Student name: _____ Student number:

Faculteit der Exacte Wetenschappen

Exam Design of Multi-Agent Systems

Vrije Universiteit Amsterdam **17 december 2007**

Exercise	**1**	**2**	**3**	**4**	**bonus**
points	25	30	15	20	10

Norm:
The tentamination mark **T** equals (the sum of the points scored for the exercises plus 10 bonus points) divided by 10.
The endmark **E** for the course Design of Multi-Agent Systems is calculated as follows: **E = (T + H + P) / 3**
Where : T = tentamination mark H = mark for the home work exercises P = mark for the small practicum

You find:

4 exercises
5 appendices (1A, 1B, 2, 3, 4)

Student name: _____ Student number:

Exercise 1 (25 points):

Relevant Appendices: Appendix 1A and Appendix 1B.

This exercise consists of two parts. Motivate your answers.

Exercise 1a (15 points)
In chapter 1 of the syllabus a number of primitive agent concepts have been introduced (see Appendix 1B of the answer sheets). In Appendix 1A, you can find some information on an intelligent system to improve medicine usage.
Analyse this information according to the primitive agent concepts and fill out Appendix 1B (3 answer sheets) indicating which agent concepts are relevant for the medicine usage system. Remember to motivate your answers clearly.

Exercise 1b (10 points)
Would you call this system an agent? Motivate your answer.

Exercise 2 (30 points)

Relevant Appendix: Appendix 2.

This exercise concerns a model for monitoring the employees of a biscuits bakery (see Appendix 2), and consists of 2 parts.

Exercise 2a (15 points)
Give a graphical representation of the information types that you would use in the Biscuits Baker agent.

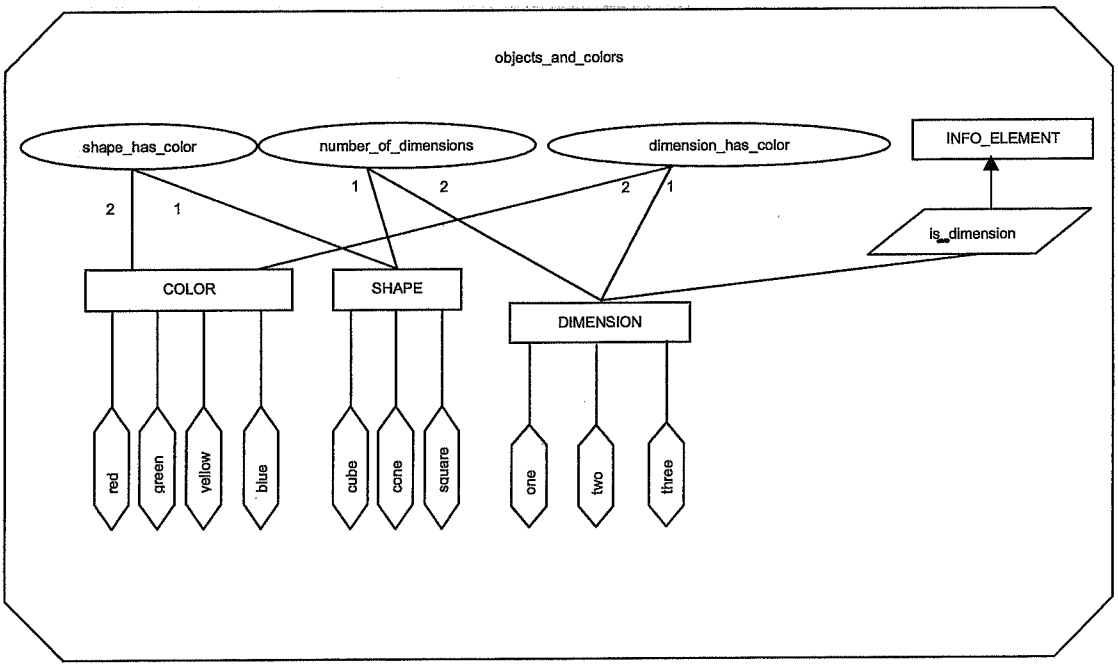
Exercise 2b (15 points)
Use the information types you have identified above to specify rules of the knowledge base needed for the Biscuits Baker agent.

Student name: _____ Student number:

Exercise 3 (15 points):

Relevant Appendix: Appendix 3.

Consider the information type objects_and_colors as shown in the Figure below. In Appendix 3 you can find a table consisting of a number of strings. Which of these strings are terms considering the information type objects_and_colors? Which are atoms? And which are ground atoms? Which of the terms are well formed? Which of the atoms are well formed? Fill in your answer in the table in Appendix 3.



