CONFIDENTIAL

UNIVERSITI TEKNOLOGI MALAYSIA

MID TERM TEST

SEMESTER I 2015/2016

SUBJECT CODE	**: SCSJ3553 / SCJ3553**
SUBJECT NAME	**: ARTIFICIAL INTELLIGENCE**
YEAR/COURSE	**: 2, 3 (SCJ / SCV / SCB / SCD/ SCR)**
TIME	**: 8.00 – 11.00PM (3 HOUR)**
DATE	**: 22 OCTOBER 2015**
VENUE	**: LECTURE ROOM (BK1-7), N28**

INSTRUCTIONS TO THE STUDENTS:

This test book consists of 3 sections:

Part A: True / False Questions [20 Marks]

Part B: Short Explanation [20 Marks]

Part C: Theory and Applications [60 marks]

ANSWER ALL QUESTIONS IN THIS QUESTION PAPER.

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

SECTION A **TOTAL 20 MARKS**

Circle TRUE or FALSE for the following questions. Each question carries 2 marks.

1. Artificial Intelligence is a branch of computer science which studies the concept of human intelligence to be adapted by a computer program.

   TRUE / ~~FALSE~~

2. An intelligent system is said to be acting humanly if the program responses to a textual natural-language conversation that cannot be distinguished from that of a human being.

   TRUE / ~~FALSE~~

3. The following statement is an example of a propositional logic syntax:

   'Success' is spelled with six letters.

   ~~TRUE~~ / FALSE

4. Given a conditional statement as follow:

   If it rains this morning, I will drive to school.

   The contrapositive of this conditional statement is:

   If I don't drive to school, then it had not rain this morning.

   TRUE / ~~FALSE~~

5. Given a natural language statement as follow:

   Everyone taking AI loves Green Technology.

   The universal quantifier is:

   $\forall x\ Taking(x, AI) \wedge loves\_Green\_Technology(x).$

   ~~TRUE~~ / FALSE

6. Unification proves a theorem by negating the statement to be proved and adding this negated goal to the set of axioms that are known to be true.

   ~~TRUE~~ / FALSE

7. In Euler theorem for solving the traveling sales person problem, the graph must have at least one or none node with odd degree.

   ~~TRUE~~ / FALSE

8. Given a graph-based problem, the total cost is a sum of search cost and the corresponding path cost.

   TRUE / ~~FALSE~~

9. Breadth-first search algorithm applies last-in-first-out (LIFO) queue strategy, in which the graph traverse by expanding the branch.

   ~~TRUE~~ / FALSE

10. Heuristics: a rule or other piece of information that is used to make methods such as search more efficient or effective. It is an estimation of the distance to the goal.

    TRUE / ~~FALSE~~

SECTION B **TOTAL 20 MARKS**

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

1. Expert System is one of the artificial intelligence application areas. What is the basis of expert systems? Provide an example of expert system in your answer.

   ANSWER: The basis of expert system is the use of large amount of domain-specific knowledge in solving problem. It relies on knowledge of human domain expert for system's solving strategies. For example, in medical, expert system that is used for diagnosing blood disease (MYCIN) is based on the knowledge of a doctor (as the domain expert). {Any appropriate example is accepted }
   Basis : 2 marks
   Example : 2 marks (should provide the specific human domain expert e.g..doctor, geologist..)

2. Explain think humanly and act rationally. Give an example for each characteristic.

   ANSWER:

   Think humanly: keyword – cognitive learning, how brain works, adapt problem solving from human

   Example: predictive text in sms, decision making system etc

   Acting rationally: keyword – smart robotics, response directly as human do, higher reasoning

   Example: swarm robotics, smart home, face detection for terrorist

3. Propositional logic is a system of symbolic logic using symbols to stand for whole propositional and logical connectives. Describe what does a proposition handles.

   ANSWER: A proposition is a statement that is either true or false but not both.

