Tutorial 4

Q1. Figure 1.1 below shows a Block World Problem. A robot will move the blocks one by one from initial state S1 to reach the goal state S19. Figure 1.2 shows the state space of the Block World Problem and the heuristic costs for each state are shown in parentheses next to their respective nodes.

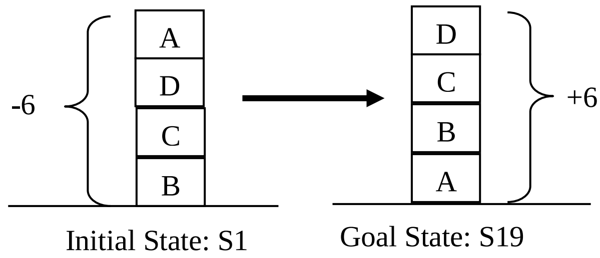

Figure 1.1

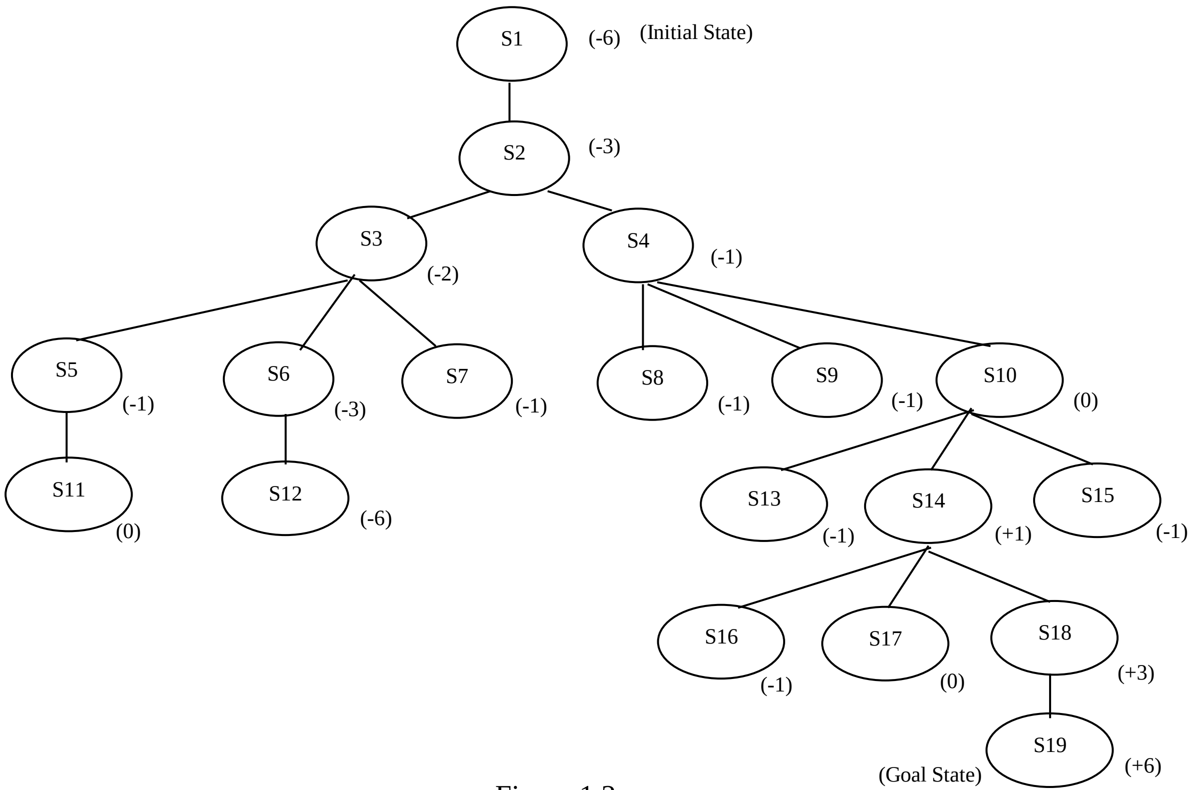

Figure 1.2

(a) Explain **step cost** used in problem formulation. Specify the value of the step cost for the problem above.

(b) Hill climbing search is unable to guarantee completeness and optimality as it may be trapped into local maximum.

