Student name: _____Student number:

Faculteit der Exacte Wetenschappen

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

Vrije Universiteit Amsterdam **19 december 2005**

Opgave/Exercise	**1**	**2**	**3**	**4**	**bonus**
Punten/points	25	30	15	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 = (voldoende) 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
5 appendices

You find:

4 exercises
5 appendices

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Opgave 1 (25 punten) *[Nederlands]:*

Relevante Appendix: Appendix 1A en Appendix 1B.
Deze opgave bestaat uit twee onderdelen. Motiveer Uw antwoorden.

Opgave 1a (15 punten)
In hoofdstuk 1 van de syllabus zijn een aantal primitive agentconcepten geïntroduceerd (zie Appendix 1B van de antwoordvellen). In Appendix 1A kun je wat informatie vinden over *Intelligent cars*. Analyseer deze informatie aan de hand van de primitieve agentconcepten. Welke agentconcepten zijn relevant voor het *adaptive cruise control* system? Vul Appendix 1B (3 antwoordvellen) in. Denk er aan dat je je antwoorden goed motiveert.

Opgave 1b (10 punten)

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

Exercise 1 (25 points) *[English]:*

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 *Intelligent cars*.
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 *adaptive cruise control* system. Remember to motivate your answers clearly.

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Exercise 1b (10 points)

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

Exercise 2 (30 points) *[English]:*

Een Nederlandse vertaling van Exercise 2 is niet beschikbaar.

Relevant Appendices: Appendix 2 and Appendix 3.

This question builds on your understanding of the generic model for Reasoning with and about Assumptions (Chapter 11). For your convenience a rather detailed partial specification of that model is given in Appendix 3. Be careful to focus directly on the parts of the specification that you need, so that you don't waste time. This generic model will be used in this exercise to diagnose the problems of turbulence. Read Appendix 2 "Turbulence Problem".

a) (15 points) Give a knowledge base for component assumption_determination that reflects the knowledge in Appendix 2. Motivate your answer in a rationale.
b) (15 points) Give a knowledge base of component observation_result_prediction that reflects the knowledge in Appendix 2. Motivate your answer in a rationale.

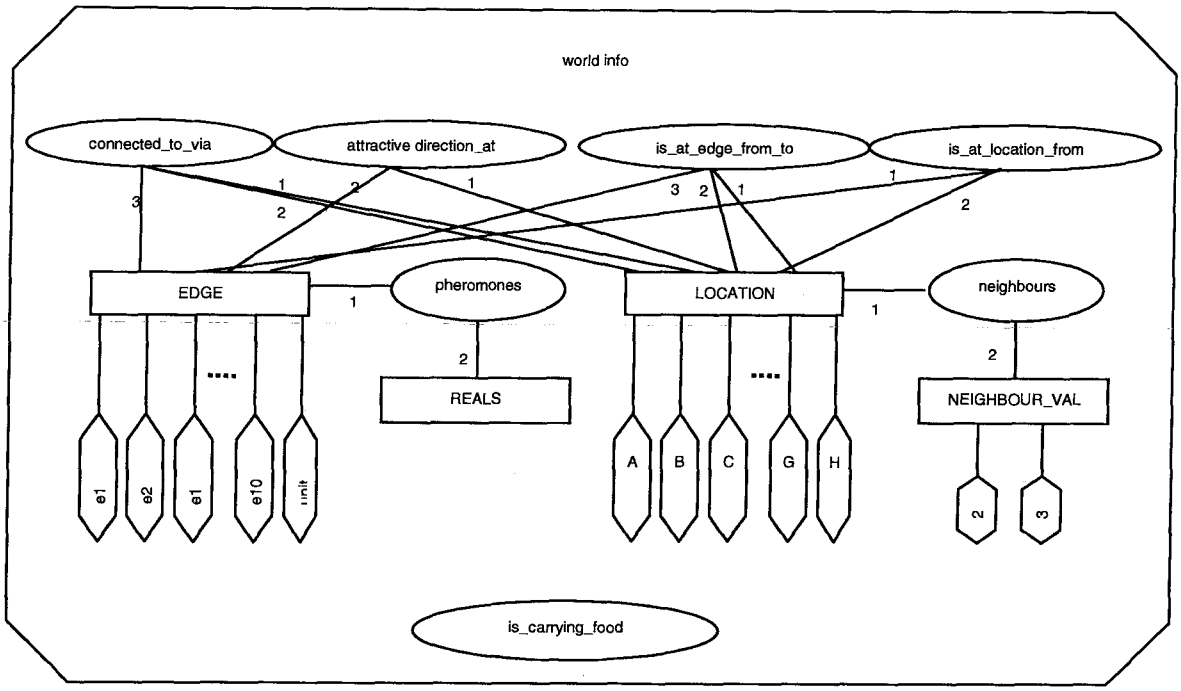
Exercise 3 (15 points) *[English]:*

Een Nederlandse vertaling van Exercise 3 is niet beschikbaar.