4. By giving appropriate examples, applies the use of moden ponen and universal elimination.

ANSWER:

An example of an argument that fits the form modus ponens:

> If today is Tuesday, then John will go to work.
>
> Today is Tuesday.
>
> Therefore, John will go to work.

This argument is valid, but this has no bearing on whether any of the statements in the argument are true; for modus ponens to be a sound argument, the premises must be true for any true instances of the conclusion. An argument can be valid but nonetheless unsound if one or more premises are false; if an argument is valid and all the premises are true, then the argument is sound. For example, John might be going to work on Wednesday. In this case, the reasoning for John's going to work (because it is Wednesday) is unsound. The argument is not only sound on Tuesdays (when John goes to work), but valid on every day of the week.

Example: "All dogs are mammals. Fido is a dog. Therefore, Fido is a mammal."

In symbols the rule as an axiom schema is

$$\forall x\, A(x) \Rightarrow A(a/x),$$

for some term *a* and where $A(a/x)$ is the result of substituting *a* for all occurrences of *x* in *A*.

And as a rule of inference it is

from $\vdash \forall x\, A$ infer $\vdash A(a/x)$,

with $A(a/x)$ the same as above.

5. What is the difference between blind search and heuristic search? Name one algorithm for each search.

   ANSWER:

   Blind \ Exhaustive Search

   - Goal is clear
   - Require significance amount of memory and computational time

   Example: breadth- and depth-first search

   Heuristics Search

   - Goal is not available
   - Based on experience (heuristics evaluation function)

   Example: best first search and hill climbing

SECTION C **TOTAL 60 MARKS**

Structured Questions: Answer questions in the space provided.

Question 1 (20 marks)

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

i. According to the following figure, describe the process of act humanly. Based on your answer, illustrate how intelligence is adapted to a computer program. (3 marks)

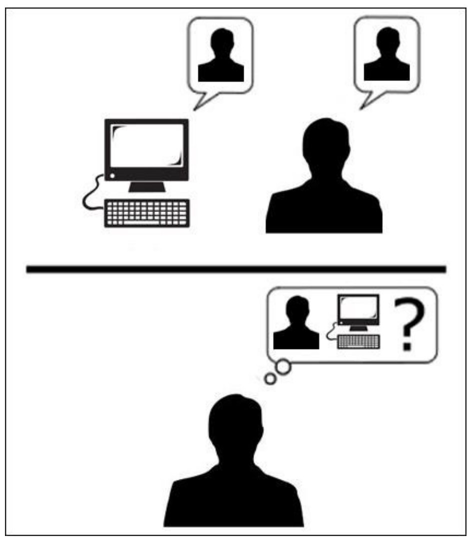


Figure 1: Turing Test

ANSWER: Turing test – user is given a terminal to query which will be answer by both human and computer program from different, unlabeled and closed room. The user will detect difference of answers at the beginning until at one point the answer cannot been distinguished.

ii. In act rationally, a computer program is capable to perceive the environment and is able to execute actions to change it. One of the examples is a spam filter, which it adapts over time depending on the incoming email. Examine how the spam filter can perceive its environment. (7 marks)

ANSWER:

Spam filter identifies incoming emails as spams due to several conditions, such as number of recipients and suspicious sender's emails. In Gmail, the content of the email is also considered, i.e. include malware attachment and undefined link. Based on this example, it would be suggested that the spam filter in Gmail can perceive its environment accordingly. The environment may be defined as the content of the emails, which in some email services, the content is not considered. It is important for current usage due to the fact that the phishing approaches have been widely used and letting the filter to examine the number of recipients is currently not enough. This is adapted by normal human reasoning, which has been translate into computer readable program.

* Any related figure drawn by students could be accepted

B. The building block of an intelligent system is knowledge representation, searching and reasoning abilities. In the rubik's cube problem, each voxel could be assigned according to certain values, as depict in Figure 2.

