Lehr- und Forschungsgebiet Informatik 5
RWTH Aachen University

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Introduction to Artificial Intelligence (Winter 2018)

Assignment 1

Submit your solution electronically via the L2P until 24.10.2018.

Homework assignments are optional but strongly recommended.

Exercise 1.1 (35 points)

On the right, an elevator control algorithm is shown. The elevator is operating in a building where floors are numbered from v to u with $v \leq 0 \leq u$. On every floor there is a button to call for the elevator. Inside the elevator there is a button for every destination floor. Buttons can be pressed at any time and turn ON when they are pressed. The core of the control algorithm is the function ϕ_v^u which selects the next floor to be served.

```
f := 0                          /* initial floor */
loop
  M := {x | button x in the elevator is ON}
  W := {x | button on floor x is ON}
  f := φ_v^u(M, W, f)           /* next floor */
  move elevator to floor f
  open door
  wait
  close door
  switch button f OFF in the elevator
  switch button OFF on floor f
endloop
```

(a) Can this elevator control be regarded as an agent? Explain your answer. If 'yes': What is the PAGE description (percepts, actions, goals, environment) of the agent? What kind of an agent is it (reflexive with/without state, goal-based, utility-based)?

(b) List performance criteria for an elevator control.

(c) Design a function[1] ϕ_v^u mapping from such that the elevator control does a good job. As a minimum requirement, ϕ_v^u should guarantee that every floor whose button is ON (in the elevator or on the floor) is served eventually (*finite-wait property*). Describe informally what else you mean by "a good job". Prove that your ϕ_v^u has the finite-wait property.

[1] i.e. a direct mapping (without internal state) from switched on buttons and current floor to the next floor

Exercise 1.2 (15 points)

Discuss which characteristics the following environments have (accessible?, deterministic?, episodic?, (semi)dynamic?, discrete?):

(a) the environment from the previous elevator exercise

(b) the internet, e. g., for an intelligent search engine

(c) the environment of a Mars rover

Exercise 1.3 (20 points)

Consider the following vacuum world. There is a rectangular room which is divided like a chessboard into square fields. Each field contains dirt with a probability of 10 percent. Beside the *suck* action the vacuum cleaner can execute the movement actions *left*, *right*, *up*, *down*, by which it can move one field in the corresponding direction. The vacuum cleaner possesses a sensor indicating whether the present field contains dirt, and a sensor indicating whether a movement action failed because of a wall.

(a) Describe a purely reflexive agent that starts in the lower left field and cleans the room as well as possible. The specification of condition-action rules is sufficient. Describe how well your agent fulfills the task. Note that a purely reflexive agent may not use information except the current sensor data.

(b) Now consider the case that the agent can memorize the last executed movement, but the initial position is unknown. (Note: For memorizing, the suck action is ignored.) Let the memorized movement initially be *none*.

(c) Discuss, why purely reflexive agents in general (as in the first part of this exercise) are not able to return to their initial position or to switch off themselves after doing their work.

Exercise 1.4 (10 points)

Consider the two-room-vacuum world from the lecture in which Murphy's Law applies:

> If the room is dirty, sucking cleans it.
> If it is already clean, sucking *sometimes* (with a 10% chance) makes it dirty.

Show that there is an action sequence for each initial state that reaches a goal state under the assumption of accessibility, i.e., full observability.