COMP30030: Introduction to Artificial Intelligence
Assignment 2

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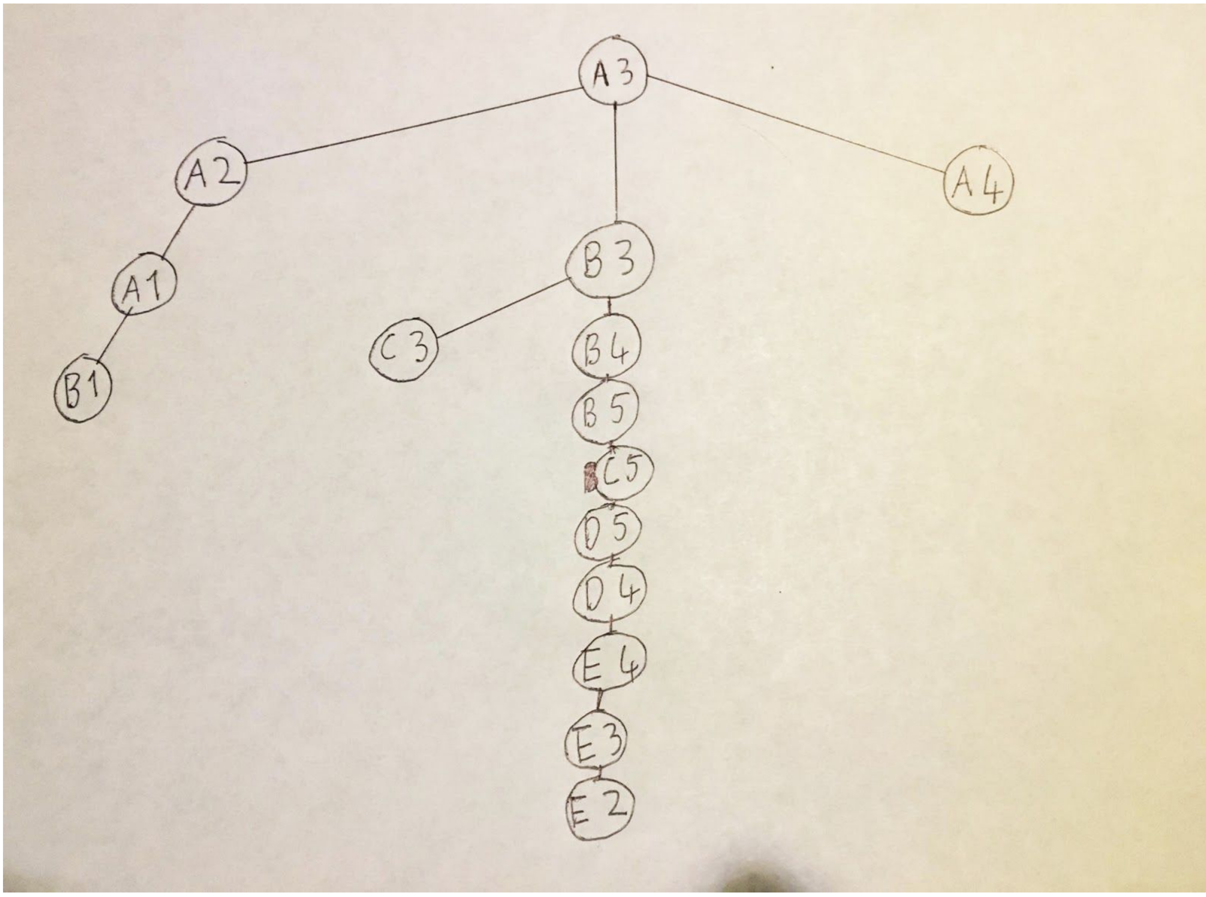
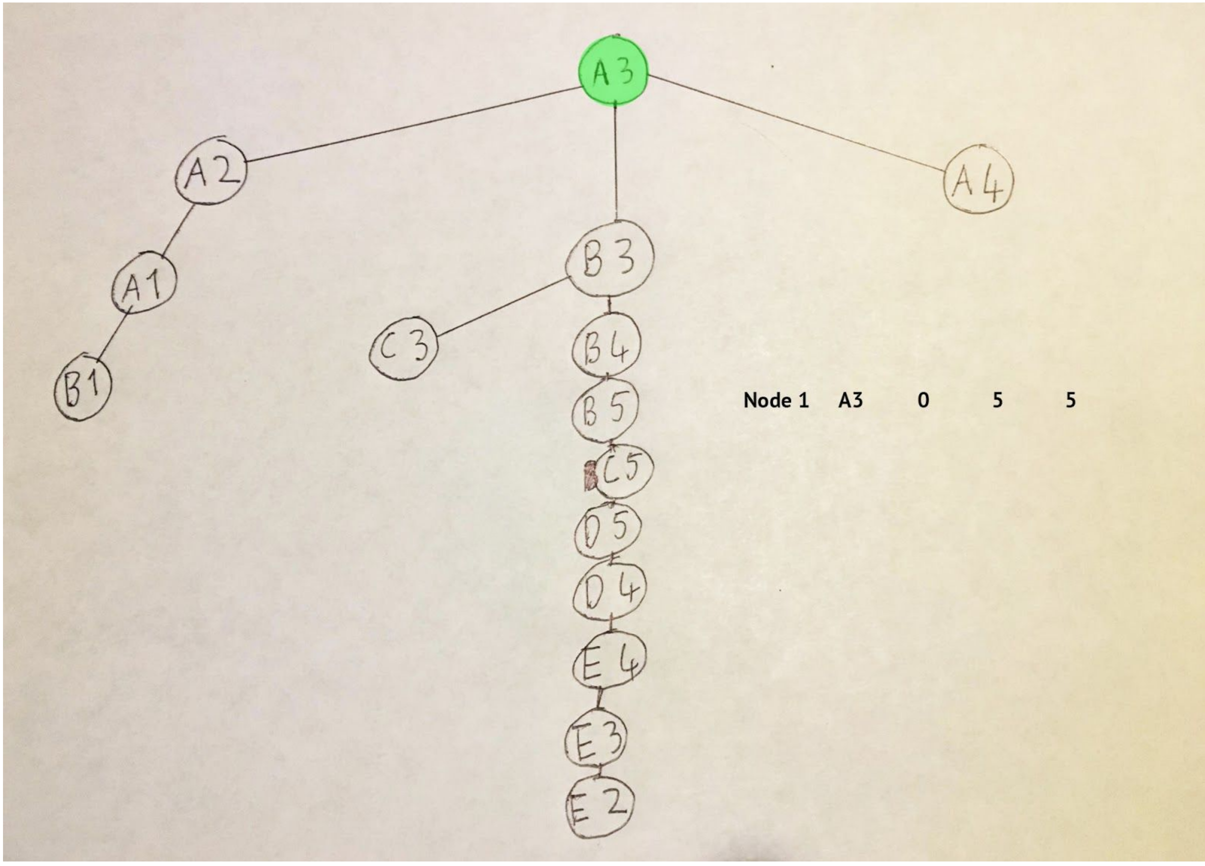
Question One