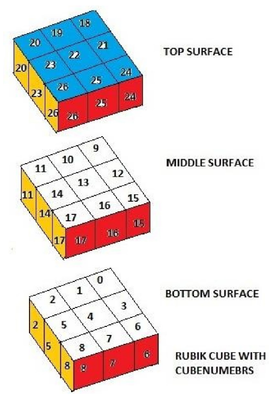


Figure 2: Rubik's cube problem

i. Based on Figure 2, propose an idea of representing the problem into the knowledge. (3 marks)

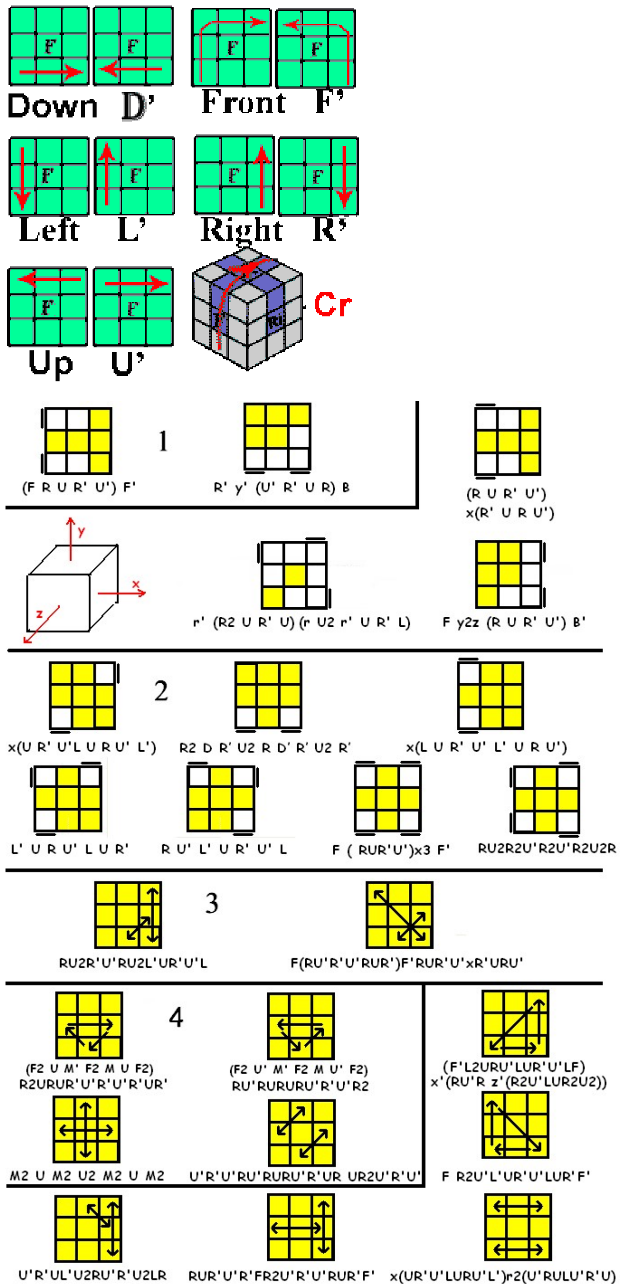
ANSWER:

Each voxel of the cube is valued based on neighbouring color, i.e. a red voxel is assigned with higher value if the neighbouring voxels share same color. Another way of representing the knowledge is to assign the values based on the location of each voxel i.e. top, bottom, middle surface using following example (* any related figure drawn by the student is accepted)

			41	42	43					
			44	4	45					
			46	47	48					
24	18	9	1	2	3	17	23	32	40	39
25	3	10	4	1	5	16	5	31	37	6
26	19	11	6	7	8	15	22	30	35	34
			12	13	14					
			20	2	21					
			27	28	29					

ii. Suggest an algorithm or pseudocode to find at least a surface with complete color. (7 marks)

ANSWER:



* any related movement is accepted

Question 2 (20 marks)

A. A system of symbolic logic using symbols to stand for whole propositions and logical connectives. Propositional logic only considers whether a proposition is true or false

i. Consider the proposition *m* below

“I am going to LEGOLAND if I pass this test.”

