Departamento de Informática
Universidad Carlos III de Madrid

Grado en Ingeniería Informática

Artificial Intelligence

June 2016

General instructions

- Time assigned to the exam is **2.5 hours**
- Teachers will not answer any question about the exam
- You cannot leave the classroom during the exam, unless you have finished it
- Exams cannot be answered using a pencil

Theory questions (9 points)

We expect very short answers. Each question has a value of 1 point.

We would like to build a planning system for a robot, R, that has to deliver some packages from some offices to other offices in a building, as the example in Figure 1. All offices can be accessed from a common corridor C and have a door. Doors can be open (all offices except for O5) or closed (as O5). If doors are closed, the robot needs a key K to open the door that is located initially at a given service office S. The key opens all doors. The goal is to find the ordered set of actions that the robot has to execute in order to move the packages (as P1 and P2 in the figure) from their initial office (they can be at any office at start) to their detination office (they can go to any other office and they do not necessarily have to go to the same office). In the example in the figure, P1 has to go to O4 and P2 to O1.

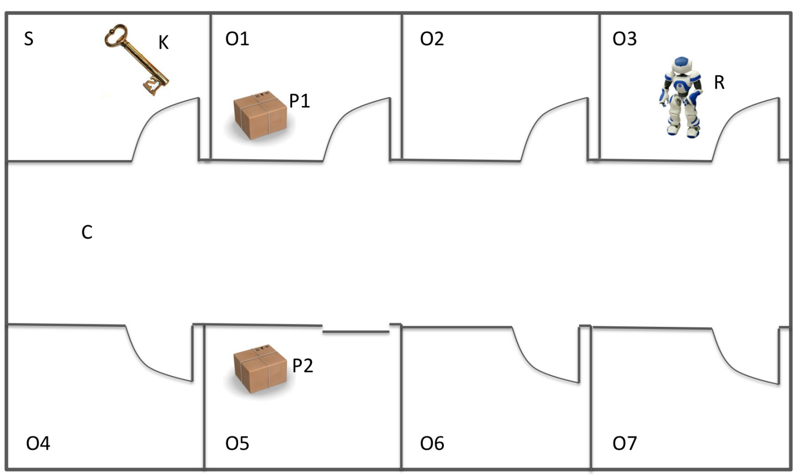

Figure 1: Example of office building.

1. Describe formally the problem space with all its components.
2. Describe formally the problem specified in Figure 1 and in the previous text. Provide a solution to the problem, given your selected problem space.
3. In case we would like to use a production system to generate a solution, describe two rules.
4. In case we would like to use a search technique to solve the problems in this problem space, which one would you use if your computer has very little memory? Explain why.
5. If the actions are stochastic, what technique would you use to find a policy to solve the problems? Explain why.
6. Formally define the problem space to use that technique.
7. If you would use a fuzzy system, what would be the difference between the computation of the parallel activation of fuzzy rules and the conflict resolution of a standard production system.
8. Describe one potential use of a genetic algorithm in this problem space.
9. Mention two sensors and two actuators that could be relevant to solve this kind of task and why they would be needed.
10. We define a grid as in Figure 2. It represents a bridge formed by the squares **A**, **B** and **C**. The goal is for a person that is currently at **B** to reach one of the two exits: **W** or **E** (marked with rewards *+1* and *+10* respectively). The person must avoid the squares on both sides of the bridge (up and down), since they represent a cliff and are marked with a negative reward of *-10*. The squares that represent the bridge (**A**, **B** and **C**) do not have a reward.

    There are two allowed actions in squares **A**, **B** and **C**: **left** (L) and **right** (R). The rest of the squares are terminal states and hence there are no allowed actions. The domain is stochastic. Suppose that actions have a **noise** of 0.1; that is, with probability 0.9 the person moves to the indicated direction, and with probability 0.1 s/he falls to the cliff.

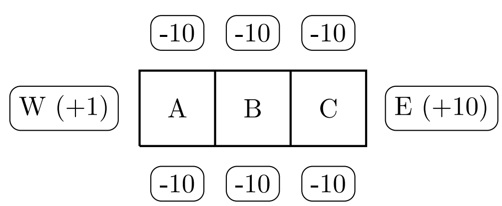

Figure 2: Grid definition.

    (a) (0.5 p) How many iterations would the *value iteration* algorithm need in order to obtain an optimal policy for this problem? Explain your answer.
    (b) (0.5 p) If we use a discount factor of $\gamma = 0.5$, the optimal policy consists of going to the right in all the bridge squares (**A**, **B** and **C**). Explain and reason if you should increase, decrease or leave the discount factor as it is, so that the optimal policy at square **A** is always to go to the left.