CIS 32 Spring 2009, Homework 5

1. Prove $(p, p \Rightarrow (q \wedge r)) \vdash (p \vee r)$ using resolution.

   (20 points)

2. Consider the problem of devising a plan for a kitchen-cleaning robot.

   (a) Write down a set of logical predicates that can be used to desribe a kitchen which includes a stove, a sink, a refrigerator, counters and a floor, each of which can be clean or dirty. The kitchen also contains a garbage bin which can be full or empty.

   (b) Write a description of a kitchen that has a dirty stove, refrigerator, counters, and floor. (The sink is clean, and the garbage has been taken out.)

   (c) Write a description of a goal state where everything is clean and there is no garbage in the bin.

   (d) Write a set of STRIPS-style operators that might be used. When describing these, take into account that:

      i. Cleaning the stove or the refrigerator will get the floor dirty.

      ii. Cleaning the refrigerator generates garbage and messes up the counters.

      iii. Washing the counters of the floor gets the sink dirty.

   (e) Describe the algorithm that a STRIPS planner would use to create a plan to clean the kitchen.

   (30 points)

3. The monkey-and-bananas problem is faced by a monkey in a laboratory with some bananas hanging out of reach from the ceiling. A box is available that will enable the monkey to reach the bananas if he climbs on it. Initially the money is at A, the bananas are at B, and the box is at C. The monkey and box have height Low, but if the monkey climbs onto the box he will have height $High$, the same as the bananas.

   The actions available to the monkey include Go from one place to another, $Push$ an object from one place to another, $ClimbUp$ onto or $ClimbDown$ from an object, and $Grasp$ or $UnGrasp$ an object. If the monkey is in the same place as an object, and at the same height, $Grasp$ results in the monkey holding the object.

   (a) Write down a set of logical predicates that make up an ontology that can describe all the elements of this problem.

   (b) Write down the initial state description.

   (c) Write down STRIPS-style descriptions of the six actions.

   (d) Write down a goal in which the monkey is at C, holding the banana, and the box is at A.

   (e) Use the POP algorithm (explaining how it works) to find a plan that achieves the above goal.

   (30 points)

4. Consider the state space for the eight puzzle as given in Figure 1 at the end of this homework. If the function $c(n_i, n_j)$ gives the value 1 for all pairs of nodes, explain how reinforcement learning can be used to learn the heuristic values of the nodes in Figure 1.

   As part of your answer, you should compute the estimated heuristic value of all the numbered nodes in Figure 1 and explain how you obtain those values. You should do this computation for three complete iterations (in other words do three complete searches, updating the heuristic values every time).

   After these three updates, explain how an agent could use the greedy search on the heuristic values to find a path to the goal state.

   (20 points)

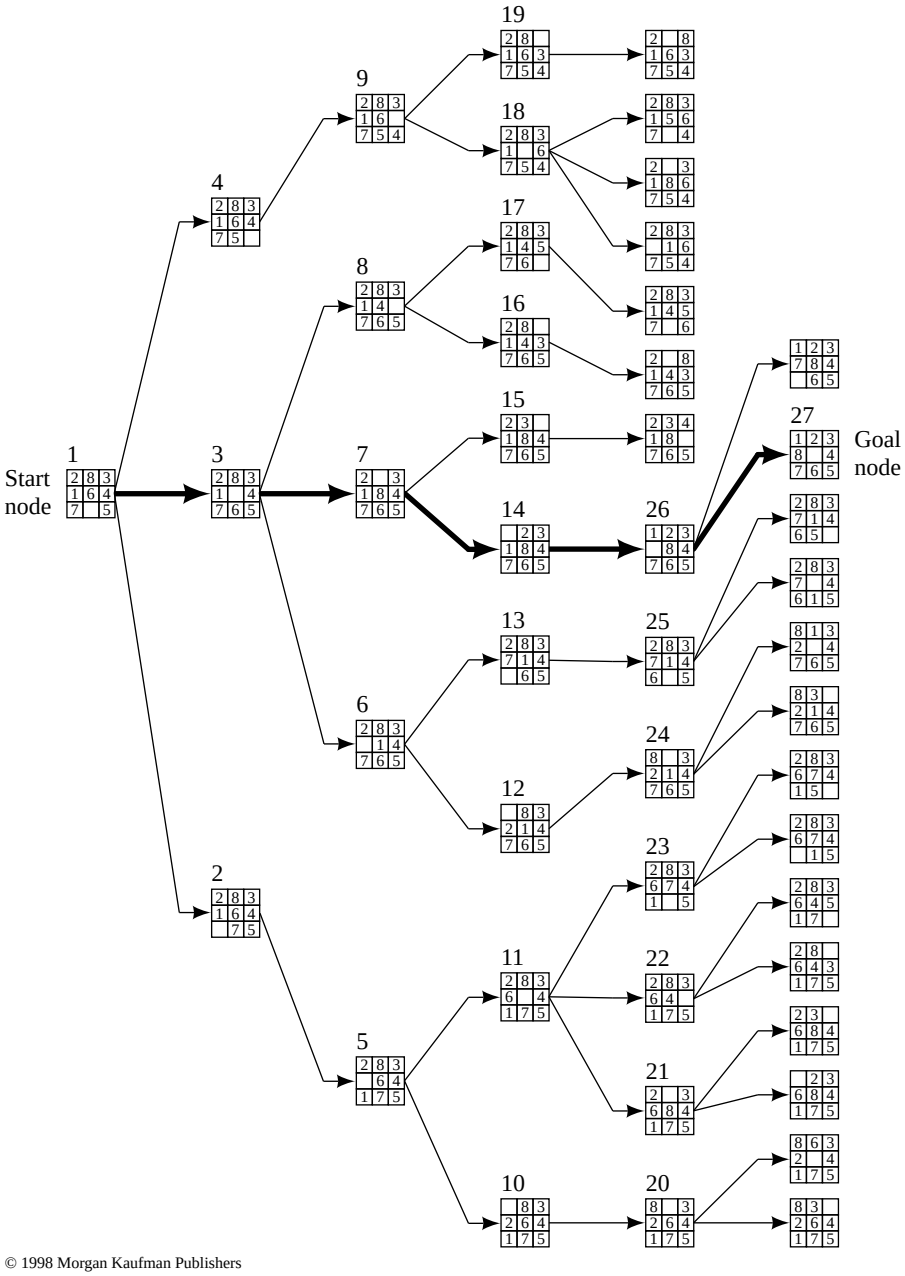

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Figure 1: Search space for the eight puzzle

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