No. of Pages	2
No. of Questions	5

BRAC University
Department of Computer Science and Engineering
Midterm Examination, Spring 2019
CSE422: Artificial Intelligence

Total Marks: 40 **Time: 1 Hour**

- Do not answer in this question paper
- Answer any **four** of the following questions

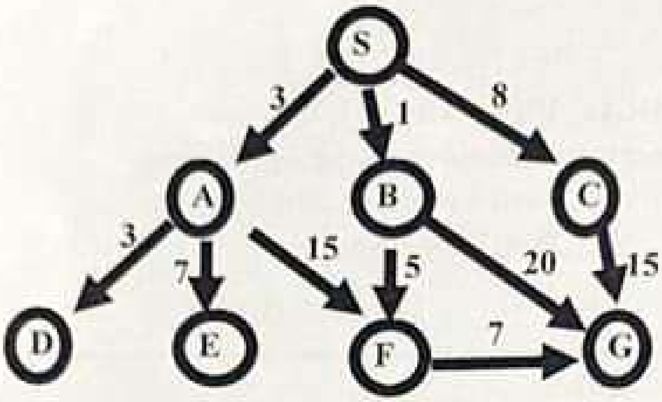
Question No. 1 **Marks: 4+6**

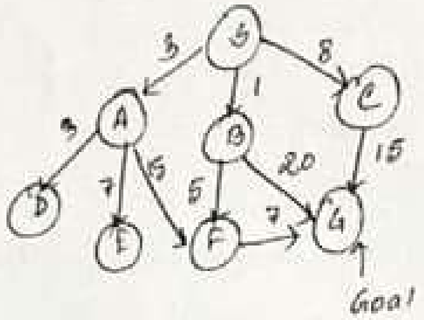
a) What is intelligent agent? What do you understand by the AI goal of "System that think rationally"? Explain with example.

An **intelligent agent** perceives its environment via **sensors** and acts rationally upon that environment with its **actuators**.

- An ideal rational agent should, for each possible percept sequence, do whatever actions will maximize its expected performance measure based on
  - (1) the percept sequence, and
  - (2) its built-in and acquired knowledge.
- Rationality includes information gathering, not "rational ignorance." (If you don't know something, find out!)
- Rationality → Need a performance measure to say how well a task has been achieved.
- Types of performance measures: false alarm (false positive) and false dismissal (false negative) rates, speed, resources required, effect on environment, etc.

b) Apply Uniform Cost Search (UCS) to the following graph to find out minimum cost solution path from node S to node G.





	S^0
S^0	$B^1\ A^3\ C^8$
B^1	$A^3\ F^6\ C^8\ G^{21}$
A^3	$F^6\ D^6\ C^8\ E^{10}\ G^{21}$
F^6	$D^6\ C^8\ E^{10}\ G^{13}$
D^6	$C^8\ E^{10}\ G^{13}$
C^8	$E^{10}\ G^{13}$
E^{10}	$G^{13}\ F^{15}$
G^{13}	F^{25}