Relevant Appendix: Appendix 4.

Consider the information type world_info as shown in the Figure below. In Appendix 4 you can find a table consisting of a number of strings. Which of these strings are terms considering the information type world_info? Which are atoms? Which of the terms are well formed? Which of the atoms are well formed? Fill in your answer in the table in Appendix 4.

Student name: _____Student number:



Opgave 4 (20 punten) *[Nederlands]:*

Relevante Appendix: Appendix 5.

De opgave gaat over een model voor het in de gaten houden van de medewerkers van een koekjesfabriek (zie Appendix 5) en bestaat uit 2 delen.

Opgave 4a (10 points)

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

Opgave 4b (10points)

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

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Exercise 4 (20 points) *[English]:*

Relevant Appendix: Appendix 5.

This exercise concerns a model for monitoring the employees of a biscuits bakery (see Appendix 5), and consists of 2 parts.

Exercise 4a (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 4b (10 points)

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

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Appendix 1A:

Intelligent cars

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 safe as possible. One such system which has been introduced by one of the major car manufacturers is *adaptive cruise control.* The system works as follows: The driver activates the system by inputting his desired minimum distance to cars in front of his car and the desired speed of the car. This data is stored within the system. After activation, the system maintains the speed that has been set. Besides that, the system also actively monitors the road ahead of the car by using sensors which are mounted at the front bumper of the car. In case the sensors output that the distance between the car and the car in front is smaller than the distance inputted by the driver, the system immediately shows a warning on the dashboard of the driver, communicating to the driver that a car is approaching ahead. At the same time, the system takes an action in which it has two possibilities: Reducing speed by decreasing the throttle, or in case this is insufficient, use the brakes of the car. After the distance is observed to be sufficient again, speed is set to the old value, or set to a lower value in case the car in front is driving slower, ensuring sufficient distance between the car and the car in front.

The developer of the system, Mr. Ford says the following about the system: *This, among other systems in the car, is meant to cooperate with the driver, not to replace him. The system contributes to the overall goal of the driver and the safety systems within the car to get from A to B as safe as possible.*

End Appendix 1A.

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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	

End Appendix 1B.

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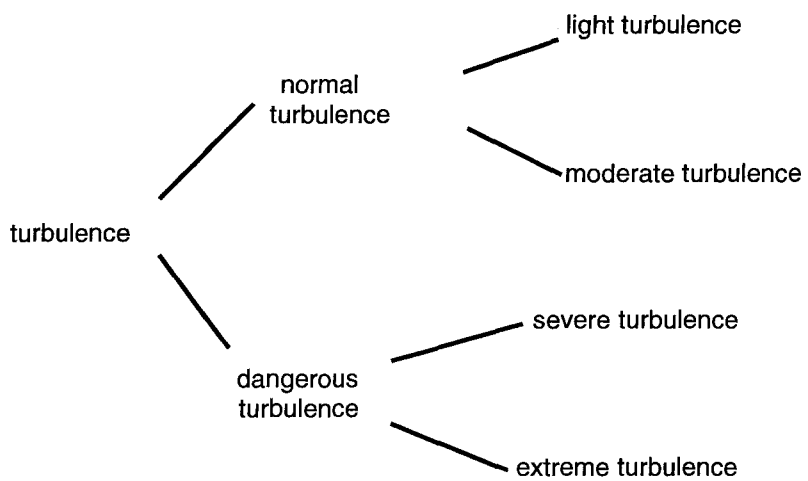
Appendix 2 Turbulence Problem

Many air travellers have experienced turbulence, an irregular air motion that often occurs unexpectedly. This sudden and vicious phenomenon is invisible to radars, and when it occurs the pilots must report the occurrence back to flight control for it might have most dramatic consequences for the crew and passengers. To diagnose the type of turbulence they use their knowledge of symptoms of different types of turbulence.