Exercise 4 (20 points):

Relevant Appendix: Appendix 4.

This question is about information states and reasoning. Study the partial specification of Appendix 4. This is the public information state S of component mouse_a.

```
S = [  observation_result(at_position(self, p0), pos),
       observation_result(at_position(food, p1), pos),
       observation_result(at_position(food, p0), pos),
       observation_result(at_position(screen, p0), neg)]
```

Exercise 4a (8 points)
Provide an information state S', that refines S and is also closed and consistent with respect to the knowledge base of component mouse_a.

Student name: _____Student number:

Exercise 4b (4 points)
Motivate that S' is a refinement of S.

Exercise 4c (4 points)
Motivate that S' is closed with respect to the knowledge base of component mouse_a.

Exercise 4d (4 points)
Motivate that S' is consistent with respect to the knowledge base of component mouse_a.

Student name: _____ Student number:

Appendix 1A: Intelligent Medicine Box System

Assisting humans in timely usage of their medicine can be crucial for their health. When looking at HIV medicine, this medicine is very sensitive to irregular intake and needs to be taken at strict times in order for the patient to stay healthy. To assist humans in taking their medicine, the company called SimPill has decided to create an intelligent system that supports humans in taking their medicine on a regular basis. The system continuously monitors the medicine box of the patient. In case the system notices that no medicine has been taken at the appropriate time, the system can warn the user that he/she needs to take medicine. Furthermore, the system can also give warnings in case the patient tries to take medicine too early. If the system considers the patient insufficiently structured in its medicine usage (which is derived by looking at the history of medicine intake), the system contacts the doctor, and informs the doctor on the current medicine usage pattern of the patient. The doctor can give the system input on what strategy the system should follow to improve the patient's intake behavior.

Student name: _____ Student number:

Appendix 1B: Answersheet (1 out of 3)

I. External primitive concepts	
A. Interaction with the world	
passive observations	
active observations	
performing actions	
B. Communication with other agents	
incoming	
outgoing	

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Appendix 1B Answersheet (2 out of 3)

II. Internal primitive concepts	
A. World Model	
B. Agent Models	
C. Self Model	
D. History	
E. Goals	
F. Plans	
G. Group Concepts	
Joint goals	
Joint plans	
Commitments	
Negotiation strategies	

Student name: _____ Student number:

Appendix 1B Answersheet (3 out of 3)

III. Types of behaviour	
Autonomy	
Responsiveness	
Pro-activeness	
Social behaviour	
Own adaptation and learning	

Student name: _____ Student number:

Appendix 2 Biscuits Baker

An owner of a bakery complains that trainees of the bakery eat more biscuits than they bake. Apart from the fact that such a behaviour is not good for production figures, there is another unpleasant effect: sometimes young bakers get stomachaches and must be transported by an ambulance to a hospital in order to clean their stomach.

The owner would like to design a software system that monitors state of health of the bakers. The system gets input from a number of sensors. The input information concerns positions of the baker and sounds he makes: the baker can lay down, stand straight or stand bent. The baker can moan, whistle or be silent. On basis of the interpretations the system has to analyse whether the state of the baker is critical.

The system must first interpret sounds and positions of the baker: if he bends, then he has a stomachache; if he whistles he feels good; if he lays down and is silent, then he is in a coma.

On the base of these interpretations the system must decide whether the state of the baker is so bad that the agent has to call for an ambulance, or that calling the foreman is enough. Calling an ambulance happens in case he is in a coma, and calling the foreman is performed in case he has a stomachache.

Student name: _____ Student number:

Appendix 3: Answersheet for Exercise 3.

	term	atom	ground atom	well-formed
X:red				
shape_has_color(D:DIMENSION, blue)				
is_dimension(D:DIMENSION)				
dimension_has_color(two, green)				
(shape_has_color(cube, yellow))				
three				
number_of_dimensions(square, four)				
D:DIMENSION				

```
end information type

information type observation_results
        sorts                                   INFO_ELEMENT, SIGN ;
        relations       observation_result:     INFO_ELEMENT * SIGN;
end information type

information type observation_result_info
        information types       truth_indication,
                                observation_results,
                                information_element_info;
end information type

information type actions_to_be_performed
        sorts                                   ACTION ;
        relations       to_be_performed:        ACTION;
end information type

information type action_info
        information types       actions_to_be_performed,
                                domain_actions;
end information type
```

4.3 Fragment of specification of the component

The component is primitive and is described shortly below.

