Homework 3. CS540

Question 1

① We know that in order to be an admissable heuristic, it must satisfy the following inequality

$$h(n) \leq c(n,a,n') + h(n')$$

$\Rightarrow$ $h(B) \leq cost(B, G) + h(G)$

$h(B) \leq 1/2 + 0$

$\therefore$ The range $0 \leq h(B) \leq 1/2$ is an admissable range.

② Itr 1: OPEN = [B, C_1]

CLOSED = [A]

Backpointers =

$B \rightarrow A$, $C_1 \rightarrow A$,

$A \rightarrow \emptyset$

	f, g, h		
A	0	0	0
B	100.5	1/2	100
C_1	1.0	1.0	0

Itr2: OPEN = [B, C_2]

CLOSED = [A, C_1]

Backpointers :

$C_2 \rightarrow C_1$, $C_1 \rightarrow A$, $B \rightarrow A$,

$A \rightarrow \emptyset$

	f	g	h
A	0	0	0
B	100.5	1/2	100
C_1	1.0	1.0	0
C_2	1.5	1.5	0

Itr 3 : OPEN = [B, C_3]
CLOSED = [A, C_1, C_2]

	f	g	h
A	0	0	0
B	100.5	1/2	100
C_1	1.0	1.0	0
C_2	1.5	1.5	0
C_3	1.75	1.75	0

Backpointers : $C_3 \to C_2$, $C_2 \to C_1$, $C_1 \to A$, $B \to A$, $A \to \emptyset$

Itr 4 : OPEN = [B, C_4]
CLOSED = [A, C_1, C_2, C_3]

	f	g	h
A	0	0	0
B	100.5	1/2	100
C_1	1.0	1.0	0
C_2	1.5	1.5	0
C_3	1.75	1.75	0
C_4	1.875	1.875	0

Backpointers :
$C_4 \to C_3$, $C_3 \to C_2$,
$C_2 \to C_1$, $C_1 \to A$,
$B \to A$, $A \to \emptyset$

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Itr 5 : OPEN = [B , C_5]
CLOSED = [A, C_1 , C_2, C_3 , C_4]

	f	g	h
A	0	0	0
B	100.5	0.5	100
C_1	1.0	1.0	0
C_2	1.5	1.5	0
C_3	1.75	1.75	0
C_4	1.875	1.875	0
C_5	1.9375	1.9375	0

Backpointers : $C_5 \to C_4$, $C_4 \to C_3$, $C_3 \to C_2$,
$C_2 \to C_1$, $B \to A$, $A \to \phi$

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3. $\lim_{1\to\infty} \int (c_i)$

$$= \lim_{i:1\to\infty} 1 + \frac{1}{(2)^i}$$

$$= \lim_{1\to\infty} 1 + \lim_{i:1\to\infty} \frac{1}{(2)^i}$$ ← Infinite geometric series. which can be written as $\frac{a}{1-r}$ (since i goes to ∞) where $a = \frac{1}{2}$ and $r = \frac{1}{2}$

$$= 1 + \frac{a}{1-r}$$

$$= 1 + \frac{1/2}{1-1/2}$$

$$= 1 + \frac{1/2}{1/2}$$

$$= 1 + 1 \approx 2$$

- It is important to note that this is only an approximation as the limit tends to infinity.

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4. The A^* algorithm will continually look for a node n for which $f(n)$ is minimum in the OPEN set. In this case, n will always be c_i where $i \to \infty$ because $\lim_{i \to \infty} f(c_i) \approx 2$ at maximum, wheras $f(B) = 100.5$.
Since the goal state is connected to B, the A^* algorithm will never reach that goal state as it will never dequeue B from the OPEN priority queue, and hence never generate the required goal state.

5. In order for B to be chosen, it must satisfy the condition $f(B) < f(C_1)$.
Furthermore, we know that the admissible range for $f(B)$ is $0 \leq f(B) \leq 1/2$.
Hence, the inadmissable range would be

$$0.5 < f(B) \leq f(C) - 0.5$$

$$\Rightarrow 0.5 < f(B) \leq 1.5$$

Hence, this bound will find the optimal even though it is inadmissible.

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6. An admissible h is sufficient in this case of A* search because as we go down the optimal path, there are non decreasing values for $f(n)$ for each node n in the path.

Proof:

$A \to B \quad f(B) = 1/2 + 1/2 = 1$ (Assuming $h(B) = 1/2$)

$B \to G \quad f(G) = 1 + 1/2 = 1.5$ //

Question 3

(1) There are $n!$ possible arrangements of trees, so $n!$ states

(2) There are $n-1$ possible swaps for a state $j \in [1, n-1]$
Hence, the neighborhood covers $\boxed{\frac{n-1}{n!}}$ % of the statespace. $= \frac{\cancel{n-1}}{n(\cancel{n-1})(n-2)!} = \boxed{\frac{1}{n(n-2)!}}$

(3) Total no. of trees $= 112,511$.

$\therefore$ Total # of states $= 112511! = \boxed{1.04 \times 10^{519455}}$

(4) Distance to first tree from office $= 10km$
Distance from last tree to office $= 10km$.

After reaching the first tree, we would have $n-1$ possible trees to go to, hence a distance of $(n-1)10$
$= (112511-1) \times 10$
$= 1125100$

Total worst case distance $= 10 + 1125100 + 10 = 1125120$

Tu LD: $\frac{11251120}{367510} = \boxed{3LD}$

(5) If each tree is at a distance of 10m, then applying

$$f(t_1 \ldots t_n) = d(0,t_1) + \sum_{1}^{n-1} d(t_i, t_{i+1}) + d(t_n, 0)$$

we get

$$10m + 112510 \times 10m + 10m$$

$$= 1125120\,m = 1125120/1000 = \boxed{1125.120\,km}$$

(6) At 25mph = 40.233 kmph,

the inspector will complete the job in

$$1125.120 / 40.233\,kmph = 27.965\,hrs \approx \underline{\underline{28\,hours}}$$

Hence, the inspector will take more than one day to complete the job.

Question 2

	CURRENT STATE	TEMPERATURE	PROBABILITY
1.	3	1.8	0.573
2.	1	1.62	0.290
3	1	1.458	1
4.	1	1.312	0.101
5.	2	1.180	0.428
6.	2	1.062	0.390
7.	2	0.956	0.123
8.	2	0.860	0.313