Suppose we have modelled an agent who would take over this duty.
To determine the type of the turbulence, our agent uses a line of reasoning modelled by the generic model for reasoning with and about assumptions (see Appendix 3). This model proceeds along the following lines: making assumptions (in some kind of order), predicting observation results for that assumption, and then evaluating the assumption by making the appropriate observations and comparing them to the assumption. If necessary, the old assumptions are rejected, and new ones are made.

The agent uses the following hierarchy (taxonomy) of types of turbulence, that he uses to efficiently order the possible assumptions:



The relations between causes and symptoms are depicted below:

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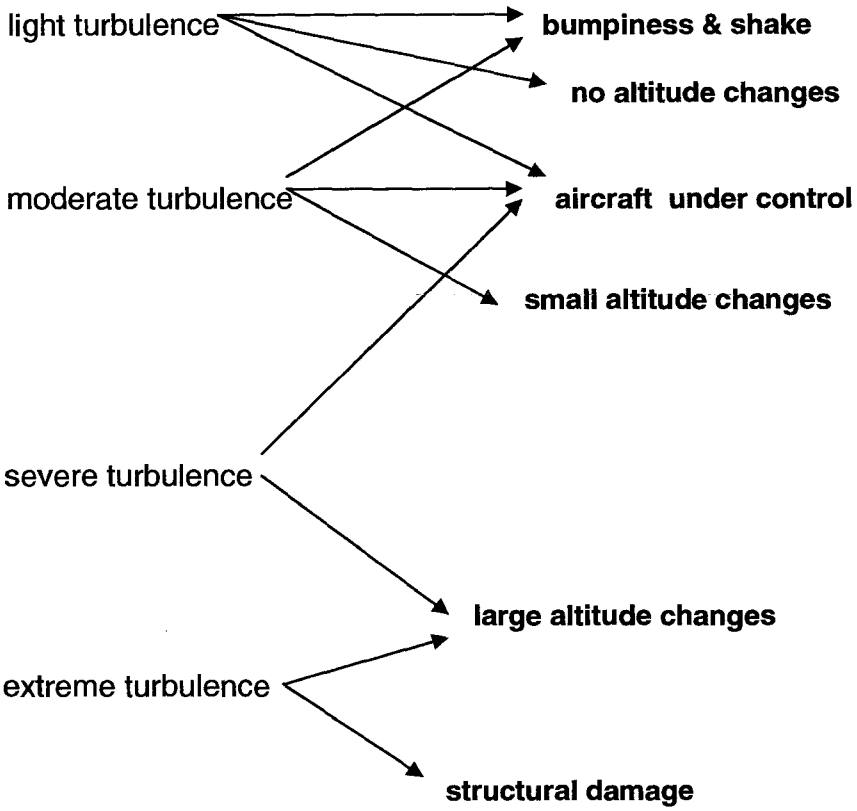

If light turbulence occurs, then the passengers experience light bumpiness and shake without noticeable changes in altitude, and the aircraft remains fully under the pilot's control. During moderate turbulence passengers and crew notice bumps and jolts and small changes in altitude are possible, and the aircraft is under control at all times. Severe turbulence causes large, abrupt changes in altitude, although the crew keeps the aircraft under control. This may cause injury to passengers but the aircraft itself experiences no damage.
In case of extreme turbulence, a very dangerous event, the aircraft is impossible to control. It is violently tossed about and this mostly results in structural damage to the aircraft.

End Appendix 2.

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Appendix 3: Reasoning with and about assumptions

information types

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

information type obs_to_be_performed
sorts INFO_ELEMENT
relations to_be_observed: INFO_ELEMENT ;
end information type

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

information type assumptions_hypotheses
sorts INFO_ELEMENT, SIGN
relations assumed: INFO_ELEMENT * SIGN ;
rejected: INFO_ELEMENT * SIGN ;
has_been_considered: INFO_ELEMENT * SIGN ;
possible_assumption: INFO_ELEMENT * SIGN ;
predicted_for: INFO_ELEMENT * SIGN * INFO_ELEMENT * SIGN ;

end information type

information type causes
relations light _turbulence, medium_turbulence, severe _turbulence,
extreme _turbulence: CAUSES;
end information type
information type symptoms
relations bumpiness_&_shake, no_altitude_changes, aircraft_under_control,
small_altitude_changes, large_altitude_changes, structural_damage : SYMPTOMS;
end information type

