Student name: _____ Student number:

Faculteit der Exacte Wetenschappen

Exam Design of Multi-Agent Systems

Vrije Universiteit Amsterdam **23 October 2008**

Exercise	1	2	3	4	**bonus**
points	25	30	20	15	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**. In order to get an endmark, T needs to be ≥ 5.5
Where : T = tentamination mark H = mark for the home work exercises P = mark for the small practicum

You find:

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

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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 automated personal fitness instructor.
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 automated personal fitness instructor. 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 a car safety agent (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 car safety agent.

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

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Exercise 3 (20 points):

Consider the following information type:

```
information type cameras
    sorts          COMPACT, SLR, DIGITAL_CAMERA;
    sub-sorts      COMPACT, SLR : DIGITAL_CAMERA;
    objects        eos_300d, d300 : SLR;
                   ixus_90, coolpix_16 : COMPACT;
    relations      is_bigger_than : DIGITAL_CAMERA * DIGITAL_CAMERA;
                   has_more_megapixels_than : DIGITAL_CAMERA * DIGITAL_CAMERA;
                   is_older_model_than : DIGITAL_CAMERA * DIGITAL_CAMERA;
end information type
```

And the following knowledge base:

```
knowledge base camera_kb
    information types cameras
    contents

    is_bigger_than(S:SLR, C:COMPACT);

    if has_more_megapixels_than(C:COMPACT, S:SLR)
    then is_older_model_than(S:SLR, C:COMPACT);

    if is_older_model_than(S1:SLR, S2:SLR)
    then has_more_megapixels_than(S2:SLR, S1:SLR);

    if is_older_model_than(C1:COMPACT, C2:COMPACT)
    then has_more_megapixels_than(C2:COMPACT, C1:COMPACT);

end knowledge base
```

The information state S is defined as follows:

```
S = [has_more_megapixels_than(ixus_90, eos_300d),
     is_older_model_than(eos_300d, d300),
     is_older_model_than(coolpix_16, d300)]
```

Exercise 3a (8 points)

Provide an information state S', that refines S and is also closed and consistent with respect to the knowledge base camera_kb.

Exercise 3b (4 points)

Motivate that S' is a refinement of S.

Exercise 3c (4 points)

Motivate that S' is closed with respect to the knowledge base camera_kb.

Exercise 3d (4 points)

Motivate that S' is consistent with respect to the knowledge base of component camera_kb.

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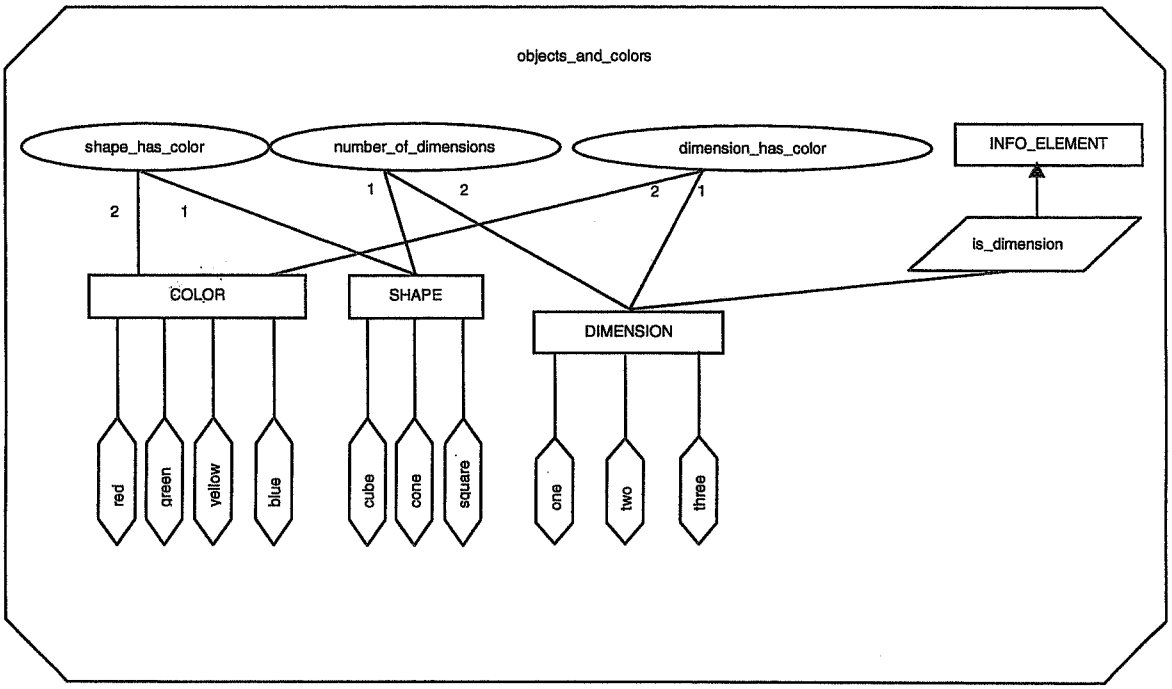
Exercise 4 (15 points):

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.