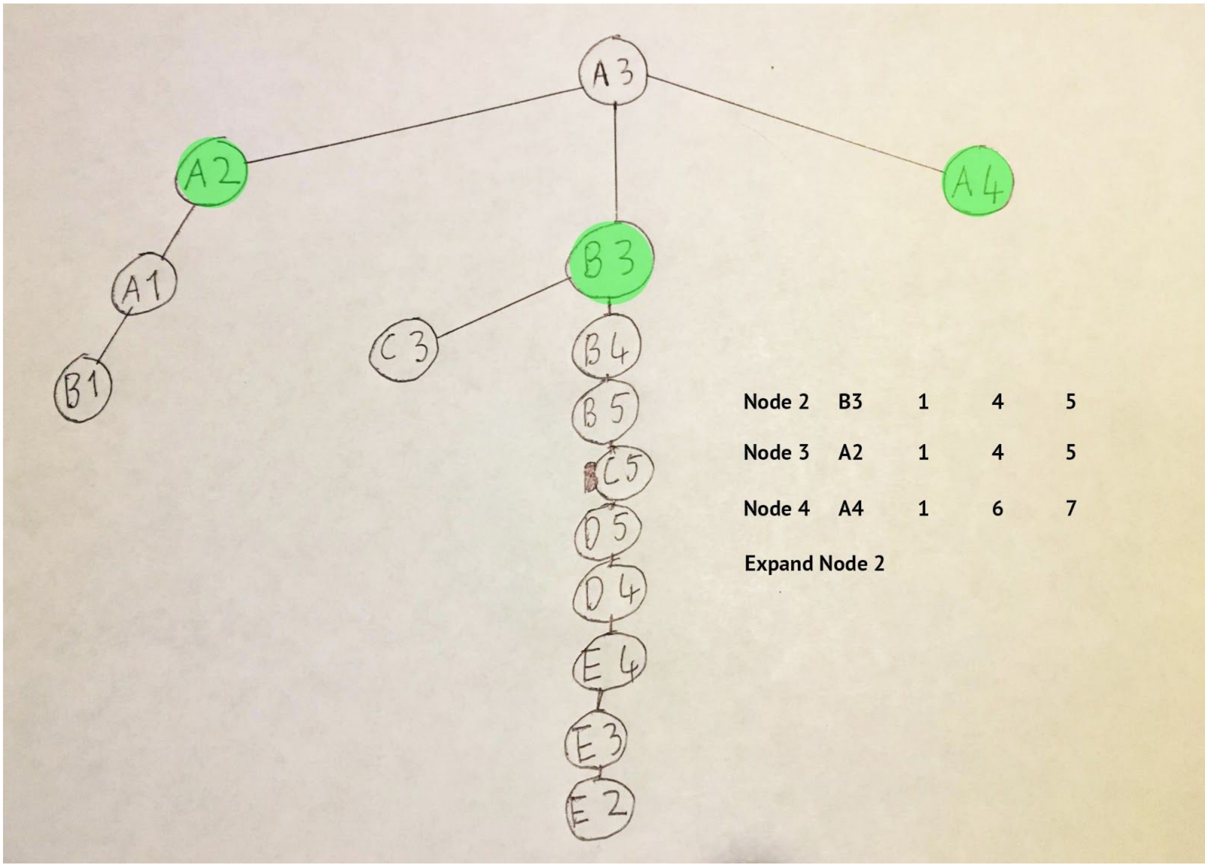
(i) Suitable Heuristic: Manhattan Distance, i.e The sum of the absolute difference between the final x,y coordinate and the start x,y coordinate
As A Formula: (|xFinal - xStart| + |yFinal - yStart|)