(i) Explain local maximum.

(ii) Discuss why hill climbing search always lead to a local maximum.

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(Q1 Continued)

(iii) Use simple hill-climbing and steepest-ascent hill-climbing to search for the best path from S1 to S19 on the state space shown in Figure 1.2. Then for each search technique, draw the resulting search tree that shows the visited nodes. Show that hill-climbing technique can be trapped into a local maximum.

(c) A search technique can be evaluated based on four criteria: completeness, optimality, time complexity and space complexity. Evaluate the efficiency of breadth-first search and steepest-ascent hill-climbing. Conclude which technique is better to solve the Block World Problem mentioned in Figure 1.1.

Q2. Figure 2 below shows an 8-puzzle problem, which requires rearrangement of the tiles to transform the order from start state to goal state. One is only permitted to slide a tile **up, down, left or right** into the blank square.

Start

1	**2**	**3**
	4	**5**
7	**8**	**6**

→

Goal

1	**2**	**3**
4	**5**	**6**
7	**8**	

Figure 2: The 8-puzzle problem

(i) Suggest a heuristic function to produce a heuristic cost for a state. Demonstrate how such heuristic cost can be computed on the **start state.** Then perform best-first search.

(ii) Evaluate the efficiency of **breadth-first search** and **best-first search** in terms of completeness, optimality, time efficiency and space efficiency in solving the problem above.

(iii) Explain why hill-climbing will fail in this problem.

Q3. The following graph in Figure 1.1 shows all the nodes in a telecommunication network. The distance (in km) from one node to another is shown on the arc.

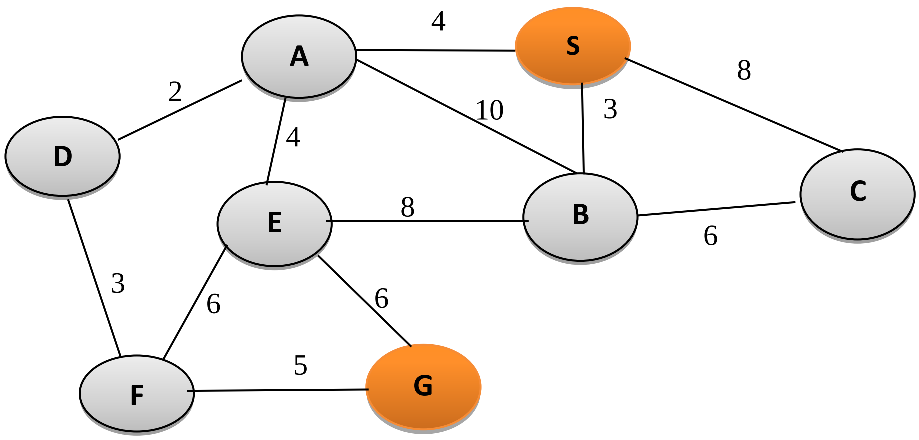

Figure 3 the search graph of a new LRT network

The Euclidean distance (in km), which is used as the heuristic cost (*h*) for different node, is provided in Table 1 below.

Table 1: The heuristic costs for different nodes

S	A	B	C	D	E	F	G
14	10	13	8	8	11	5	0

(i) Assume that some data are to be sent from node S to node G using the shortest route. Describe the goal formulation and problem formulation.

(ii) **Show the resulting search tree** of A* search to find the shortest path from S to G. **State the shortest path**.
(Remark: Ignore repeated nodes that have been visited previously)

(iii) Evaluate the efficiency of A* search in solving the path-finding problem above.

Q4. Consider 2 heuristic h_1 and h_2 of A* for the puzzle problem are defined as:

$h_1(n)$= number of misplaced tiles
$h_2(n)$= total Manhattan distance

Start State

3	1
2	

Goal State

1	2
3	

(i) Illustrate the **state space** of the puzzle to reach the goal state based on:

- $h_1(n)$
- $h_2(n)$

(ii) **Show the resulting search trees** of A* search to find the shortest path using the heuristic functions of:

- $h1(n)$
- $h2(n)$

You must clearly show the function cost, given that:
f(n) = h(n) + g(n), where *g(n)* is the path cost.