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HW 1: Search

1. Graph Search
   1. Greedy search using the instantaneous transition costs

      Expanded Order: Start, B, D, C, Goal
      Path Returned: Start, B, C, Goal

   2. Depth first search

      Expanded Order: Start, A, Goal
      Path Returned: Start, A, Goal

   3. Breadth first search

      Expanded Order: Start, A, B, C, D, Goal
      Path Returned: Start, A, Goal

   4. Uniform cost search

      Expanded Order: Start, B, A, D, C, Goal
      Path Returned: Start, B, C, Goal

   5. Greedy search with the heuristic values listed at each state

      Expanded Order: Start, A, Goal
      Path Returned: Start, A, Goal

   6. A* search with the heuristic values listed at each state

      Expanded Order: Start, A, B, D, C, Goal
      Path Returned: Start, B, C, Goal

2. Downhill Skiing
   1. If the mountain is N units tall (eg., it is N = 6 units tall in the figure), what is the size of the state space? Justify your answer. (You may ignore "unreachable" states.) What are the start/goal states?

The state space is every tile the skier can be on, and all their possible velocities on those tiles. For a mountain N units tall this results in approximately N + (N-1) + (N-3) + (N-6) + … + (N-(N-1)) different states. This represents every possible speed on each tile, taking into account the tiles it takes to reach that speed. The start state is tile 0 with a velocity of 0, and the goal state is tile G with a velocity of 0.

2. Give an example of a state that is not reachable. Suppose that Alice cannot coast (she must either accelerate or decelerate): does this yield more unreachable states? If so, give an example of one and justify your answer either way.

One example of a state that is not reachable is being on tile 1 with a velocity of 7. If Alice cannot coast then the total number of states is not affected. Coasting does not allow Alice to accelerate any faster, merely maintain her current velocity. Coasting essentially allows Alice to have a velocity of 7 on tiles that aren't a multiple of 7 away from the first tile where you can obtain a velocity of 7. Without coasting, this can still be achieved by accelerating and decelerating between 0 and 1 to move forward 1 tile every other turn.

3. Is Alice's current elevation (i.e., distance from the chair lift) an admissible heuristic? Why or why not?

For a heuristic to be admissible it must always be less than or equal to the true cost to the goal state. If the cost is the number of moves, then unless Alice is limited to a velocity of 1 this heuristic can overestimate the true cost, and is therefore not admissible.

4. State and justify a non-trivial, admissible heuristic for this problem which is not current elevation.

After making a state change, Alice will have a (potentially new) velocity and a tile she ends up in. A simple heuristic that would be admissible would be to calculate the number of turns required to fully decelerate from the new velocity, though this isn't very useful. A more useful heuristic could calculate the number of tiles you are away from the goal if you were to take your new velocity and position, then accelerate as much as possible followed by fully decelerating. This is a relatively cheap calculation, and cannot be more than the real number of steps to reach the goal.