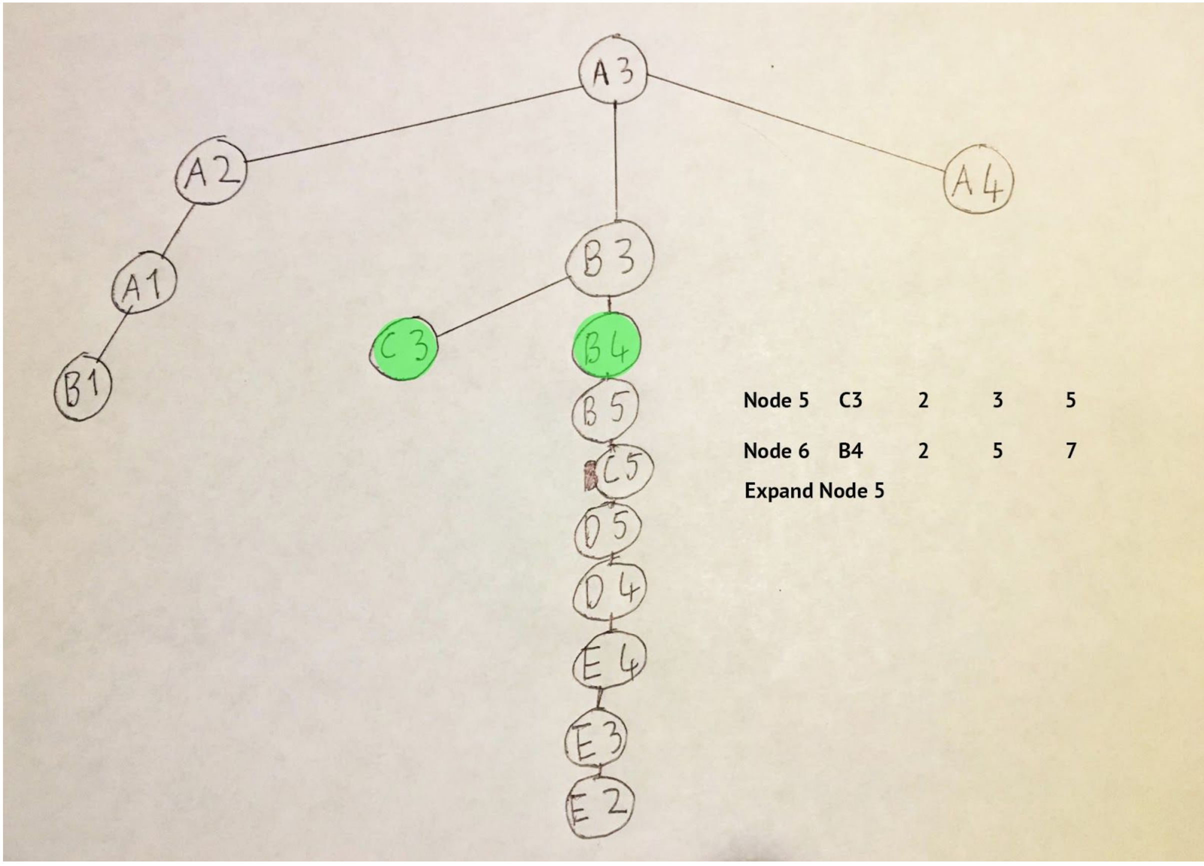
(ii) Concise Representation Of The Search Tree