Student name: _____Student number:

information type world_info
information types symptoms, causes;
end information type

information type information_element_info
sorts INFO_ELEMENT
objects light _turbulence, medium_turbulence, severe _turbulence,
extreme _turbulence, bumpiness_&_shake, no_altitude_changes,
aircraft_under_control, small_altitude_changes, large_altitude_changes,
structural_damage: INFO_ELEMENT;
end information type

information type observation_info
information types obs_to_be_performed, information_element_info;
end information type

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

information type assumption_info
information types assumptions_hypotheses , information_element_info, truth_indication;
end information type

component assumption_determination

input information types assumption_info, observation_result_info;
output information types assumption_info;

knowledge base assumption_determination_local_kbs
information types assumption_info, observation_result_info;
contents

/* USE as MANY RULES as YOU LIKE */

... ...

end knowledge base

component assumption_evaluation

input information types observation_result_info, assumption_info;
output information types observation_info, assumption_info;

knowledge base assumption_evaluation_local_kbs
information types observation_result_info, assumption_info, observation_info;

contents
if predicted_for(OBS: INFO_ELEMENT, S1: SIGN, HYP: INFO_ELEMENT, S2: SIGN)
then to_be_observed(OBS: INFO_ELEMENT);

if assumed(HYP: INFO_ELEMENT, S: SIGN)
and predicted_for(OBS: INFO_ELEMENT, pos, HYP: INFO_ELEMENT, S: SIGN)
and observation_result(OBS: INFO_ELEMENT, neg)
then rejected(HYP: INFO_ELEMENT, S: SIGN)
and has_been_considered(HYP: INFO_ELEMENT, S: SIGN);

if assumed(HYP: INFO_ELEMENT, S: SIGN)
and predicted_for(OBS: INFO_ELEMENT, neg, HYP: INFO_ELEMENT, S: SIGN)
and observation_result(OBS: INFO_ELEMENT, pos)
then rejected(HYP: INFO_ELEMENT, S: SIGN)
and has_been_considered(HYP: INFO_ELEMENT, S: SIGN);

end knowledge base

component observation_result_prediction

input information types assumption_info;
output information type assumption_info;

knowledge base observation_result_prediction_local_kbs
information types assumption_info;

contents

Student name: _____Student number:

/ USE as MANY RULES as YOU LIKE */*

end knowledge base

information links

private link assumptions
domain assumption_determination
    information type assumption_info;
co-domain observation_result_prediction
    information type assumption_info;

sort links identity
object links identity
term links identity
atom links
    (possible_assumption(HYP: INFO_ELEMENT, S: SIGN),
        possible_assumption (HYP: INFO_ELEMENT, S: SIGN)) :
            <<true, true>, <false,false>>;
end link

private link predictions
domain observation_result_prediction
    information type assumption_info;
co-domain assumption_evaluation
    information type assumption_info;

sort links identity
object links identity
term links identity
atom links
    (predicted_for(OBS: INFO_ELEMENT, S1: SIGN, HYP: INFO_ELEMENT, S2: SIGN),
        predicted_for(OBS: INFO_ELEMENT, S1: SIGN, HYP: INFO_ELEMENT, S2: SIGN)) :
            <<true, true>, <false,false>>;
end link

private link hypotheses
domain assumption_determination
    information type assumption_info;

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```
co-domain assumption_evaluation
        information type assumption_info;

sort links identity
object links identity
term links identity
atom links
  (possible_assumption(HYP: INFO_ELEMENT, S: SIGN),
        assumed(HYP: INFO_ELEMENT, S: SIGN)): <<true,true>, <false,false>>;
end link

private link assessments
domain assumption_evaluation
        information type assumption_info;
co-domain assumption_determination
        information type assumption_info;

sort links identity
object links identity
term links identity
atom links
        (rejected(HYP: INFO_ELEMENT, S: SIGN),
                rejected(HYP: INFO_ELEMENT, S: SIGN)):  <<true, true>, <false, false>>;

        (has_been_considered(HYP: INFO_ELEMENT, S: SIGN),
        has_been_considered(HYP: INFO_ELEMENT, S: SIGN)):       <<true, true>, <false, false>>;
end link
private link required_observations
domain assumption_evaluation
        information type observation_info;
co-domain external_world
        information type observation_info;
sort links identity
object links identity
term links identity
atom links
        (to_be_observed(OBS: INFO_ELEMENT),
                to_be_observed(OBS: INFO_ELEMENT)) :
                        <<true, true>, <false,false>>;
end link
```

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```
private link observation_results
domain external_world
        information type observation_result_info;
co-domain assumption_evaluation
        information type observation_result_info;

sort links identity
object links identity
term links identity
atom links
(observation_result(OBS: INFO_ELEMENT, S:SIGN),
                                observation_result(OBS: INFO_ELEMENT, S:SIGN)) :
                        <<true, true>,<false,false>>;

end link
```

End Appendix 3.

