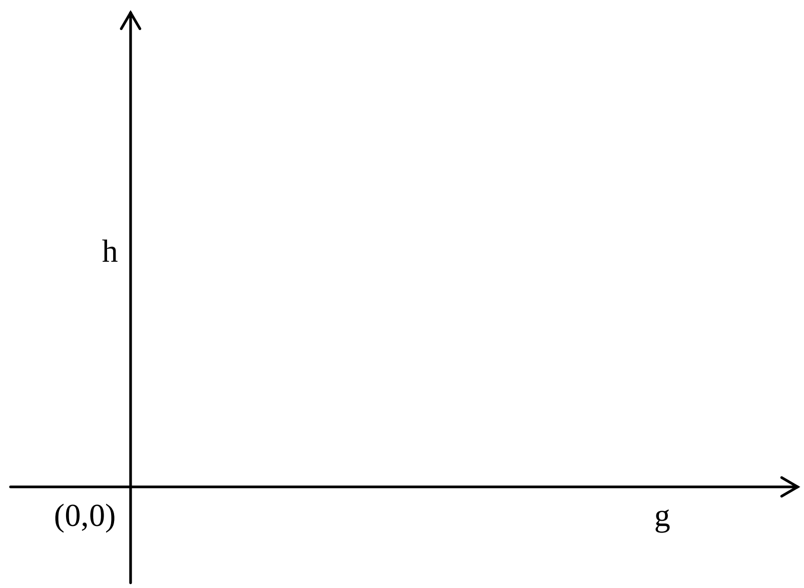
DQE Fall 2007 Artificial Intelligence
Problem #1

Consider the A* heuristic search algorithm. The function used to compute the estimated cost of a node in the search space is normally given as: f(n) = g(n) + h(n). Consider a modification of this cost function given as the ff function as follows:

$$ff(n) = \mu.g(n) + (1-\mu).h(n).$$

Also, consider g values to be measured along the traditional x-axis and h values to be measured along the y-axis of a graph plot, as shown below.



Answer the following questions in the context of the modified cost function and draw a separate graph, if needed, to show the answer of each of the following questions:

1. (3) On the graph mark the locations of a start node and a goal node for a typical search using the A* algorithm.
2. (4) Some problems have only one start node but multiple goal nodes; each goal having different total path cost. Show on this graph a situation, by drawing points, in which there is only one start node but five different goal nodes, each having a different total path cost.
3. (3) Assume that there are six nodes that lie between the start node and the goal node. Select reasonable and rational locations for these six points and mark them as points on the graph. Connect these points via a path that begins at the start node, passes through the six intermediate nodes in order, and ends at the goal node. Number the intermediate points from 1 to 6 to show the order in which the nodes are visited.
4. (5) Is it possible for an A* search to expand a node that lies to the right of the goal node on this graph? Why or why not?
5. Consider the point number 3(g_3, h_3) and point number 4(g_4, h_4) on this path (Search moves from #3 to #4 along the path)

a. (5) What does it mean when h_3 is smaller than h_4? Describe also in terms of the admissibility and monotonicity properties of the h function.
b. (5) What does it mean when ff_3 is smaller than ff_4? Relate your reason to the admissibility and monotonicity of the h function.

6. (20) Consider the case of some constant values c1 and c2 such that:

   $c1 = \mu.g(n) + (1-\mu).h(n)$ and

   $c2 = \mu.g(n) + (1-\mu).h(n)$

   Draw the boundaries given by the above two equations for the following cases (each on a separate graph)

   1. $c1 = c2+10$ and $\mu=0$;
   2. $c1 = c2+10$ and $\mu=1.0$;
   3. $c1 = c2+10$ and $\mu=0.5$;
   4. $c1 = c2+10$ and $\mu=0.25$
   5. How can you show on this graph the situation when A* search using ff function with $\mu=0.5$ has expanded all nodes from the Open List that have a value less than 30?

7. (5) For what value of μ can you say that a path to goal node may not be found, even though it may exist. Explain in terms of the point locations and paths on the graph.

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Problem #2

1. (4) Represent the sentence “All Germans speak the same language” in predicate calculus. Use the predicate *Speaks(x,l)* meaning that person *x* speaks language *l*.
2. (4) Represent the sentence “All people living in Germeny are Germans” in predicate calculus. Use the predicate *LivesIn(x,c)* meaning that person *x* lives in country *c*.
3. (4) Represent the sentence “John lives in Germany and every German plays soccer” in predicate calculus. Use the predicate *Plays(x,g)* meaning person *x* plays game *g*.
4. (8) We want to find answer to the question Does John speak German? Are the above formulas sufficient to answer this question? Explain your answer. If you need to add a new formula in order to extract an answer to this question state that formula.
5. (10) Convert all the above formulas to the clause form. Do not forget to standardize the variable names.
6. (20) Show how an answer to this query can be extracted using resolution refutation proof and answer extraction process with all the formulas that you now have. Very clearly show every step of the process. Every predicate must be written clearly and every step of the resolution refutation proof must be shown clearly.