How A* Would Navigate This Search Tree Using Manhattan Distance For Four Iterations

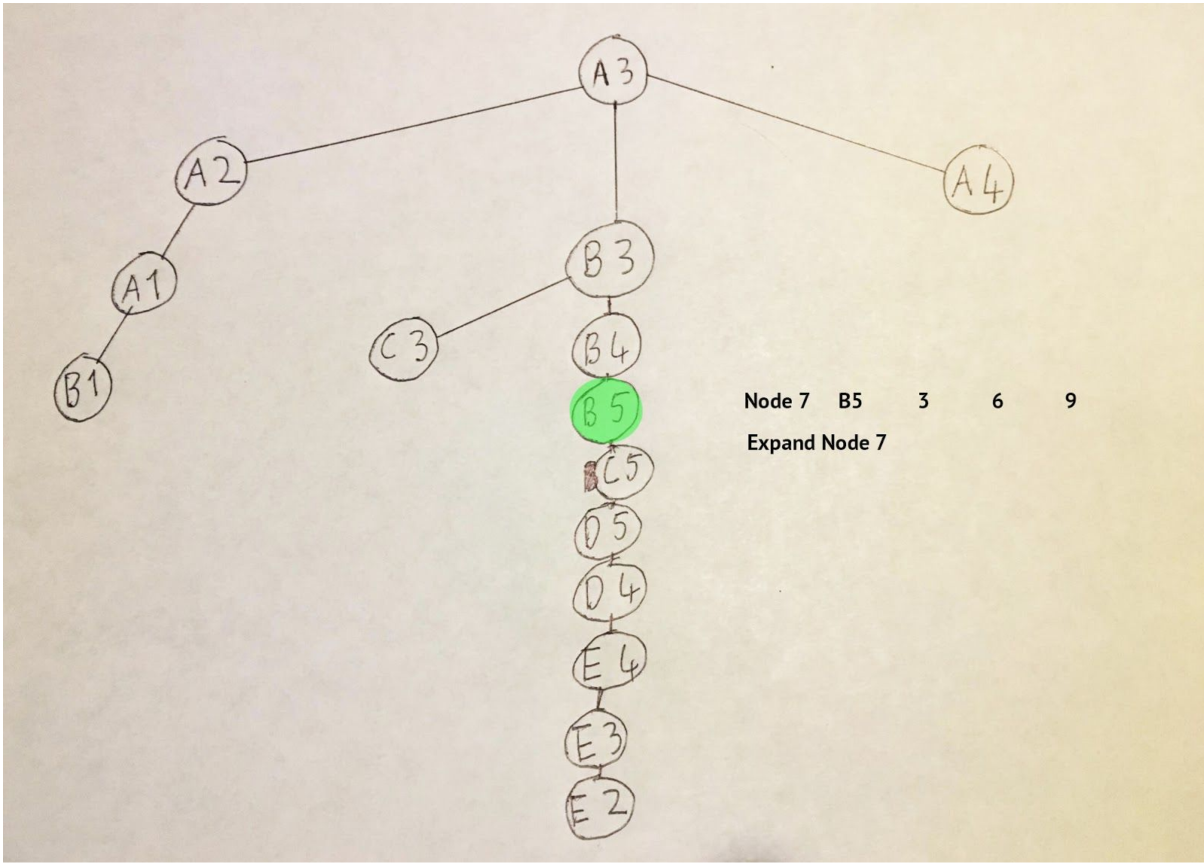






Node 5	C3	2	3	5
Node 6	B4	2	5	7

Expand Node 5