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Appendix 4: Answersheet for Exercise 3.

	term	atom	well-formed
neighbours(2, N:NEIGHBOUR_VAL)			
is_at_edge_from_to(L1:LOCATION, L2:LOCATION, E:EDGE)			
LOCATION: G			
Is_carrying_food			
attractive_direction_at(X:LOCATION, B)			
2			
is_at_location_from(e1, A)			
connected_to_via(A, e1, X:LOCATION)			

End Appendix 4.

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Appendix 5

Nederlands: 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.
De 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 (Processes and Process Abstraction Levels) 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 natuurlijk 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.

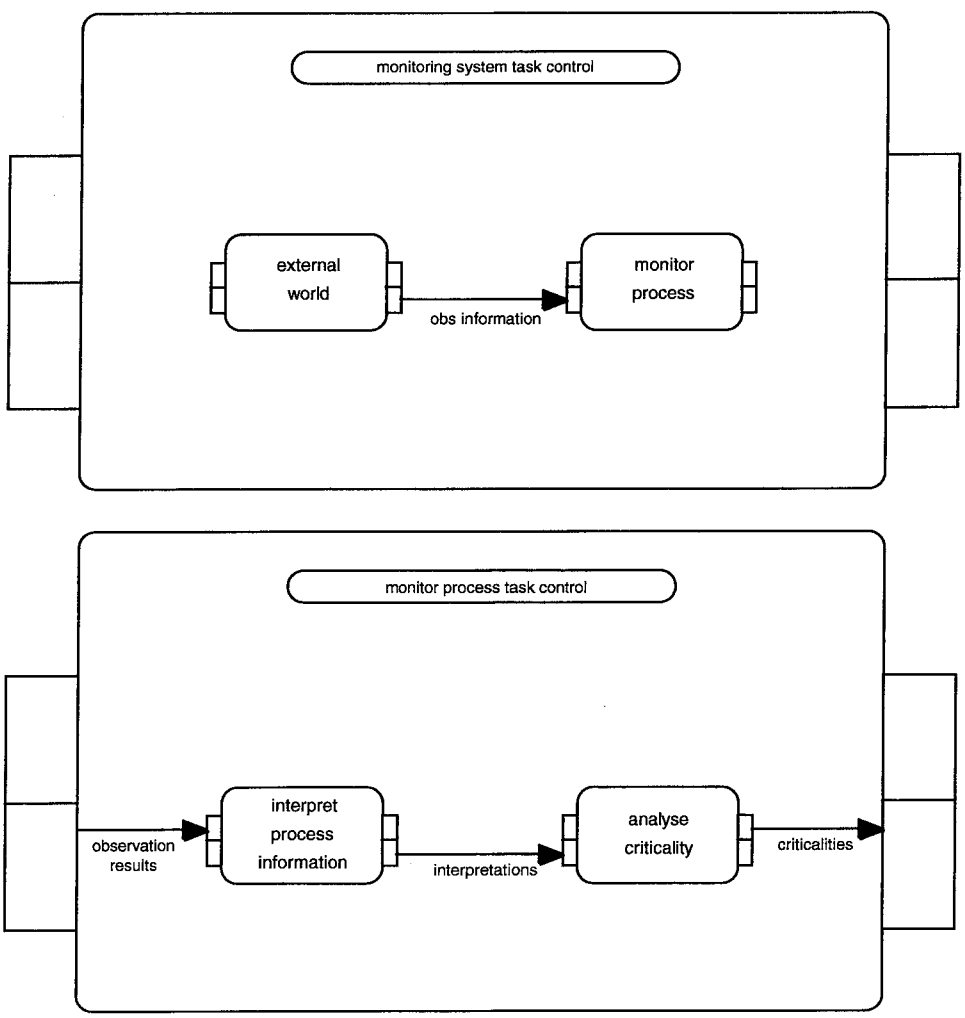
English: Biscuits Baker

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 (Processes and Process Abstraction Levels). 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. Based on 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.
Based on 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.

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.



End Appendix 5.
End of the examination text.