So, minimum cost $= S \rightarrow B \rightarrow F \rightarrow G$
$= 1+5+7 = 13$

Question No. 2 **Marks: 10**

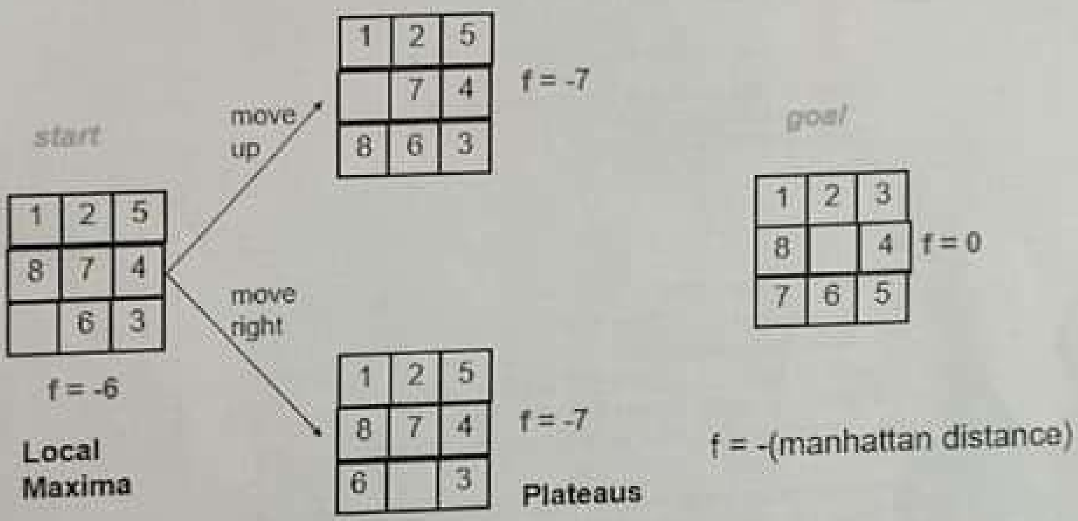
Write down drawbacks of hill climbing approach, explain with the following example.

start

1	2	5
8	7	4
	6	3

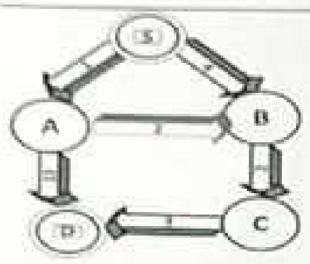
goal

1	2	3
8		4
7	6	5



Question No. 3 **Marks: 4+6**

How A* search algorithm always become optimal and choose the right shortest path, show it with a proof and explain. How do we reach the destination *D* from start node *S* with shortest path (i.e., low cost) using A* search algorithm (consider the following fig).



Heuristic Value	
S	7
A	6
B	3
C	2
D	0

- Suppose some suboptimal goal G_2 has been generated and is in the fringe. Let *n* be an unexpanded node in the fringe such that *n* is on a shortest path to an optimal goal *G*.
-

- $f(G_2) = g(G_2) + h(G_2)$
- $f(G_2) = g(G_2)$ [since $h(G_2) = 0$] ....(1)
- Again, $f(G) = g(G) + h(G)$
- $f(G) = g(G)$ [since $h(G) = 0$] ....(2)
- But, $g(G_2) > g(G)$ [since G_2 is suboptimal].......(3)
- Therefore, $f(G_2) > f(G)$ [from equation (1), (2) and (3)] ...... (4)

- Suppose some suboptimal goal G_2 has been generated and is in the fringe. Let *n* be an unexpanded node in the fringe such that *n* is on a shortest path to an optimal goal *G*.

- Therefore, $f(G_2) > f(G)$ ...... (4) [from equation (1), (2) and (3)]
- Again, $h(n) \leq h^*(n)$ ....(5) [since h is admissible; Here, *h*(n)* is the true cost to reach the goal state from *n*]
- $g(n) + h(n) \leq g(n) + h^*(n)$ ...... (6) [Adding g(n) in both sides of equation (5)]
- $f(n) \leq f(G)$ ...... (7) [Because, $f(n) = g(n) + h(n)$; and $f(G) = g(n) + h^*(n)$; Here, *h*(n)* is the true cost to reach the goal state from *n*]
- $f(n) \leq f(G) < f(G_2)$ [From equation (4) and (7)]

Therefore, $f(G_2) > f(n)$, and A* will never select G_2 for expansion before expanding *n* to reach at optimal goal G.