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Appendix 1A: Automated Personal Fitness Trainer

In order for people to successfully participate in a fitness program, two crucial factors need to be well taken care of: (1) making sure the fitness program is tailored towards the person, and (2) motivating the person in such a way that the full program will be completed. These two factors can be dealt with by humans (e.g. a personal trainer), but nowadays automated personal fitness trainers are becoming available as well. An example of such a trainer is present on the Wii (a game computer by Nintendo), and in particular the Wii fit program. Below is a description of this automated personal trainer.

The automated personal trainer of the Wii fit can tailor a fitness program by measuring a number of elements, namely the weight of the human (done by the human stepping on the Wii balance board), the age of the human (which is requested via the television screen, and communicated to the automated personal trainer via the remote control), and the date of birth (which is also communicated). Furthermore, the personal assistant agent can request the human to do some basic tests, such as a balance test to investigate the physical shape of the person. The results are measured by the automated personal trainer. Eventually, the automated personal trainer communicates a so-called Wii fitness age, which represents the current shape the person is in. Based upon this age, the human can set certain goals for the fitness program via a communication with the remote control. All this information is stored by the personal assistant, and used during training. During this training, the automated personal assistant communicates fitness tips on its own initiative. Furthermore, on a regular basis the human receives feedback on the current performance of the exercises and how far the person is from the goal that has been set.

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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	

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Appendix 1B: Answersheet (3 out of 3)

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

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Appendix 2: Car Safety Agent

Safety is a hot issue in the car industry, and new inventions to improve the safety of cars are therefore seen quite often nowadays. The systems are meant to aid the driver in driving as safely as possible. An example of such a system has been introduced by one of the major car manufacturers and involves a *car safety agent*. This agent does two things: (1) maintain a safe distance from the cars in front in case the car is set in cruise control, and (2) stop the car when drivers are unable to control the car. The agent basically derives actions using particular observations (some of the elements could also be seen as communication, but in this case we consider them observations for the sake of simplicity). Hereby, the agent can observe a number of things, namely: (1) the gaze of the driver (what is the driver focusing on), this can either be road, or it can be far away; (2) the steering pattern (which can be exceptional or regular); (3) the distance between the car and the car in front; (4) the current speed; (5) the preferred speed set by the driver, and (6) the minimum distance set by the car driver. Based upon this information the car safety agent can derive several actions, namely (1) reducing the speed of the car, (2) increasing the speed of the car, or (3) maintaining the current speed.

The following knowledge is used to derive such actions. First, the car safety agent derives whether the driver is able to control the car (which is internal information that is derived). In case of a gaze which is far away, and an exceptional steering pattern, the driver is categorized as being unable to control the car because the driver is not focusing on the road, and does not control the car well. Otherwise, the driver is able to control the car. In case the driver is unable to control the car, the speed is reduced. If the driver is able to control the car, the following rules are used to maintain a safe distance from the car in front: In case the distance between the car and the car in front is less than the minimum distance set by the driver, then the car reduces speed. If the distance between the car and the car in front is greater than or equal to the minimum distance specified, and the current speed is lower than the preferred speed, then the speed of the car is increased. If the distance between the car and the car in front is greater than or equal to the minimum distance specified, and the current speed is higher than the preferred speed, then the speed of the car is decreased. Finally, in case the current distance between the cars is greater than of equal to the minimum distance required, and the current speed is equal to the preferred speed, then the current speed is maintained.

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Appendix 3: Answersheet for Exercise 4

	term	atom	ground atom	well-formed
shape_has_color(C:COLOR, D:DIMENSION)				
four				
is_dimension(D:DIMENSION)				
dimension_has_color(two, blue)				
I:INFO_ELEMENT				
number_of_dimensions(blue, square)				
number_of_dimensions(is_dimension(three), three)				
(D:DIMENSION)				