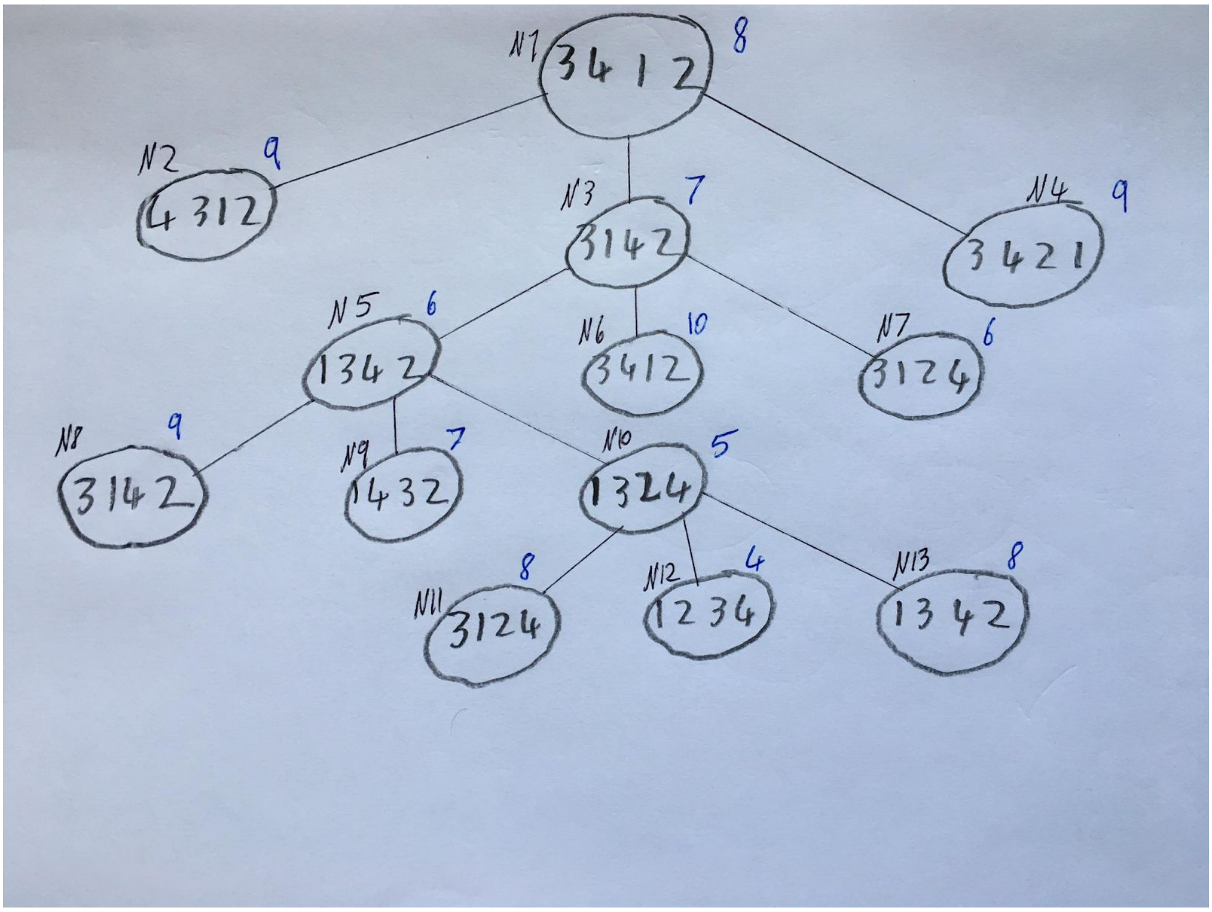


Node 7	B5	3	6	9

Expand Node 7

Question Two

Note: f(x) in blue



Root Node:				
	Node Ordering	**g(x)**	**h(x)**	**f(x)**
Node #1	3412	**0**	**8**	**8**

