Faculteit der Exacte Wetenschappen

Tentamen Ontwerp van Multi-agentsystemen / Design of Multi-Agent Systems

Vrije Universiteit Amsterdam **16 februari 2005**

Opgave/Exercise	**1**	**2**	**3**	**4**	**bonus**
Punten/points	30	20	20	20	10

Normering:	*Norm:*
Het **tentamencijfer T** is gelijk aan het totaal behaalde punten voor de tentamenopgaven plus de bonus punten gedeeld door 10.	The tentamination mark **T** equals sum of the points scored for the exercises plus 10 bonus points divided by 10.
Het **Eindcijfer** voor het hoorcollege Ontwerp van Multi-agentsystemen wordt als volgt berekend.	The endmark **Eindcijfer** for the course Design of Multi-Agent Systems is calculated as follows:
Eindcijfer = (T + H + P) / 3	
Waarbij	Where
T = tentamencijfer H = cijfer huiswerkopgave P = cijfer voor het klein practicum	T = tentamination mark H = mark for the home work exercises P = mark for the small practicum

U treft aan:

4 opgaven
4 appendices

You find:

4 exercises
4 appendices

Student name: _____ Student number:

Opgave 1 (30 points)

De opgave gaat over een model voor het in de gaten houden van de medewerkers van een koekjesfabriek (zie Appendix 1A) en bestaat uit 3 delen.

Opgave 1a (10 points)

Formaliseer de kennis uit de probleembeschrijving in kennisbanken en geef aan welke kennisbanken in welke componenten gebruikt worden. Motiveer je antwoord.

Opgave 1b (10 points)

Geef aan welke agent concepten voor het systeem relevant zijn. Motiveer je keuzes kort. Gebruik de speciale antwoordvellen (3 stuks) van Appendix 1B.

Opgave 1c (10points)

Zou jij dit systeem een agent noemen? Motiveer je antwoord in hooguit 15 woorden.

English:
Exercise 1 (30 points)

This exercise concerns a model (see Appendix 1A) for monitoring the employees of a biscuits bakery, and consists of three parts.

Exercise 1a (10 points)

Formalise the knowledge used by the system in knowledge bases, and indicate in which component which knowledge base is used. Motivate your answer.

Exercise 1b (10 points)

Indicate which agent concepts are relevant for the system. Motivate your choices briefly. Use the special answer sheets (3 of them)s of Appendix 1B.

Exercise 1c (10 points)

Would you call this system an agent? Motivate your answers in a maximum of 15 words.

Student name: _____ Student number:

Opgave 2 (20 points)

Deze opgave bestaat uit drie delen. Lees probleem beschrijving Towers of Hanoi gegeven in Appendix 2.	This exercise consists of three parts. Read the description of the problem Towers of Hanoi (see Appendix 2).

Opgave 2a (10 points)

Formuleer de vereisten voor dit probleem.	Formulate the requirements of this problem.

Opgave 2b (10 points)

Geef de noodzakelijke domein specifieke informatie types voor dit probleem.	Give the necessary domain specific information types for this problem.

Opgave 3 (20 punten)

In Appendix 3 kun je wat informatie vinden over assistente Q.
Stel dat je het generieke agentmodel zou gebruiken om een artificiële agent te ontwerpen die Q's taak zou kunnen overnemen. In het generieke agentmodel (hoofdstuk 7 van de syllabus) komen een aantal componenten voor:

agent_interaction_management,
world_interaction_management,
maintenance_of_agent_information,
maintenance_of_world_information,
own_process_control,
agent_specific_task.

Motiveer waarvoor een component nodig is, motiveer ook waarom een component eventueel niet nodig is.

English:

Student name: _____ Student number:

Question 3 (20 points)

In Appendix 3 you can find some information on assistant of a Film Director Q.
Suppose you would use the generic agent model to design an artificial agent that can take over Q's task. In the generic model (hoofdstuk 7 van de syllabus) there are components:

agent_interaction_management,
world_interaction_management,
maintenance_of_agent_information,
maintenance_of_world_information,
own_process_control,
agent_specific_task.

Motivate why a component is needed; in case you left out a component, motivate why this component is not necessary.

Opgave 4 (20 punten)

Het onderwerp van deze opgave betreft informatie toestanden. Bestudeer de partiële specificatie van Appendix 4. S is een public informatietoestand van de component mouse_a.

