**CONFIDENTIAL**



## UNIVERSITI TEKNOLOGI MALAYSIA

# **MID TERM TEST**

# **SEMESTER I 2014/5**

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| **SUBJECT CODE** | **: SCSJ3553 / SCJ3553** |
| **SUBJECT NAME** | : ARTIFICIAL INTELLIGENCE |
| **YEAR/COURSE** | **: 2, 3 (SCJ / SCV / SCB / SCD/ SCR)** |
| **TIME** | **: 2 HOUR** |
| **DATE** | **: 14 OKTOBER 2013** |
| **VENUE** | **: N28 BK1-BK6** |

**INSTRUCTIONS TO THE STUDENTS:**

This test book consists of 3 sections:

Part A: True / False Questions [15 Marks]

Part B: Short Explanation [20 Marks]

Part C: Theory and Applications [65 marks]

**ANSWER ALL QUESTIONS IN THIS QUESTION PAPER.**

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| **Name** |  |
| **I/C No.** |  |
| **Year/Course** |  |
| **Section** |  |
| **Lecturer Name** |  |

**SECTION A TOTAL 15 MARKS**

***Circle TRUE or FALSE for the following and state the reason for each of your answer. Each question carries 3 marks.***

1. Intelligent agent is a system that perceives and acts based on inputs from environments. This is an example of acts rationally.

TRUE / FALSE

REASON: *Intelligent agent is one that acts rationally*

1. x cat(x) ⇒ has\_paws(x) can be used to represent “all cats have paws”.

TRUE / FALSE

REASON: *We represent the statement in mathematical logic taking ‘x ‘as cat and which has paws*

1. In proposition logic, the syntax of a logic defines the syntactically acceptable objects of the logic, or well-formed formulae.

TRUE / FALSE

REASON: *The syntax of a logic is formed by acceptable objects of the logic and well-formed formulae*

1. In Artificial Intelligence, the knowledge representation should provide a natural scheme for expressing the required knowledge.

TRUE / FALSE

REASON: *Knowledge representation models the required knowledge based on a standard scheme*

1. Proposition logic involves not only logic, but also the generalization of a specific statement, including universal and existential.

TRUE / FALSE

REASON: *Propositional logic does not involves generalization elements of universal and existentials*

**SECTION B TOTAL 20 MARKS**

***Short Explanation Questions: Answer each question in the space provided. Each question carries 4 marks.***

1. Theoretically, it is possible to design a machine that can think rationally. There are two important elements involved, namely logic and reasoning. Explain briefly.

*Logic: concerns on the validity of an argument which is determined by its acceptable meanings*

*Reasoning: capacity for consciously making sense of things, applying logic, establishing and verifying facts, and changing or justifying practices, institutions, and beliefs based on new or existing information*

1. What is the differences between propositional logic and predicate logic? Provide TWO (2) differences.

*Propositional logic: based on truth table, represent acceptable meanings for an argument, do not require generalization (universal and existential), sentence is necessarily not or partially complete*

*Predicate logic: form a complete sentence in a form of logic, involve generalization if the required, represent feasible reasoning and verifiable facts*

1. Resolution is a technique for proving theorems in predicate calculus. The resolution refutation is one of the important practical application in resolution theorem proving. Briefly explain how the refutation applied in resolution theorem proving.

*Iteratively applying the resolution rule in a suitable way allows for telling whether a propositional formula is satisfiable and for proving that a first-order formula is unsatisfiable*

1. Application of inference rules is one of the proof methods. Give TWO (2) prominent characteristics of this method.

*Sound generation of new sentence from the old one*

*A proof is a sentence of inference rule application*

*Inference rules can be used as operators in a standard search algorithm*

1. Resolution consists of three parts: unit resolution, set of support, and input resolution. Explain briefly the input resolution and provide an example of proof involved.