Iteration 1: Node Removed from Q:	Node #1

New children added to the queue:

	Node Ordering	**g(x)**	**h(x)**	**f(x)**
Node #2	4312	**1**	**8**	**9**
Node #3	3142	**1**	**6**	**7**
Node #4	3421	**1**	**8**	**9**

Iteration 2: Node Removed from Q:	Node #3

New children added to the queue:

	Node Ordering	g(x)	h(x)	f(x)
Node #5	1342	**2**	**4**	**6**
Node #6	3412	**2**	**8**	**10**
Node #7	3124	**2**	**4**	**6**

Iteration 3: Node Removed from Q:	Node #5

New children added to the queue:

	Node Ordering	g(x)	h(x)	f(x)
Node #8	3142	**3**	**6**	**9**
Node #9	1432	**3**	**4**	**7**
Node #10	1324	**3**	**2**	**5**

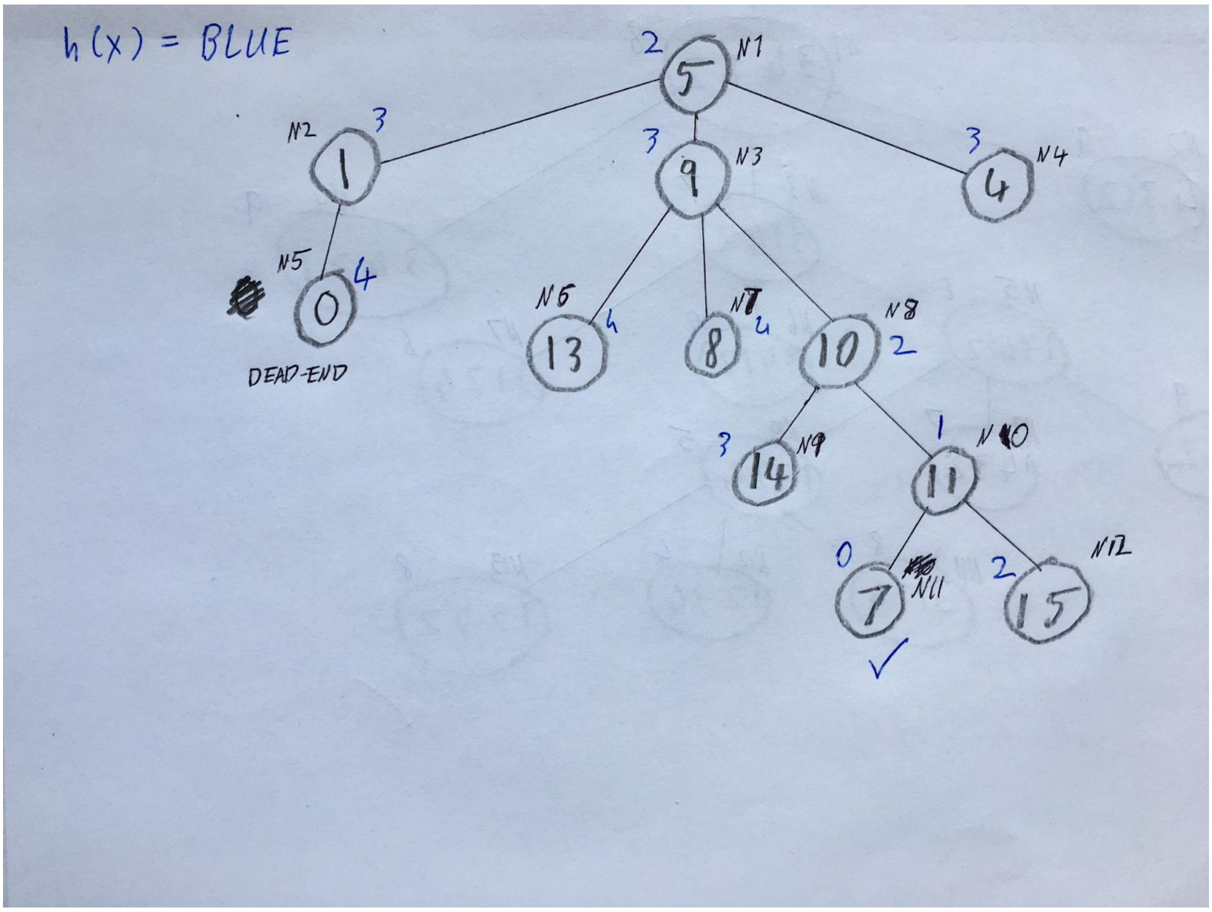
Iteration 4: Node Removed from Q:	Node #10