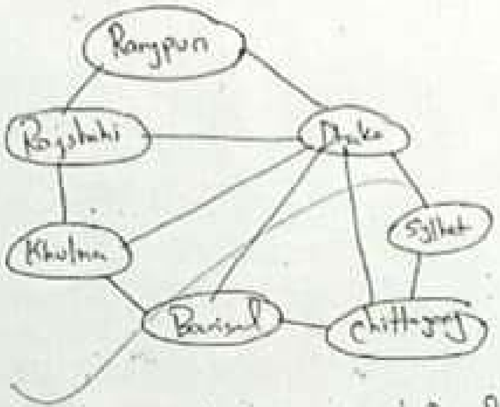
×S→A 1+5=6 ×S→A→B→C (1+2+1)+1=6
×S→B 4+2=6 ×S→B→C (4+2)+1=7
×S→A→B (1+2)+2=5 S→A→B→C→D (1+2+1+3)+0
S→A→D (1+13)+0=14 S→B→C→D (4+2+3)+0=9 =8

S→A→B→C→D = 8

Question No. 4

Marks: 2+8

Consider the following map of Bangladesh. Construct a constraint graph considering the divisions of Bangladesh. Color the map using only 3 colors (Red, Green, and Blue) where adjacent divisions should not be the same color. Apply backtracking with forward checking algorithm for solving this constraint satisfaction problem.



Rangpur	Rajshahi	Khulna	Dhaka	Barisal	Sylhet	Chittagong
~~R~~	~~R~~	~~R~~	R	~~R~~	~~R~~	~~R~~
~~B~~	B	~~B~~	R			
	B	G	R	~~G~~ ~~B~~ ~~R~~		~~R~~
	B	G	R	~~B~~ B		~~B~~
	~~B~~	G	R	B	~~G~~	G
G	B	G	R	B	B	G
G	B	G	R	B	B	G

RT (Back tracking)

Rangpur	Rajshahi	Khulna	Dhaka	Barisal	Sylhet	Chittagong
RGB	RGB	RGB	RGB	RGB	RGB	RGB
GB	GB	~~R~~ GB	R	GB	GB	GB
G	B	G	R	GB	GB	GB
G	B	G	R	B	GB	G
G	B	G	R	B	B	G

Question No. 5 **Marks: 6+4**

Suppose a genetic algorithm uses chromosomes of the form $x = abcdefgh$ with a fixed length of eight genes. Each gene can be any digit between 0 and 9. Let the fitness of individual x be calculated as:

$f(x) = (a + b) - (c + d) + (e + f) - (g + h)$, and let the initial population consist of four individuals with the following chromosomes:

$x1 = 6\ 5\ 4\ 1\ 3\ 5\ 3\ 2$
$x2 = 8\ 7\ 1\ 2\ 6\ 6\ 0\ 1$
$x3 = 2\ 3\ 9\ 2\ 1\ 2\ 8\ 5$
$x4 = 4\ 1\ 8\ 5\ 2\ 0\ 9\ 4$

a) Evaluate the fitness of each individual, showing all your workings, and arrange them in order with the fittest first and the least fit last.

b) Perform the following crossover operations:

i. Cross the fittest two individuals using one–point crossover at the middle point.

ii. Cross the second and third fittest individuals using a two–point crossover (points b and f).

a) Evaluate the fitness of each individual, showing all your workings, and arrange them in order with the fittest first and the least fit last.

Answer:

$$
\begin{aligned}
f(x_1) &= (6+5) - (4+1) + (3+5) - (3+2) = 9 \\
f(x_2) &= (8+7) - (1+2) + (6+6) - (0+1) = 23 \\
f(x_3) &= (2+3) - (9+2) + (1+2) - (8+5) = -16 \\
f(x_4) &= (4+1) - (8+5) + (2+0) - (9+4) = -19
\end{aligned}
$$

The order is x_2, x_1, x_3 and x_4.

b) Perform the following crossover operations:

i) Cross the fittest two individuals using one–point crossover at the middle point.

Answer: *One-point crossover on x_2 and x_1:*

$$
\begin{array}{ll}
x_2 = \mathbf{8712} \mid \mathbf{6601} & \\
x_1 = 6541 \mid 3532 & \Rightarrow
\end{array}
\quad
\begin{array}{l}
O_1 = \mathbf{8712}3532 \\
O_2 = 6541\mathbf{6601}
\end{array}
$$

---Good Luck---

65 | 41 35 | 32 ⇒ 65 9212 32
23 | 9212 | 85   23 4135 85