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

- Geef een informatietoestand S' die S verfijnt en bovendien consistent en gesloten (refines, consistent and closed) ten opzichte van de kennisbank van component mouse_a (8 punten).
- Motiveer dat S' een verfijning van S is (4 punten).
- Motiveer dat S' gesloten is ten opzichte van de kennisbank van component mouse_a (4 punten).
- Motiveer dat S' consistent is ten opzichte van de kennisbank van component mouse_a (4 punten).

English:
Question 4 (20 points)

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),
```

Student name: _____ Student number:

observation_result(at_position(screen, p0), neg)]

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

Student name: _____ Student number:

APPENDIX 1

Appendix 1A Koekenbakker

Een eigenaar van een koekjesfabriek klaagt dat medewerkers in opleiding meer koekjes eten dan ze bakken. Nog los van het feit dat dit gedrag slecht is voor de omzetcijfers, is er nog een ander vervelend gevolg: soms krijgen jonge bakkers buikpijn en moeten ze per ambulance worden afgevoerd om hun maag leeg te laten pompen.

The eigenaar wil graag een software systeem laten ontwerpen dat de gezondheidstoestand van de bakkers in de gaten houdt. Deze taak lijkt erg op de taak die het proces monitor_process zoals beschreven in hoofdstuk 9 kan uitvoeren. Het systeem kan gebruik maken van de data van een aantal sensoren. De input bestaat uit de lichaamshouding van de bakker en de geluiden die de bakker maakt. De bakker kan liggen, rechtop staan, of voorovergebogen staan. De bakker kan kreunen, fluiten of stil zijn. Op grond van de interpretatie van de input moet het systeem analyseren of de toestand van de bakker kritiek is.

Het systeem moet eerst de geluiden en houdingen van de bakker interpreteren: als de bakker voorovergebogen staat, dan heeft hij buikpijn; als hij fluit voelt hij zich goed, als hij ligt en stil is, dan is hij bewusteloos.

Op grond van deze interpretaties moet de het systeem beslissen of de toestand van de bakker zo erg is dat de ambulance gebeld moet worden, of dat volstaan kan worden met het roepen van de voorman. Het kan natuulijk ook zijn dat het systeem niets hoeft te doen.

Omdat deze taak erg lijkt op de taak van het proces monitor_process zoals dat beschreven is in hoofdstuk 9, is hieronder een grafische representatie van deze component gegeven.

