National University of Singapore
School of Computing
CS3243 Introduction to AI

Tutorial 2: Informed Search

Issued: Week 3 Discussion in: Week 4

Important Instructions:

- **Assignment 2** consists of **Question 5** from this tutorial.
- Your solution(s) must be TYPE-WRITTEN, though diagrams may be hand-drawn.
- You are to submit your solution(s) during your **Tutorial Session in Week 4**.

Note: you may discuss the assignment question(s) with your classmates, but you must work out and write up your solution individually. Solutions that are plagiarised will be heavily penaltised.

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1. (a) Provide a counter-example to show that the **tree search** implementation for the **Greedy Best-First Search** algorithm is **incomplete**.

   (b) Briefly explain why the **graph search** implementation for the **Greedy Best-First Search** algorithm is **complete**.

   (c) Provide a counter-example to show that neither the **tree search** nor the **graph search** implementations for the **Greedy Best-First Search** algorithm are **optimal**.

2. (a) Prove that the **tree search** implementation of the **A* Search** algorithm is optimal when an **admissible heuristic** is utilised.

   (b) Prove that the **graph search** implementation of the **A* Search** algorithm is optimal when a **consistent heuristic** is utilised. Assume graph search **Version 3**.

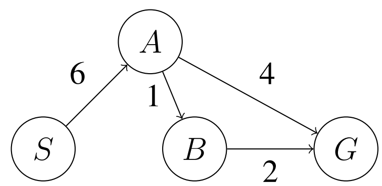
3. (a) Given that a **heuristic** h is such that $h(t) = 0$, where t is any goal state, prove that if h is **consistent**, then it must be **admissible**.

   (b) Give an example of an **admissible heuristic** that is **not consistent**.

4. We have seen various search strategies in class, and analysed their worst-case running time. Prove that ***any deterministic search algorithm*** will, in the worst case, **search the entire state space**. More formally, prove the following theorem

Theorem 1. *Let $\mathcal{A}$ be some complete, deterministic search algorithm. Then for any search problem defined by a finite connected graph $G = \langle V, E \rangle$ (where V is the set of possible states and E are the transition edges between them), there exists a choice of start node s_0 and goal node g so that $\mathcal{A}$ searches through the entire graph G.*

5. (a) In the search problem below, we have listed 5 heuristics. Indicate whether each **heuristic** is **admissible** and/or **consistent** in the table below.



	S	A	B	G	**Admissible**	**Consistent**
h_1	0	0	0	0		
h_2	8	1	1	0		
h_3	9	3	2	0		
h_4	6	3	1	0		
h_5	8	4	2	0		

(b) Write out the order of the nodes that are explored by the **A* Search** algorithm. Assume a **graph search** implementation that utilises heuristic h_4. Further, assume graph search **Version 3**.

You should express your answer in the form A–B–C (i.e., no spaces, all uppercase letters, delimited by the dash (–) character), which, for example, corresponds to the order A, B, and C.

(c) Which heuristic would you use? Explain why.

(d) Prove or disprove the following statement:

The heuristic $h(n) = max\{h_3(n), h_5(n)\}$ is admissible.