Problem Set 1: Due January 16

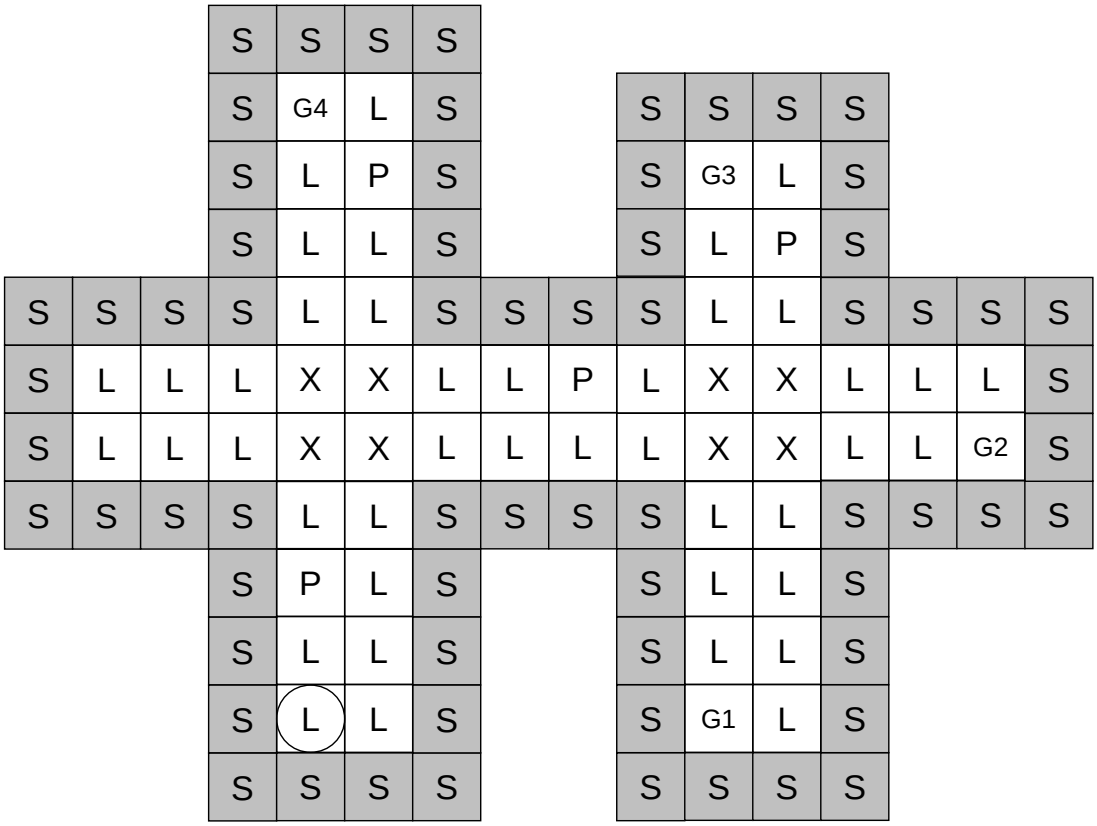

Figure 1: An instance of the Blocks World problem

In this assignment, we consider simple agents that operate as taxi drivers in a simplified city environment called *Road World*. This environment is divided into discrete locations, partitioned into the following categories: Lane (L), Shoulder (S), Intersection (X), Pothole (P), and Goal Locations (G1)-(G4). *Road World* is composed of two-lane streets which are joined together by four way intersections. All streets are surrounded by shoulders, no two potholes are adjacent, or immediately diagonal to one another, and no pothole is within an intersection. An example of such a world is illustrated in Figure 1.

At any given moment the agent is in one of the locations, facing North, South, East or West (interpret up as North in Figure 1). The agent is equipped with sensors so it can determine: 1) its current location type (L, S, X, P, Gn); and 2) the type of location directly ahead.

At each time step, the agent is allowed to move forward to the location directly ahead,

or to rotate left or right by 90 degrees. In *Road World*, the agent is not required to follow normal rules of the road (e.g., driving on the right), although the agent is *not* able to drive on the shoulders (they can only be used for sensory input). It is also important to note that since the agent can only move or turn at any point in time, the method it must use for changing lanes is rather unconventional.

The agent's aim in life is to reach one of the goal locations (labeled G1-G4 on the map). As it maneuvers through the world, however, the agent must avoid potholes as these will irreparably damage the taxi.

1. (10 points) Characterize the *Road World* environment based on the criteria described by Russell and Norvig on page 41-42. Be specific and justify your answers with a sentence or two per classification.

2. (10 points) A simple reflex agent uses a table that maps *current* percepts to actions. Create such a table that will get the agent to location G1 assuming it starts in the circled 'L' location and is initially headed North. Remember, driving into a pothole will destroy the agent. Your table should have three columns, one for each sensor and one for the resulting action. The table should also be as small as possible; use the symbol $*$ to indicate that any value for the specified sensor is acceptable to trigger the resulting action.

3. (10 points) For each of the remaining goal locations (G2-G4) write a table that gets the agent from the circled 'L' to the goal or argue precisely why it is not possible.

4. Now consider *Dream Road World* which is the same as a *Road World* environment, except there are no potholes at all.

   (a) (5 points) Is it possible to write a table-based agent that is guaranteed to visit every non-shoulder location on the *Fantasy Road World* version of the map in Figure 1?

   (b) (10 points) Is it possible to write a table-based agent that is guaranteed to visit every non-shoulder location on all possible *Fantasy Road World* maps? Justify your answer as precisely as possible.

5. (5 points) Return once again to the *Road World* environment, but now suppose the agent had a limited amount of information (1 bit) that it could manipulate. The agent can read this bit with a new sensor called `state` and can set it to 1 with the action `mark` or set it to 0 with the action `erase`.

   Show how the state based reflex agent can improve its performance on the tasks from questions 2 and 3. Specifically show how we can now create a table for the state based agent that allows it to reach a goal that was previously unreachable.