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

PAPER CODE	EXAMINER	DEPARTMENT	TEL
CPT302	K.L. Man	SAT	1509

2nd SEMESTER 2021/2022 -

Mock Assessment Paper

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.**

Question 1. [20 marks]

(a) Briefly describe the overall operation of the *InteRRaP* agent architecture including the layer interactions in *InteRRaP*.

[7 marks]

(b) Explain briefly the principal characteristics and differences between a *Vickrey auction* and a *Dutch auction*.

[3 marks]

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

	0	1	2	3
3	*			
2			*	
1	*			
0		R		*

where "R" represents a robot 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 the set of rules to show how the robot, starting from (0,1) cleans up all the dirt.

[10 marks]

Question 2. [20 marks]

(a) Explain what you understand by *Blind commitment*, *Single-minded commitment* and *Open-minded commitment*.

[3 marks]

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

```
1. B := B0;
2. I := I0;
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) or succeeded(I, B) or believeimpossible(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
```

(b) Recall that "Practical Reasoning = deliberation + means ends reasoning". With reference to the above code, answer the following questions:

1. What commitment protocol is used in this code?
2. What should be modified in this code if the commitment protocol "Opened-minded commitment" is used?
3. What should be modified in this code if the commitment protocol "Single-minded commitment" is used?
4. Assume the commitment protocol "Single-minded commitment" is used in the above code. When should an agent stop to reconsider its intentions?

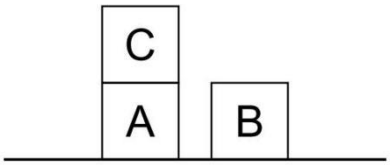


Figure 1: Initial configuration

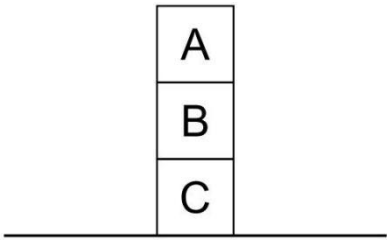


Figure 2: Goal configuration

[5 marks]

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

1. Define a set of predicates to describe the above configurations.
2. Design a plan (which consists of a sequence 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.

[12 marks]

Question 3. [20 marks]

(a) Describe what is an *"subsumption architecture"*. Give an example of subsumption architecture and explain how such a subsumption architecture operates.

[6 marks]

(b) With the aid of an example, illustrate why the concept of"cooperation" plays an important role in CDPS.

[4 marks]

(c) Describe the five stages of *task-sharing* protocol in *Contract Net* (including how the five stages work).

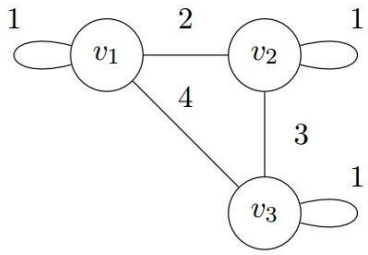
[10 marks]

Question 4. [20 marks]

(a) Explain what you understand by the *Core* of a coalitional game and what happens when the core is empty?

[3 marks]

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



Let μ be the characteristic function defined by the above subgraph. Give the values of $\mu(\{v_1\})$, $\mu(\{v_2\})$, $\mu(\{v_3\})$, $\mu(\{v_1, v_2\})$, $\mu(\{v_1, v_3\})$, $\mu(\{v_2, v_3\})$ and $\mu(\{v_1, v_2, v_3\})$.

[7 marks]

(c) Consider the coalitional game with agents $Ag = \{a, b, c\}$ and characteristic function v defined by the following:

- $v(\emptyset) = 0$
- $v(\{a\}) = 0$
- $v(\{b\}) = 0$
- $v(\{c\}) = 0$
- $v(\{a, b\}) = 90$
- $v(\{a, c\}) = 80$
- $v(\{b, c\}) = 70$
- $v(\{a, b, c\}) = 120$

Compute the Shapley values for the agents a, b, and c. You are required to show the relevant steps in your answers about how you have obtained the values.

[10 marks]

Question 5. [20 marks]

(a) In a survey, CPT302 students were asked to rank their favorite module among 4 modules: AI (Artifical Intelligence), BD (Big Data), CG (Computational Geometry) and DM (Database Management). The results are shown below:

Number of Voters	3	1	1	1	1	1	1
1^{st} choice	AI	AI	BD	BD	CG	CG	DM
2^{nd} choice	DM	BD	CG	CG	BD	DM	CG
3^{rd} choice	BD	CG	DM	AI	DM	BD	BD
4^{th} choice	CG	DM	AI	DM	AI	AI	AI

With reference to the above results, calculate with justification, the winner (i.e. the most favorite module) using:

1. plurarity voting.
2. the Borda count.
3. sequential pairwise voting with the agenda AI, BD, CG, DM.

[8 marks]

(b) Player 1 can play A, B, C or D; and Player 2 can play X or Y. Consider the following *payoff matrix*:

	X	Y
A	6,3	5,3
B	4,2	4,3
C	3,2	5,2
D	5,4	6,5

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

[4 marks]

(c) Consider the game where Player 1 plays A, B, C, D; and Player 2 plays R, Q, S, T with the following *payoff matrix*:

	R	Q	S	T
A	2,2	1,1	1,1	1,1
B	1,1	4,3	1,1	1,1
C	1,1	1,1	3,4	1,1
D	1,1	1,1	1,1	5,5

With reference to the matrix above, answer the following questions:

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

[8 marks]

End of the Mock Assessment Paper