English: 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.

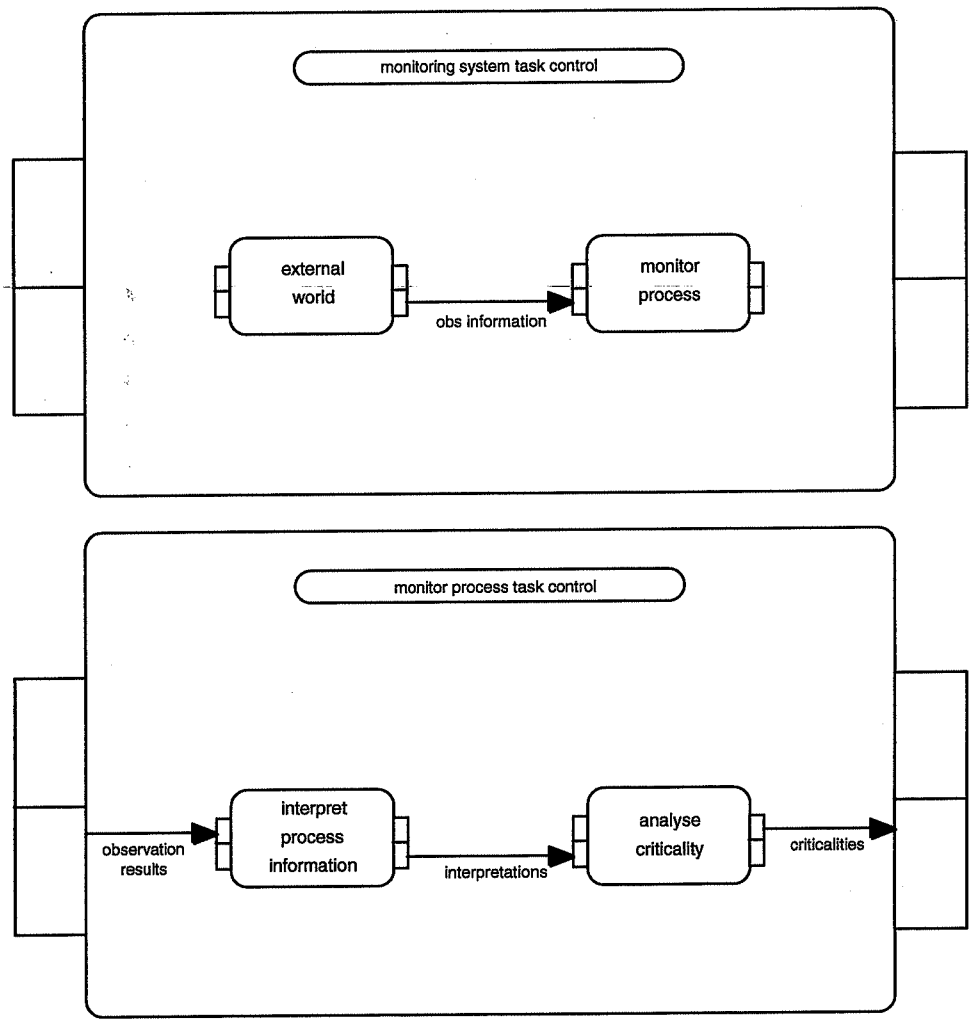
The owner would like to design a software system that monitors state of health of the bakers. The task of the system is similar to the task of the process monitor_process as it is described in Chapter 9. The system can use data of a number of sensors. The input information concerns positions of the baker and sounds he makes: the baker can lay down, stand straight or 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 bents, 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. Of course it is also possible that system has to do nothing.

Student name: _____ Student number:

Since the task of the system is similar to the task of the process monitor_process as it is described in Chapter 9, a graphical representation of this component is given below.



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	

Student name: _____ Student number:

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 protocols	
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:

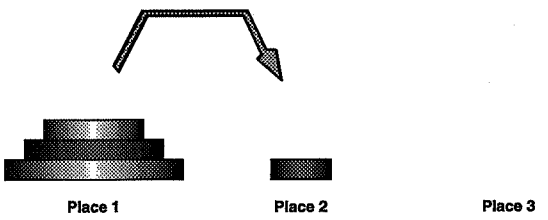
Appendix 2

Towers of Hanoi (in English only)

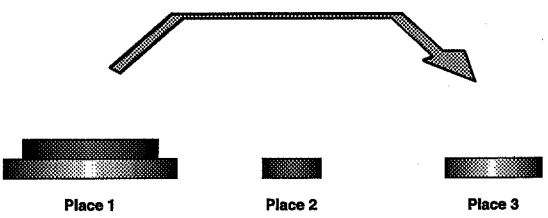
An agent is needed that is capable of controlling the execution of a solution for the problem of the towers of Hanoi for towers of hight four. A tower of Hanoi is a tower of blocks of increasing size (seen from the top down). The goal of the exercise is to move the tower from place 1 to place 3. There are four blocks, the smallest one is called block a, the next one is called block b, the next is block c, and the largest block is block d. The agent can only move one block at a time, that block has to be on top, and a block can only be placed on the ground or on top of a larger block.

Furthermore, blocks may only be placed on place 1, place 2, or place 3. Part of the knowledge used by the agent is the following:

1. If I observe that all blocks are at place 1,
   then I decide to move block a to place 2.

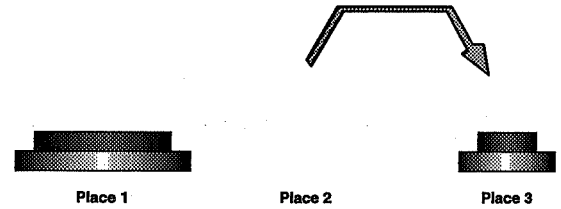


2. If I observe that blocks b, c, and d are at place 1,
   and I observe that block a is at place 2,
   then I decide to move block b to place 3.

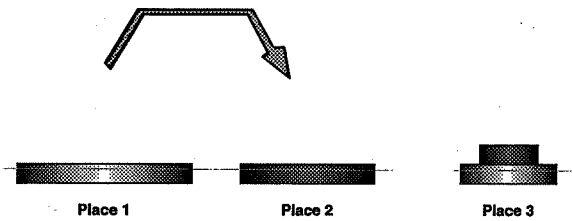


Student name: _____ Student number:

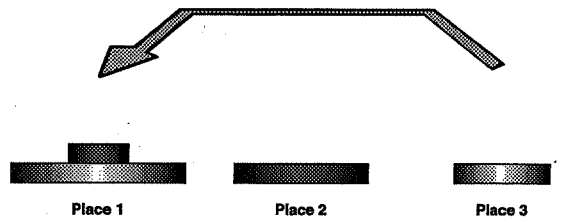
3. If I observe that blocks c and d are at place 1,
   and block a is at place 2
