TU Clausthal

**Department of Informatics**

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# Artificial Intelligence

## – Sheet 1: Agents and Problem Formulation –

Date: 15. April 2014

Points:

_____ of 30

Group / Tutor:

Name(s) & Matr. no.:

Remarks:

- Exercises can be solved in **groups up to 2 students**.
- With **formal proofs** we do really mean **formal proofs**; i.e., not just text but mathematical methods (e.g. *proofs by induction*, proper formalizations, etc.).
- In order to be **permitted to the exam**, Clausthal students must have fulfilled the following requirement: In **average 50%** of each exercise sheet has to be solved successfully *and* on all but one exercise sheet at least **25%** of the points have to be reached.

### Exercise 1 (6 Points, Intelligence)

Discuss the following statements: "Surely computers cannot be intelligent—they can only do what their programmers told them to do."
Contrast these statements to "Surely humans cannot be intelligent—they can only do what the laws of physics tell them to do."

### Exercise 2 (6 Points, Environments)

For each of the following agents, (1) develop a **PEAS** (Performance, Environment, Actuators, Sensors) description of the task environment, (2) characterize the environment according to the six properties given in the lecture (observability, determinism,etc.), and (3) select a suitable agent design: (a) Robocup soccer player, (b) autonomous driving vehicle.

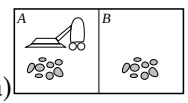
### Exercise 3 (6 Points, Rational agents)

Consider the following definition of a *rational agent:*

> For each possible percept sequence $per$, a rational agent should select an action that is expected to maximize its performance measure, given the evidence provided by $per$ and whatever built-in knowledge the agent has.

Now consider the following scenario. There are two rooms $A$ and $B$, each can be *dirty* or *clean* (cf. Figure 1(a)). A vacuum-cleaner agent can perform actions *left, right*, and *suck* (all actions have their obvious effects). Actions may fail with some low probability.

(a)




(b)

| Percept sequence | Action |
|---|---|
| $[A, Clean]$ | $Right$ |
| $[A, Dirty]$ | $Suck$ |
| $[B, Clean]$ | $Left$ |
| $[B, Dirty]$ | $Suck$ |
| $[A, Clean]$, $[A, Clean]$ | $Right$ |
| $[A, Clean]$, $[A, Dirty]$ | $Suck$ |
| ⋮ | ⋮ |

Figure 1: Vacuum-world

Does the the simple agent program in Figure 1(b) describe a rational agent? Show formal arguments for both possible answers.

**To be submitted:**

23. April 2014
**before** class

**Exercise 4 (6 Points, Expressiveness of standard agents)**

Give **formal** proofs of the following claims.

1. For every purely reactive agent, there is a behaviorally equivalent standard agent.
2. There are standard agents that have no behaviorally equivalent purely reactive agent.

**Exercise 5 (4 Points, Equivalence of agents)**

**Formally** prove Theorem 1.18: State-based agents are equivalent in expressive power to standard agents, i.e. for every state-based agent there is a behaviorally equivalent standard agent *and* vice versa.

**Exercise 6 (2 Points, Bounded Memory)**

Is Theorem 1.18 still true if we restrict the set of state-based agents to agents with bounded memory (i.e. those with *finite* internal states $I$)? Explain.