Final project

MARKOV DECISION PROCESS FOR TEMPERATURE CONTROL

Artificial Intelligence
Bachelor in computer science
Spring 2023

1. Problem statement

We want to build a thermostat that optimises energy consumption but looking for the comfort of the user. The basic operation in this case will be:

1. The user indicates on the thermostat the temperature at which he/she would like a room to be. For this project, we will assume that the user's desired temperature is 22 degrees Celsius.
2. The thermostat incorporates a thermometer that measures the actual temperature of the room, giving a value that can be between 16 and 25 degrees, from half a degree to half a degree.
3. For the sake of simplicity, we consider that neither lower nor higher temperatures than those given can occur [R1].
4. The thermostat must decide, at half-hourly intervals, whether to switch the heating on or off. For example, at 15:00 it decides to turn it on, at 15:30 it decides to turn it on again and at 16:00 it decides to turn it off. In this case, the heating would be on from 15:00 to 16:00 and off from 16:00 to 16:30.

With the heating on, after half an hour, the room temperature will have risen by half a degree half of the times. 20% of the times it will have risen by one degree, 20% of the times it will have stayed the same and 10% of the times it will even have fallen by half a degree. Exceptions:

- If the temperature is 16º, as it cannot go down any further because of [R1], 30% of the times it stays the same. It goes up by one or half a degree in the same percentage as for the rest of the temperatures.
- If it is 25, it cannot go up. 10% of the times it goes down and the rest stays the same.
- If it is 24.5, it can only go up by half a degree, which happens 70% of the times. 20% of the times it stays the same.

With the heating off, the temperature change in half an hour will have been -0.5 degrees 70% of the times, +0.5 degrees 10% of the times and no change the rest of the times. Exceptions:

- If the temperature is 16 degrees, since it cannot go down any further by [R1], 90% of the times it stays the same.
- If it is 25, it cannot go up. 30% of the times it stays the same.

The thermostat will be based on the optimal MDP policy corresponding to this problem, with the objective that the real temperature matches the one set by the user, at which point the thermostat stops working.

2. Project development

The main objective of the project is to obtain the optimal policy for the thermostat. The first step will be to identify the tasks necessary to reach this goal. Some tasks may require software development.

- The programs should be as generic as possible, using constants to adapt them to this particular project.
- The programming language should be Python. To use other languages, please consult the teacher in your group.
- This practice must be done in pairs.
- The problem statement does not say anything about the costs of the actions. Students should make an analysis of the costs that could be used and explain it in detail in the project report.

3. Delivery

- Each pair must submit a zip file via the link provided at Aula Global.
- The zip file name must be "AI Project 2023 <st-code1> <st-code2>.zip", where <st-codex> are the last six digits of each of the students in the pair.
    - Example: AI Project 2023 123456 345678.zip
- The zip file will include:
    - A project report with the following sections (PDF file):
        1. Executive summary
        2. Objectives
        3. Formal description of the MDP model
        4. Detailed cost model analysis
        5. Optimal policy for a certain set of costs, chosen by the students.
        6. Project phases (design, implementation, testing, …)
        7. Budget (financial estimate of how much the study and implementation would have cost if someone else had contracted it out)
        8. Conclusions (technical comments related to the development of the project and personal comments: difficulties, challenges, benefits, etc.).
    - A folder with additional files. It is mandatory to include here: A folder with additional files. It is mandatory to include here:
        - all the source code used in the project.
        - a video (5 minutes maximum) explaining the executive summary of the project.
- The deadline for submitting the project is 15 May at 11:59pm.