Write the converse of the proposition *m* in simple English. (1 marks)

ANSWER: If I pass this test, I am going to LEGOLAND.

ii. Write the contrapositive of the proposition *m* in simple English. (1 marks)

ANSWER: If I do not pass this test, I will not go to LEGOLAND.

iii. Write the inverse of the proposition *m* in simple English. (1 marks)

ANSWER: I am not going to LEGOLAND if I do not pass this test.

B. Write the truth table for the propositions below: (7 marks)

i. $(p \wedge q) \rightarrow \neg r$

ii. $p \wedge (\neg q \vee r)$

iii. $p \rightarrow (\neg q \vee r)$

ANSWER:

p	q	r	$\neg q$	$\neg r$	$p \wedge q$	$(p \wedge q) \rightarrow \neg r$	$\neg q \vee r$	$p \wedge (\neg q \vee r)$	$p \rightarrow (\neg q \vee r)$
T	**T**	**T**	**F**	**F**	**T**	**F**	**T**	**T**	**T**
T	**T**	**F**	**F**	**T**	**T**	**T**	**F**	**F**	**F**
T	**F**	**T**	**T**	**F**	**F**	**T**	**T**	**T**	**T**
T	**F**	**F**	**T**	**T**	**F**	**T**	**T**	**T**	**T**
F	**T**	**T**	**F**	**F**	**F**	**T**	**T**	**F**	**T**
F	**F**	**T**	**T**	**F**	**F**	**T**	**T**	**F**	**T**
F	**T**	**F**	**F**	**T**	**F**	**T**	**F**	**F**	**F**
F	**F**	**F**	**T**	**T**	**F**	**T**	**T**	**F**	**T**

1m 1m 2m 3m

C. You are given the following statements;

If it is sunny and warm day you will enjoy. If it is warm and pleasant day you will go cycling. If it is raining there will be no cycling. If it is raining you will get wet. It is warm day. It is sunny.

Using the above statements, construct a proof by ***refutation resolution*** for:

'You will enjoy'.

Use the following notation to represent the problem. (10 marks)

S	**:**	**It is sunny**
W	**:**	**It is warm**
R	**:**	**It is raining**
P	**:**	**It is pleasant**
C	**:**	**Go Cycling**
E	**:**	**Enjoy**
Wt	**:**	**Get Wet**

ANSWER

1) If it is sunny and warm day you will enjoy. (1.5 marks)

$S \wedge W \Rightarrow E$

Implication elimination,

$\neg(S \wedge W) \vee E$,

Use de Morgan,

$\neg \mathbf{S} \vee \neg \mathbf{W} \vee E$…….(1)

(2) If it is warm and pleasant day you will go cycling. . (1.5 marks)

$W \wedge P \Rightarrow C$

Implication elimination,

$\neg(W \wedge P) \vee C$,

1.5 marks

Use de Morgan,

$\neg \mathbf{W} \vee \neg \mathbf{P} \vee C$…….(2)

(3) If it is raining then no cycling. . (1 mark)

$R \Rightarrow \neg C$ 1 mark

Implication elimination,

$\neg \mathbf{R} \vee \neg C$,……..(3)

(4) If it is raining you will get wet. (1 mark)

$R \Rightarrow \mathbf{Wt}$ 1 mark

Implication elimination,

$\neg \mathbf{R} \vee \mathbf{Wt}$,……..(4)

(5) It is warm day. (0.5 mark)

W …………(5) } 0.5 mark

(6) It is sunny. (0.5 mark)

S…………(6) } 0.5 mark

Add the negation of goal (7), (1 mark)