   and block b is at place 3
   then I decide to move block a to place 3.
4. If I observe that blocks c and d are at place 1,
   and blocks a and b are at place 3
   then I decide to move block c to place 2.



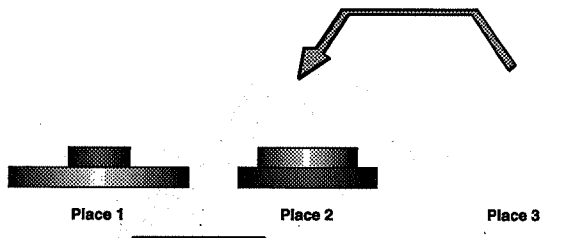
5. If I observe that block d is at place 1,
   and blocks a and b are at place 3
   and block c is at place 2
   then I decide to move block a to place 1.



6. If I observe that blocks a and d is at place 1,
   and block b is at place 3
   and block c is at place 2
   then I decide to move block b to place 2.
7. If I observe that blocks a and d are at place 1,
   and blocks b and c are at place 2
   then I decide to move block a to place 2.



8. If I observe that block d is at place 1,
   and blocks a, b and c are at place 2
   then I decide to move block d to place 3.



Student name: _____ Student number:

Appendix 3

(Een Nederlandse vertaling van Question 2 is niet beschikbaar.)

Assistant of a film director

Q is an assistant of a film director. A big part of her duties is to recruit actors for new roles. She investigates the suitability of an actor with respect to different types of roles, e.g. whether he is capable to play the role of a villain, a hero, etc. In that connection, Q regularly looks for new actors on the Internet and also attends new plays in theaters watching actors performance on stage. She discusses the conclusions of her investigations with the director, and later on she announces to the actors the director's decisions. The actors in their turn ask Q professional advice on their performance and make various requests to Q such as copying scripts, etc. It is her duty to fulfil such requests.

Another part of her obligations is passive monitoring of the filming conditions such as lighting of the stage, sound effects, etc. She discusses her observations with the director, and after receiving his instructions Q informs stage workers and actors what must be improved.

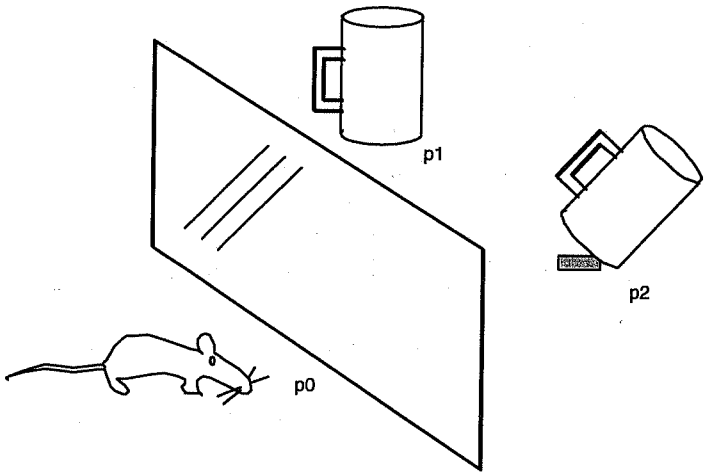
Together with the director and the crew she does her best to produce a film good enough to be nominated for a national film festival. Together with the director she is responsible for making a schedule, so that the film is finished in time.
We asked the director about Q's personal characteristics. Below is the interview with him.