The component mouse_a

The interfaces are defined by:

input interface: the information type observation_result_info;
output interface: the information type action_info;

The contents of the knowledge base:

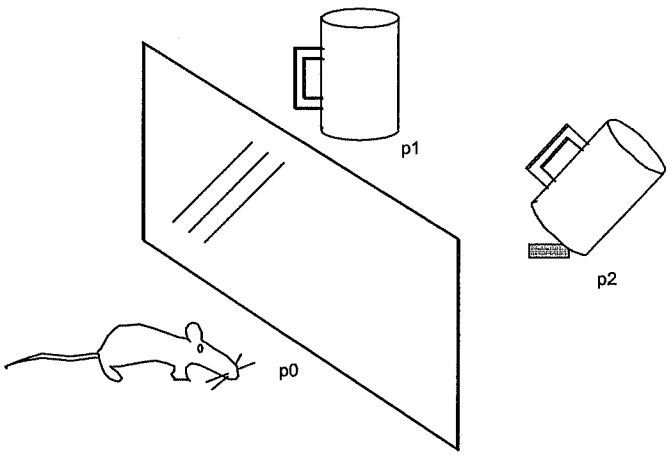
```
if      observation_result(at_position(food, P:POSITION), pos)
 and    observation_result(at_position(screen, p0), neg)
 and    observation_result(at_position(self, P:POSITION), neg)
then    to_be_performed(goto(P:POSITION)) ;

if      observation_result(at_position(self, P:POSITION), pos)
 and    observation_result(at_position(food, P:POSITION), pos)
then    to_be_performed(eat) ;
```

Student name: _____Student number:

Appendix 4

4.1 Problem Description

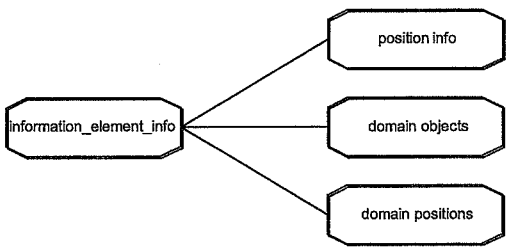
Separated by a transparent screen (a window, at position p0), at each of two positions p1 and p2 a cup (upside down) and/or a piece of food can be placed. At some moment (with variable delay) the screen is raised, and the mouse is free to go to any position. A genuine mouse is known to go to food and eat it.



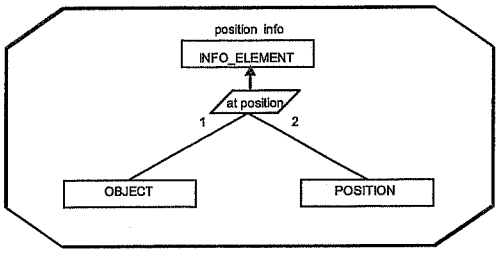
In sections 4.2 and 4.3 of this Appendix a partial specification can be found of the artificial mouse.

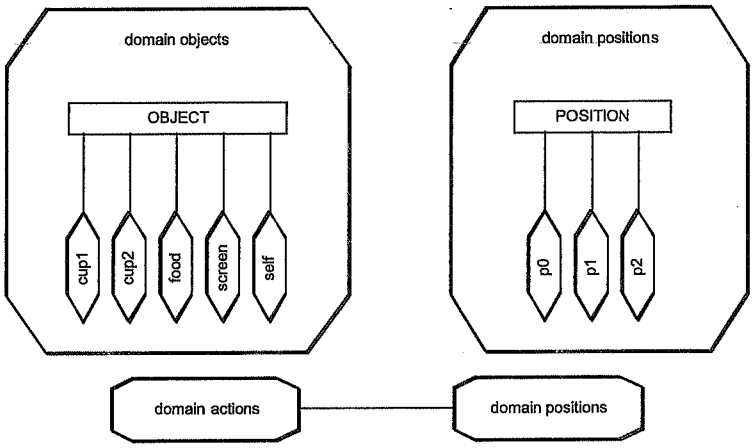
4.2 Information types

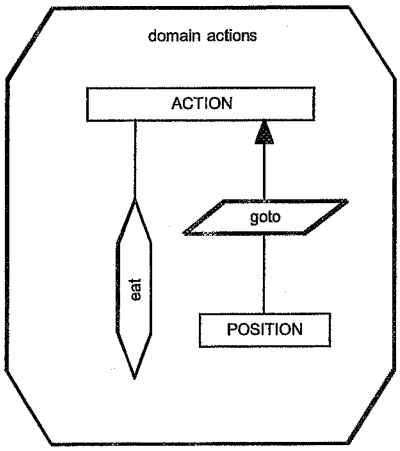
The information types being used within the whole system are:



Student name: _____ Student number:







In addition to these domain specific types, the generic types are shown in a textual format below.

information type truth_indication

sorts		SIGN ;
objects	pos,	
	neg :	SIGN;