New children added to the queue:

	Node Ordering	g(x)	h(x)	f(x)
Node #11	3124	**4**	**4**	**8**
Node #12	1234	**4**	**0**	**4**
Node #13	1342	**4**	**4**	**8**

The path chosen by A* is:	**Node #1 → Node #3 → Node #5 → Node #10 → Node #12**

Question 3



Node	Location	g(x)	h(x)
#1	5	0	2

Iteration 1: Children added to Q:

Node	Location	g(x)	h(x)
#2	**1**	**1**	**3**
#3	**9**	**1**	**3**
#4	**4**	**1**	**3**

Child selected to be expanded is Node #	2

Iteration 2: Children added to Q:

Node	Location	g(x)	h(x)
#5	**0**	**2**	**4**

Child selected to be expanded is Node #	3

Iteration 3: Children added to Q:

Node	Location	g(x)	h(x)
#6	**13**	**2**	**4**
#7	**8**	**2**	**4**
#8	**10**	**2**	**2**

Child selected to be expanded is Node #	8

Iteration 4: Children added to Q:

Node	Location	g(x)	h(x)
#9	14	3	3
#10	11	3	1

Child selected to be expanded is Node #	10

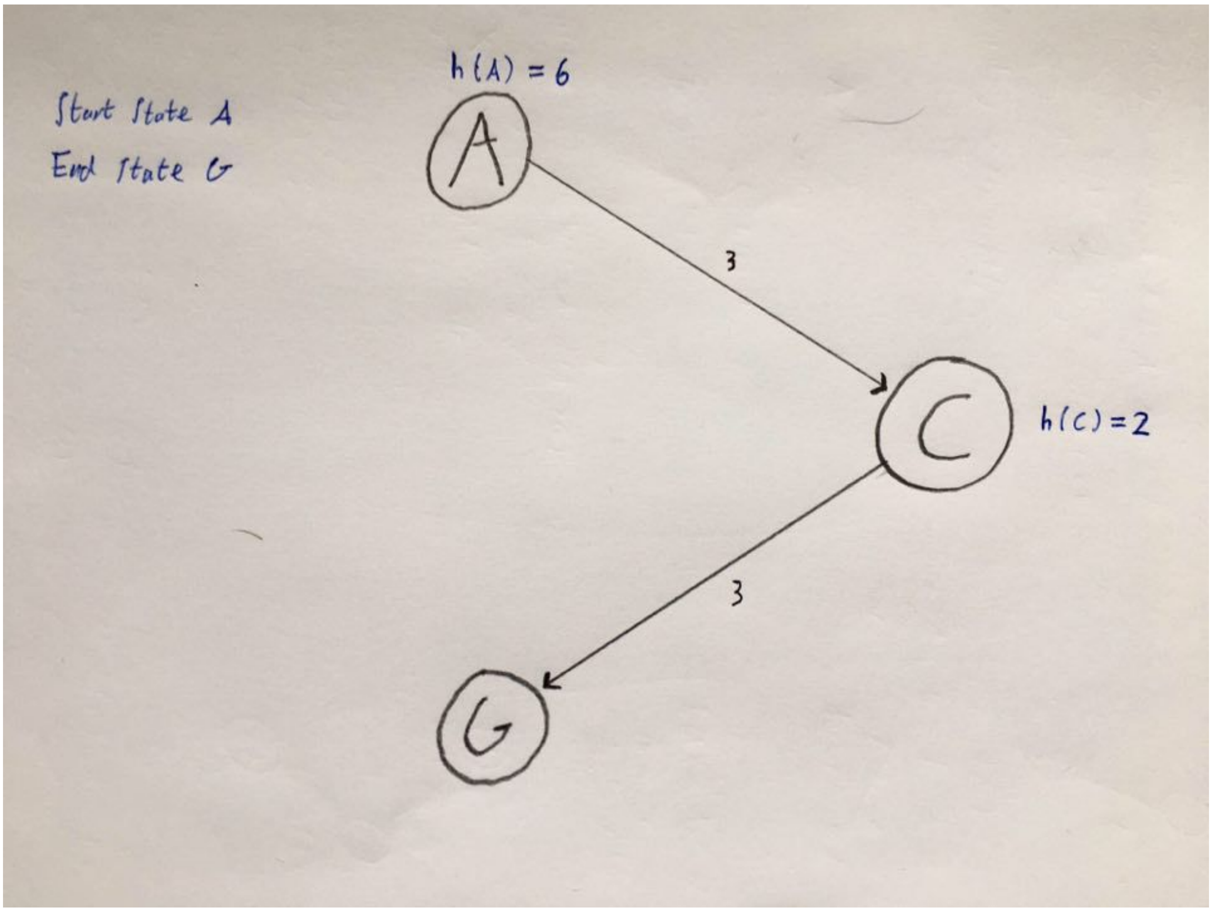
Iteration 5: Children added to Q:

Node	Location	g(x)	h(x)
#11	7	4	0
#12	15	4	2

The path found by Greedy Best Search is:	**Node #1 → Node #2 → Node #3 → Node #8 → Node #10 → Node #11**

Question Four

Part (i):



Part (ii):
Firstly, let’s establish what each term means in the context of our diagram.

A → Start State
C → Intermediate State
G → End State

What is Admissibility
A heuristic is admissible if the heuristic cost from A to G is less than or equal to the actual cost.
Summary: H(A) ≤ Cost(A → G)

What is Consistency
A heuristic is consistent if the heuristic cost from A to any intermediate node C is less than or equal to the actual cost.
Summary: H(A) - H(C) ≤ Cost(A → C)

Consistency Implies Admissibility
Implied in the question and also proven to be true, is the fact that consistency implies admissibility. If our heuristic is consistent, i.e it's estimates from one node to the next are always less than or equal to the actual cost, then we know that our heuristic is admissible too. This is due to the fact that admissibility will essentially equal the sum of each consistent leap between nodes.

Admissibility Does Not Imply Consistency
However, we have been asked why this same principle does not apply the other way around. Why admissibility does not, in turn, imply consistency.

Admissibility does not imply consistency, because the actual cost of getting from one node to the end node can be correct without each jump from one node to the next having the correct value.

The underlying principle behind this is quite simple. If we add 3 and 3, we get 6. However, we can also add 2 and 4 to get 6, or 5 and 1. If we imagine each of these additions as a leap from one node to the next, we can see that there are many ways we could reach a total cost of 6 from jumping only between three nodes.

This means that if we jump from A to C and our heuristic value is 4 but the actual jump costed 3, as in the diagram above, our heuristic would not be admissible. However, it could still be consistent. It may also be inconsistent (probably more likely to be inconsistent), however the main point is that we don't know either way, thus consistency is not implied.

<u>Proof By Contradiction</u>

Proof: Admissible
H(A) ≤ Actual Cost(A)
6 ≤ 6 = TRUE.

Thus, admissible.

Proof: Inconsistent
Actual Cost(A → C) = 3
Heuristic Cost(A → C) = H(A) - H(C) = 6 - 2 = 4

Actual Cost(C → G) = 3
Heuristic Cost(C → G) = H(C) - H(G) = 2 - 0 = 2

Our second jump is consistent, as 2 ≤ 3 = TRUE, however our first jump is not consistent, as 4 ≤ 3 = FALSE.

Thus, NOT consistent.

Therefore, admissibility DOES NOT imply consistency.

Conclusion
We have thus shown intuitively that admissibility does not imply consistency through our above explanation, and the diagram provided.
Finally, we have also proven this by inconsistency in our above proof.