I know Q for five years. She is an energetic person committed to our plans to produce a best film possible. So I need not check her work constantly and give her certain freedom in her decisions.
She started with this job five years ago and was inexperienced. She has learned a lot over the years on this job and became an excellent assistant. She is indispensable in our group. Creative people like us often have difficult features in their characters. I have a bad tempo and never want to go into details of any routine matter and my actors are capricious and demanding. Q often takes initiative to mediate our conflicts and always finds unexpected and effective solutions.
Q is ambitious. In time she wants to be a film director herself, so she studies my work carefully and this year she will negotiate with investors to get money for a small budget movie she is planning to shoot herself.

Student name: _____ Student number:

Appendix 4 Mouse A

4.1 Problem Description

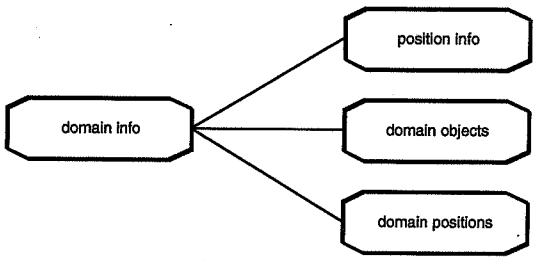
Separated by a transparent screen (a window, at position p0), at each of two positions p1 and p2 a cup (upside down) and/or a piece of food can be placed. At some moment (with variable delay) the screen is raised, and the mouse is free to go to any position. A genuine mouse is known to go to food and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



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

4.2 Informatie typen

De informatie typen die in het hele systeem gebruikt worden zijn:



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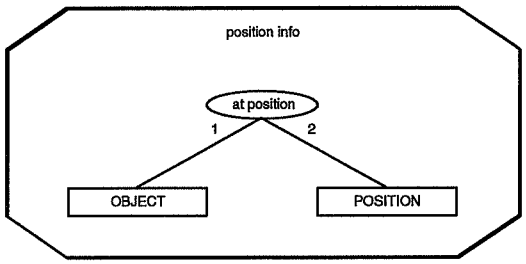

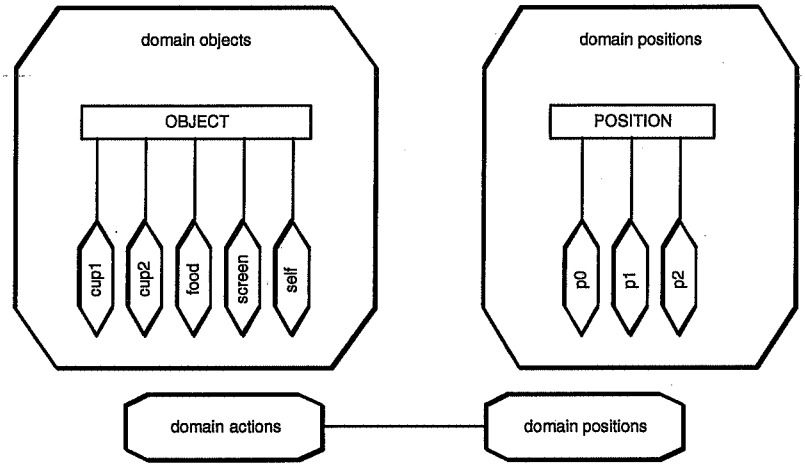

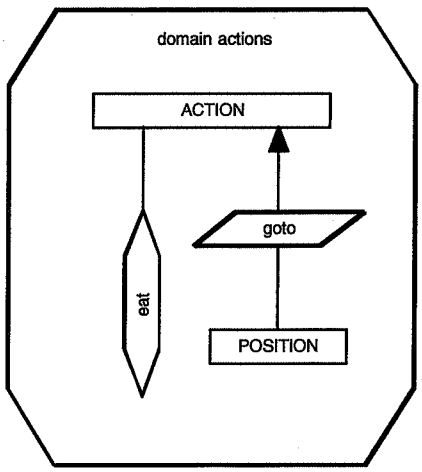

information type truth_indication
sorts SIGN ;
objects pos, neg : SIGN;
end information type

Student name: _____ Student number:

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

information type information_element_info
        sorts                                   INFO_ELEMENT ;
        objects  at_position(O:OBJECT,P:POSITION) : INFO_ELEMENT ;
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 Fragmenten van specificatie van de component

De component is primitief en wordt hier kort beschreven.

De component mouse_a

De interfaces worden gedefiniëerd door:
input interface: de informatietypen observation_result_info;
output interface: het informatietype action_info;

De kennisbank is:

```
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) ;
```