*Input resolution: always combine a sentence from the query or knowledge base from another sentence*

*Example: modus ponen i.e.* x cat(x) ⇒ has\_paws(x) to cat(garfield) ⇒ has\_paws(garfield)

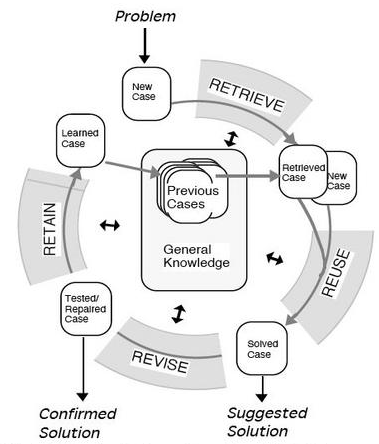
**SECTION C TOTAL 65 MARKS**

***Structured Questions: Answer questions in the space provided.***

1. a. An intelligent system should have the capability of act and think, both humanly and rationally.

i. According to the following figure, explain the process of think rationally.

Provide suitable real world application if possible. (3 marks)



**Reasoning**

**Logic**

*Given a premise, a logical consequence and a rule conditional that implies the conclusion given the precondition, one can explain that (not limited to):*

*- determines whether the truth of a conclusion can be determined for that rule, based solely on the truth of the premises;*

*- attempts to support a determination of the rule;*

*- Given a true conclusion and a rule, it attempts to select some possible premises that, if true also, can support the conclusion, though not uniquely*

*Example: weather forecast, economy climate prediction, disease diagnosis (anything related to prediction is acceptable)*

ii. Give an example of artificial intelligence application and describe the capabilities of think humanly and act rationally. (7 marks)

***Hint: Examples of applications such as iPhone’s Siri and Google search engine***

*Think humanly: The cognitive modelling approach; If the program's input/output and timing behavior matches human behavior, that is evidence that some of the program's mechanisms may also be operating in humans.*

*Example: any related application in the areas of vision, natural language, and learning*

*Act rationally: Turing’s test - to provide a satisfactory operational definition of intelligence; These programs must behave according to certain normal conventions of human interaction in order to make themselves understood*

*Example: any related application in the areas of human-computer interface, robotics*

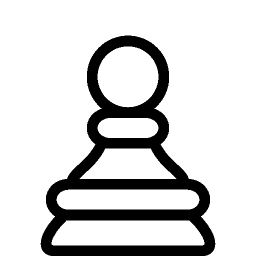
1. b. The building block of an intelligent system is knowledge representation, searching and reasoning abilities.

i. Describe how knowledge can be represented and provide an example.

You can draw illustrations if necessary. (2 marks)

*To represent information about the world in a form that a computer system can utilize to solve complex tasks such as diagnosing a medical condition. Any related illustration i.e. semantic network, predicate logic, etc is acceptable*

ii. Given a chess game as in the following figure, extract a knowledge representation and propose a searching step (in a form of flowchart, pseudocode, or mathematical formulation i.e. predicate logic) to allow the knight moves and defeat the pawn. (Assume that the pawn is never moved) (8 marks)



1 2 3 4 5 6

A

B

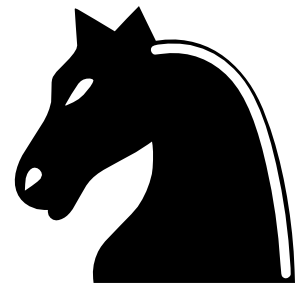
C

D

E

F

G



KNOWLEDGE REPRESENTATION (MOVES IN ‘L’ DIRECTION)

move(B1,D2)

move(D2,C4)

move(C4, D6)

move(D6,B5)

…

SEARCHING

**B1**

**(B1,A2)**

(B1,D2)

**(A2,C3)**

(A2,B4)

(D2,B3)

(D2,C4)

(B4,D5)

(B4,A6)

(B3,A5)

(C4,A5)

(C4,D6)

(C3,E4)

**(C3,B5)**

(B3,D4)

2. a. Convert the English sentences in parts (i) – (v) into standard predicate logic sentences using the predicates indicated. (15 marks)

i. Every member in the club is either a mountain climber or a skier or both.

∀x[member(x) ⇒ (mc(x) ∨ sk(x)) ∨ (mc(x) ∧ sk(x)) ]

ii. A likes whatever B dislikes and dislikes whatever B likes.

∀x[like(B, x) ⇒ ¬like(A, x)] ∧ ∀x[¬like(B, x) → like(A, x)]

iii. Men can have beard. Dollah is a man. He does not have a beard.

∃x men(x) ⇒ beard(x)

so, men(Dollah) ⇒ ¬beard(Dollah) is acceptable

2. b. Convert the following predicate logic formulas into clause form.

