

# CS 367 Challenge Problem 2007

## **Goal:**

The purpose of this challenge problem is to provide you with an opportunity to do research. Science is not usually done by individuals working in isolation from their peers. Instead, science can be seen as a dialogue where problems are identified, analysed, and refined and where solutions are proposed, criticised, and modified. This dialogue is normally carried on via conference papers and journal articles. Unfortunately, you do not have the time to carry on your dialogue this way. Instead, you will be publishing your dialogue in the CS367 class forum. The threads for this dialogue should all begin with “*Challenge Problem: x*” where  $x$  is the aspect under discussion.

While ideally a large number of you would jump at this challenge just for the experience, I realise that this is unlikely. So, I am going to provide an incentive for you to participate. Separate from the reward for being the first to solve the challenge problem, I will also include in the final exam a question worth 5 marks that will require you to understand some aspect of this challenge problem. **The question will be on the exam regardless of whether the challenge problem has been solved.** The best way to understand the challenge problem and its solution and (hopefully) gain those 5 marks is to participate in attempting to help solve the challenge problem. This way, even if you don't end up with the “winning” posting, you will probably still get more marks than if you ignore the challenge problem.

## **Deadline:**

The deadline for submitting a “solution” to the challenge problem is noon on the last day of lectures (whether a lecture is given or not).

## **Background:**

When  $A^*$  was originally introduced in 1968 by Peter Hart, Nils Nilsson, and Bertram Raphael, they proved that if heuristic  $h1$  was “more informed” than  $h2$  then any node expanded by  $A^*$  using  $h1$  must also be expanded when  $A^*$  uses  $h2$ . To say that  $h1$  is **more informed than**  $h2$  means that for all non-goal nodes  $n$ ,  $h1(n) > h2(n)$ . There is another, weaker, relationship between heuristic evaluation functions called “dominance”. To say that  $h1$  **dominates**  $h2$  means that for all nodes  $n$ ,  $h1(n) \geq h2(n)$  (“ $\geq$ ” means “greater than or equal to”). If  $h1$  simply dominates  $h2$  (i.e., but  $h1$  is not more informed than  $h2$ ) then it is quite possible that  $h1$  expands nodes that  $h2$  does not.

## **The Challenge Problem:**

Your challenge is to find an augmentation to  $A^*$ , call it  $A\#$ , such that it is guaranteed that: if heuristic  $h1$  dominates  $h2$  then any node expanded by  $A\#$  using  $h1$  must also be expanded when  $A\#$  uses  $h2$ .

## **The Reward:**

The person will get 3 percentage points added to their final mark, who first publishes in one posting on the forum both of the following:

1. The pseudo-code of **A#** (in sufficient detail that it is obvious to me that they have an **A\*** augmentation that solves the challenge problem).
2. A rigorous (i.e., convincing to me) argument that their **A#** does have the necessary guarantee.

Getting 3 more percentage points means that 3 will be added to whatever your final mark (out of a hundred) is in the course. So if the winner would have gotten a final mark of 87, they will now get a 90.

For this challenge problem, postings can be made by teams of people as well as by individuals (such postings must be clearly marked as such by listing who the contributing members are). If the winning posting is made by a team, then the team must agree among themselves how the 3 percentage points is to be divided among the team members.

***Nota Bene:** I reserve the right to arbitrarily divide up the 3 percentage points among students if there are convincing reasons for doing so.*

## **The Rules:**

1. You can use any resource you want. For example, you can use the internet, books, articles, papers, etc.
2. You are free to work together on this. However, I would encourage you to use the forum to communicate your progress.
3. The winner is not allowed to be a lurker, i.e., someone who reads the postings without making any contributions (except for submitting their winning posting). Specifically, the winner must have made at least two reasonable contributions (as deemed by me) at least a week before they submitted their winning posting.
4. If the winner is a team, then the team, as a whole, must satisfy condition **3**. For example, if there are 4 members of the team, the team would satisfy condition **3** if among the team members there are least two postings (making reasonable contributions) that were made, either individually or as members of teams, at least a week before the team submit their winning posting.
5. When you submit your candidate winning posting, you ***must*** email me with the subject line containing the words: “CS367 Challenge Problem Submission”. The email must tell me the forum thread name containing your submission and give pointers to the two required prior postings. I will try to notify you, via that thread, within one working day whether your submission is a winning one and whether the two required posting are deemed reasonable contributions.
6. ***Do not expect me to correct any errors that are made in any challenge problem posting!*** Even if you write complete rubbish in a posting I do not intend to respond. However, I reserve the right to respond if I see fit. The idea is that it is your responsibility to work among yourselves to correct yourselves.

7. All arguments are to be technical ones. **Personal attacks (e.g., saying that someone's idea is the "dumbest" thing you've ever heard) are totally inappropriate!**