Give two examples to show how to cheat in *Sealed-Bid Auctions*?

[3 marks]

(c) Consider a 4-by-4 cell Vacuum World as follows:

	0	1	2	3
3		*	H	
2			*	
1	H			
0		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 4-by-4 cell Vacuum World.
2. Use these rules to instruct the robot to clean up all the dirt starting from (0,1) while avoiding falling into any hole.

[10 marks]

Question 2. [20 marks]

(a) What is a *Practical Reasoning*?

[3 marks]

The following pseudo-code defines a control loop for a practical reasoning ("DBI: Beliefs-Desires-Intentions") agent:

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

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

1. Discuss the commitment strategie(s) used in this code.
2. What should be modified in this code if the commitment protocol "Single-minded commitment" is used?
3. What should be modified in this code if the commitment protocol "Overcommitted" is used?
4. What should be modified in this code if the commitment protocol "Opened-minded commitment" is used?

[8 marks]

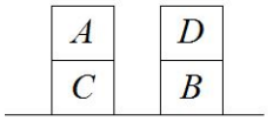


Figure 1: Initial configuration

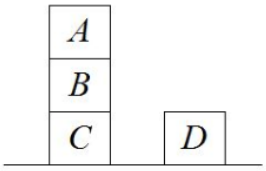


Figure 2: Goal configuration

(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 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) Explain the main principles of a *"subsumption architecture"*.

[3 marks]

(b) Design a subsumption architecture for the *4-by-4 cell Vacuum World* shown in Question 1.(c) and use *inhibition* to coordinate the behaviors.

[7 marks]

(c) Explain what is meant by a *Contract Net Protocol* (CNP) and briefly describe the five main stages of CNP. Also, give a practical example of a CNP.

[10 marks]

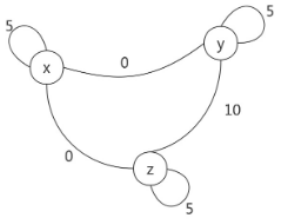
Question 4. [15 marks]

(a) In the context of coalitional games, answer the following two questions:

1. *The core is always nonempty.* If you think the statement is correct, then justify it. Otherwise, give a counterexample.
2. *Is the core always unique?* If your answer is yes, then justify it. Otherwise, give a counterexample.

[4 marks]

(b) Consider the following weighted subgraph representation of a characteristic function:



Let ν be the characteristic function defined by the above subgraph. Give the values of $\nu(\{x\})$, $\nu(\{y\})$, $\nu(\{z\})$, $\nu(\{x, y\})$, $\nu(\{x, z\})$, $\nu(\{y, z\})$, and $\nu(\{x, y, z\})$.

[5 marks]

(c) Consider the coalitional game with agents $Ag = \{x, y, z\}$, characteristic function ν as defined in Question 4.(b), and $\nu(\varnothing) = 0$. Compute the Shapley values for the agents x, y, and z. You are required to show the relevant steps in your answers about how you have obtained the values.

[6 marks]

Question 5. [25 marks]

(a) Give an example to explain why *"a Pareto efficent outcome might not be good"*.

[3 marks]

(b) Tom can play with strategies $\{A, B\}$; and Peter can play with strategies $\{C, D\}$. Consider the following *payoff* matrix:

	Tom A	Tom B
Peter C	(3,2)	(2,3)
Peter D	(2,0)	(0,2)

Answer the following three questions:

1. Determine if either Tom or Peter has any dominant strategy and justify your answer.
2. Identify all (pure strategy) Nash Equilibria and justify your answer (justification should consider all combinations of strategies applied from both Tom and Peter).
3. Identify with justification, if any, the pairs that maximise the social welfare.

[8 marks]

(c) Some CSE304 tennis club members are asked by the club manager to vote among five coaches: Adam, Bob, Chuck, David and Evan. The preference is shown below:

Number of Voters	20	12	10	8	4
1^{st} choice	Adam	Bob	Bob	Chuck	David
2^{nd} choice	Chuck	David	Chuck	Adam	Chuck
3^{rd} choice	Bob	Chuck	Adam	David	Bob
4^{th} choice	David	Adam	David	Bob	Adam
5^{th} choice	Evan	Evan	Evan	Evan	Evan

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

1. How many votes are needed to obtain a majority?
2. Who is the elected coach if the club manager uses the plurality method to count the votes?
3. Is there a *Condorcet candidate* in the above election?

4. Calculate the winner using a sequential pairwise voting with the agenda: Adam, Bob, Chuck, Evan.

[9 marks]

(d) The same election is to be decided by the *Borda count method* with 250 CSE304 tennis club members/voters. If Adams gets 442 points, Bob gets 1210 points, Chucks gets 1888 points, and Evan gets 10 points, how many points does David obtain? Who wins the election?

[3 marks]

(e) Explain why a Condorcet candidate is also a majority candidate.

[2 marks]

END OF PAPER