(10 marks)

* 1. ∀x ((student(x) ∧ love(x, Mary)) happy(x))) (2 marks)

∀x, [ ¬ (student(x) ∧ love(x, Mary)) ˅ happy(x) ]

∀x ,[¬ (student(x) ˅ ¬ ( love(x, Mary)) ˅ happy(x)]

Remove ∀x:

¬ student(x) ˅ ¬ love(x, Mary) ˅ happy(x)

* 1. ∀x food(x)  likes (john,x) (2 marks)

∀x ¬ food(x) ˅ likes(john,x)

Remove ∀x:

¬ food(x) ˅ likes(john,x)

* 1. ∀x IsAStudent(x) ∧ IsTakingAI(x) ⇒ IsCool(x) (2 marks)

∀x ¬ (IsAStudent(x) ∧ IsTakingAI(x) ) ˅ IsCool(x)

∀x ¬ IsAStudent(x) ˅ ¬ IsTakingAI(x) ˅ IsCool(x)

Remove ∀x:

¬ IsAStudent(x) ˅ ¬ IsTakingAI(x) ˅ IsCool(x)

* 1. ∀x EatsRamen(x) ⇒ IsHomeless(x) ∨ IsAGradStudent(x) (2 marks)

∀x ¬ EatsRamen(x) ˅ IsHomeless(x) ˅ IsAGradStudent(x)

Remove ∀x:

¬ EatsRamen(x) ˅ IsHomeless(x) ˅ IsAGradStudent(x)

* 1. ∃x Mushroom(x) ∧ Poisonous(x) ∧ Purple(x) (2 marks)

Remove ∃x:

Mushroom(x) ∧Poisonous(x) ∧Purple(x)

Separate into three 3 clauses:

Mushroom (x)

Poisonous (x)

Purple (x)

3. a. What are the differences between these two search strategies? (4 marks)

i. Backward Chaining

*goal-driven state space searching. Search takes the goal, sees what rules applied and which conditions are true to be used. The condition becomes subgoal, search continues backward through rules and subgoals to the given facts*

ii. Foreward Chaining

*data-driven state space searching, starts from given data of a problem toward a goal. given facts, rules ,Apply rules to facts to produce new facts. search continues until a path that satisfies goal is generated*

3. b. For each case below, which strategy is recommended, explain why you determine so? (4 marks)

1. A teacher investigates his students’ signs of difficulty to understand a specific topic as clues that can help to determine a better way to deliver the subject matters.

*goal- directed. Presence of clueness as the goal. The teacher will refer to his/her knowledge, conditions that justify the difficulty in understanding the subject matter. He will search through the condition as the subgoal to reach the decision to deliver better.*

1. Archeologist plan tofind what fossils to be found at a specific site.

*Data-directed. With information gathered at initial state in the site, scientist will interpret and move to next state through the path that most probably leads to finding the desired minerals*

3. c. Figure 2 illustrates a salesman traveling problem (TSP). Suppose a salesperson has four cities, says X, Y, Z, and W, to visit and then must return to starting city. The route of the salesperson is given by the below graph. Assume that X is starting city of the salesperson and a value in arc is distance of two cities.

8

X

Y

Z

W

5

6

7

3

4

**Figure 2**

Based on the salesman traveling problem (TSP) above, answer the following questions (i) – (v):

i. Give the state space of the TSP problem. (3 marks)

*N=set of nodes={X, Y, Z, W},*

*A=set of arcs={XY, YW, WZ, ZX, XW, ZY},*

*S=start state={X}, and GD=goal state={X|salesperson has shortest path for traveling from X, visit each city exactly once, and return back to X}.*

*Hence, state space of the problem is [N, A, S, GD]*

ii. Draw the search tree of the above TSP. (5 marks)

X

Y

Z

W

Z

W

X

W

Z

X

X

X

X

X

Y

W

W

Y

Y

Z

Z

Y

iii. Determine the shortest path and its length. (2 marks)

*shortest path is XZYWX and its cost is 12*

iv. If the backward chaining algorithm is applied, how do you determine the desired series of visits? (2 marks)

*The desired series of visits will be the path from the starting any city except city X, then visiting other cities exactly once and end by returning back to X. Since cities cannot be revisited, the solution path should avoid and cannot include visits of a city which has already been visited i.e. avoid visiting the same city again*