$\neg$ E ……..(7) 1 mark

Resolve (1) & (7), (1 mark)

(8) $\neg \mathbf{S} \vee \neg \mathbf{W}$

Resolve (6) & (8), (1 mark)

(9) $\neg \mathbf{W}$

Resolve (5) & (9), (1 mark)

Nil

Question 3 (20 marks)

A. State space search requires effective strategies that depends on how the problems are represented using graph theory. One of problems is Traveling Salesperson Problem (TSP).

i. Given the following Figure 3, analyze either this graph can help the traveling salesperson to travel from city A to city G in such a way that the salesperson need to visit every city once. (3 marks)

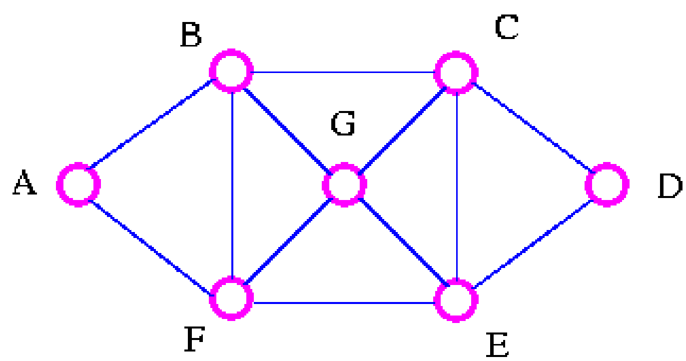


Figure 3: Traveling Salesperson Problem (TSP)

ANSWER:

Given by Euler theorem, the graph is solvable if and only if exactly two node or none have odd degree. In the figure, none of the nodes has odd degree, which tell us that this problem is solvable.

ii. Given a problem of Route Inspection Problem (RIP), a route inspector need to measure routes from one village to another. The inspector need to visit each village only once, but also required to end his tour at the village which he have started. In Figure 4, the nodes represent the villages and the values represent the distance in kilometre. Analyze the shortest route for the inspector to travel using tree-based graph. (7 marks)

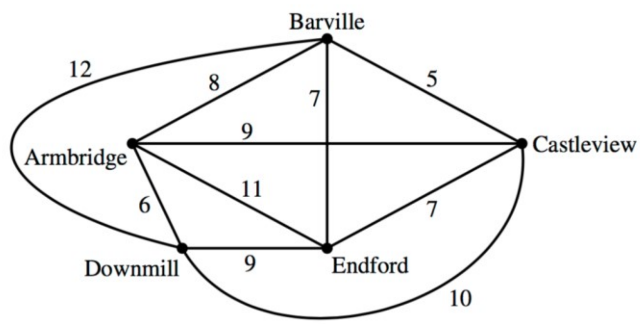


Figure 4: Route Inspection Problem (RIP)

ANSWER:

1. Student redraw the graph into tree (1 mark)
2. Student stated at which city he/she starts (1 mark)
3. Ensure that each branch connect to every city only once (1 mark)
4. Ensure that the route started and ended at the same city (1 mark)
5. Student shows ALL values in the tree (1 mark)
6. Student show the total cost at the end of each leaf and stated which route is the cheapest (2 mark)

B. In exhaustive search, there are two algorithms used to find a goal state, namely depth-first and breadth-first search algorithms.

i. Based on the pseudocode presented in Figure 5, suggest that this exhaustive search algorithm is either depth-first or breadth-first search algorithm. Explain the answer with your own understanding. (3 marks)

```
Exhaustive-Search(G, v):

    for each node n in G:
      n.distance = INFINITY
      n.parent = NIL

    create empty queue Q

    v.distance = 0
    Q.enqueue(v)

    while Q is not empty:

      u = Q.dequeue()

      for each node n that is adjacent to u:
          if n.distance == INFINITY:
              n.distance = u.distance + 1
              n.parent = u
              Q.enqueue(n)
```

Figure 5: An exhaustive search algorithm

ANSWER:

- breadth-first search

- the distance attribute of each vertex (or node) is needed for example when searching for the shortest path between nodes in a graph. At the beginning of the algorithm, the distance of each vertex is set to INFINITY, which is just a word that represents the fact that a node has not been reached yet, and therefore it has no distance from the starting vertex. We could have used other symbols, such as -1, to represent this concept. The parent attribute of each vertex can also be useful to access the nodes in a shortest path, for example by backtracking from the destination node up to the starting node, once the BFS has been run, and the predecessors nodes have been set.

ii. Given a graph in Figure 6, show how depth-first search algorithm is performed, given that the goal state is H. Show your answer in a table.
(7 marks)

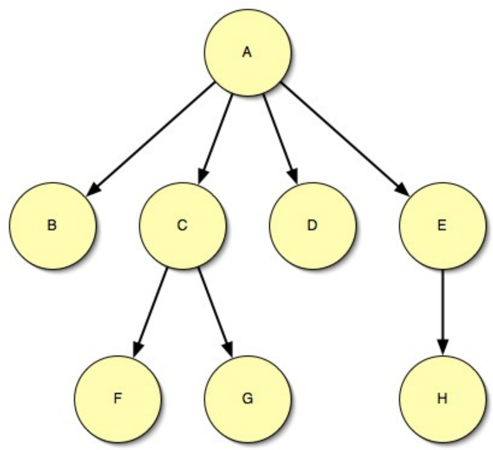


Figure 6: A graph traversal problem

ANSWER:

Iteration	Open	Closed
0	[A]	[]
1	[A B]	[]
2	[A]	[B]
3	[A C]	[B]
4	[A C F]	[B]
5	[A C]	[B F]
6	[A C G]	[B F]
7	[A C]	[B F G]
8	[A]	[B F G C]
9	[A D]	[B F G C]
10	[A]	[B F G C D]
11	[A E]	[B F G C D]
12	[A E H]	[B F G C D]

Appendix A

$$
\begin{aligned}
(\alpha \wedge \beta) &\equiv (\beta \wedge \alpha) && \text{commutativity of } \wedge \\
(\alpha \vee \beta) &\equiv (\beta \vee \alpha) && \text{commutativity of } \vee \\
((\alpha \wedge \beta) \wedge \gamma) &\equiv (\alpha \wedge (\beta \wedge \gamma)) && \text{associativity of } \wedge \\
((\alpha \vee \beta) \vee \gamma) &\equiv (\alpha \vee (\beta \vee \gamma)) && \text{associativity of } \vee \\
\neg(\neg\alpha) &\equiv \alpha && \text{double-negation elimination} \\
(\alpha \Rightarrow \beta) &\equiv (\neg\beta \Rightarrow \neg\alpha) && \text{contraposition} \\
(\alpha \Rightarrow \beta) &\equiv (\neg\alpha \vee \beta) && \text{implication elimination} \\
(\alpha \Leftrightarrow \beta) &\equiv ((\alpha \Rightarrow \beta) \wedge (\beta \Rightarrow \alpha)) && \text{biconditional elimination} \\
\neg(\alpha \wedge \beta) &\equiv (\neg\alpha \vee \neg\beta) && \text{de Morgan} \\
\neg(\alpha \vee \beta) &\equiv (\neg\alpha \wedge \neg\beta) && \text{de Morgan} \\
(\alpha \wedge (\beta \vee \gamma)) &\equiv ((\alpha \wedge \beta) \vee (\alpha \wedge \gamma)) && \text{distributivity of } \wedge \text{ over } \vee \\
(\alpha \vee (\beta \wedge \gamma)) &\equiv ((\alpha \vee \beta) \wedge (\alpha \vee \gamma)) && \text{distributivity of } \vee \text{ over } \wedge
\end{aligned}
$$

From aima.eecs.berkeley.edu/slides-ppt, chs 7-9