Student name: _____ Student number:

Faculteit der Exacte Wetenschappen

Exam Design of Multi-Agent Systems

Vrije Universiteit Amsterdam **28 October 2010**

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

Norm:
The exam mark **T** equals (the sum of the points scored for the exercises plus 10 bonus points) divided by 10.
The end mark **E** for the course Design of Multi-Agent Systems is calculated as follows: **E = (T + H + P) / 3** , note that the grade for the exam should be sufficient (≥ 5.5) in order to receive a grade.
Where : T = exam 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)
You can answer in Dutch as well as English

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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 intelligent soccer coaching agent.
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 intelligent soccer coaching agent. 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 the building of an intelligent blackjack agent, and is explained in Appendix 2.

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

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

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Exercise 3 (20 points)

Relevant Appendix: Appendix 3.

Consider the following two information types:

```
information type input_it
        sorts           COUNTRY;
        subsorts        ASIAN_COUNTRY, EUROPEAN_COUNTRY: COUNTRY;
        objects         netherlands, belgium, italy: EUROPEAN_COUNTRY;
                        china, indonesia: ASIAN_COUNTRY;
        relations       current_country: COUNTRY;
                        next_country: COUNTRY;

end information type

information type output_it
        relations       long_trip_ahead;
                        short_trip_ahead;
                        going_to_switch_continent;
end information type
```

Furthermore, consider the following specification of the component travel:

```
component travel

input  information types  input_it;

output information types  output_it;


knowledge base country_information_kbs

 information types        input_it, output_it;

contents
if      current_country(E:EUROPEAN_COUNTRY)
 and    next_country(A:ASIAN_COUNTRY)
then    long_trip_ahead;

if      current_country(A:ASIAN_COUNTRY)
then    long_trip_ahead;

if      current_country(E1:EUROPEAN_COUNTRY)
 and    next_country(E2:EUROPEAN_COUNTRY)
then    short_trip_ahead;

if      current_country(E:EUROPEAN_COUNTRY)
 and    next_country(A:ASIAN_COUNTRY)
then    going_to_switch_continent;

if      current_country(A:ASIAN_COUNTRY)
 and    next_country(E:EUROPEAN_COUNTRY)
then    going_to_switch_continent;
end knowledge base
```

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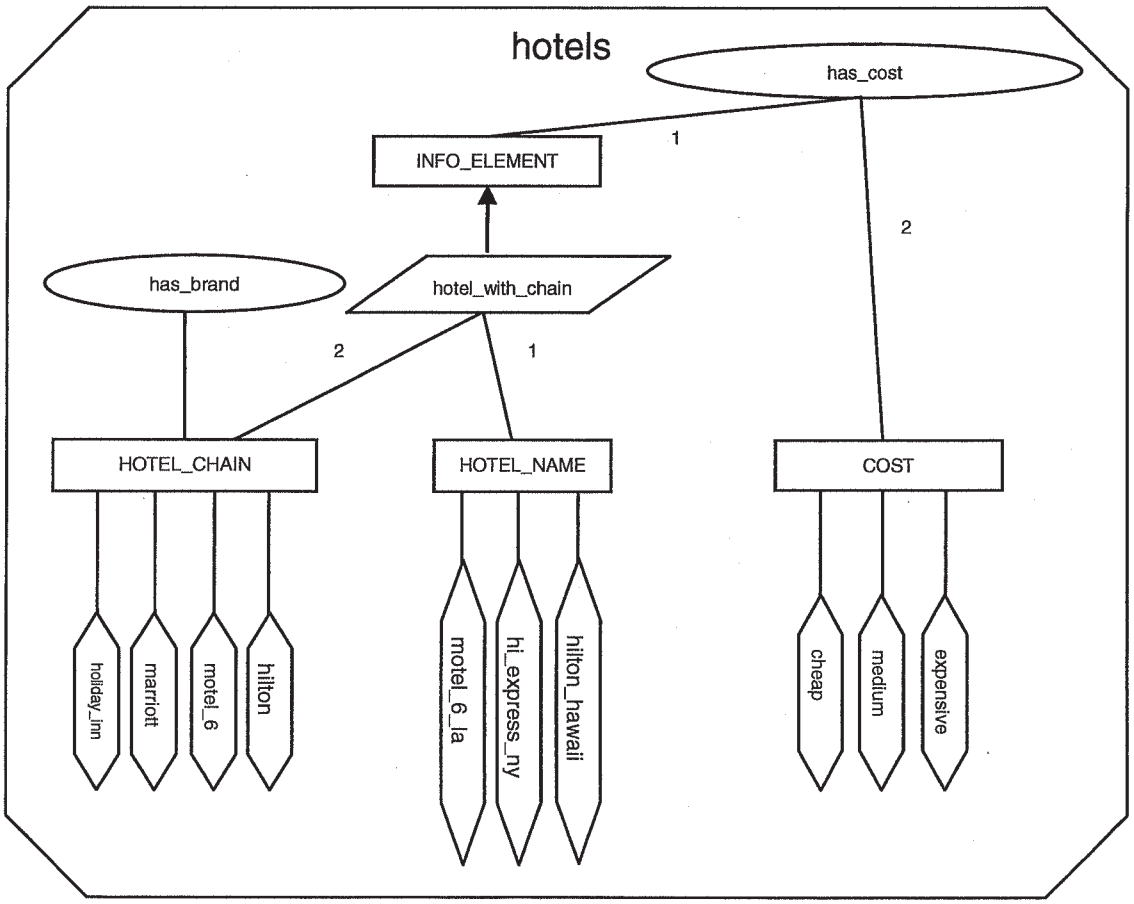
a) (10 points) Consider the information state [current_country(china), next_country(italy)]. Give a minimal refinement of this information state that is both closed and consistent with respect to the knowledge base country_information_kbs.
b) (10 points) Give a trace of the behavior of component travel given that the subsequent **input information states** of that component are as expressed in Appendix 3. Use the answer sheet and fill in your answer in Appendix 3.

Exercise 4 (15 points)

Relevant Appendix: Appendix 4.

Consider the information type hotels 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 hotels? 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 4.



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Appendix 1A: Intelligent Soccer Coaching Agent

Mostly, when soccer clubs perform bad one of the obvious solutions is to fire the trainer/coach and hire a new one. The question is however whether the coaches actually do a good job in the first place. The company called *Cruijff Automated Coaching* is now in the process of developing an automated coach and think that they can create a better automated coach compared to a human coach. The coach does not handle the training of the players, but only focuses on coaching during the matches.

The coach performs several main tasks in close collaboration with the team players:

1. Determine the tactic to follow based upon the opponents and the strength of the own team.
2. Determine what players should play from the start.
3. Determine when and how to change tactics during the game, if needed.
4. Determine when to substitute players.

In order to perform its tasks, and to reach its goal of winning every possible match (which it clearly has in common with the players of the team), it collects information from various sources.

To determine the tactic to follow it takes into account the main strengths of the opponent (e.g. do they have good offensive players, etc.) which is available through the scouts. Furthermore, the circumstances during the match are taken into account as well, for example whether it is humid or rainy. Finally, the characteristics of the own players are taken into account, based upon communication with these players, and observing their previous performances. Once the tactic has been selected, this information is forwarded to all the players. The same information as previously described is used to select which players should start in the beginning, this information is again made available to all players of the team and to the referees.

During the game, the coach closely observes the performance of the team, and that of the opponent to identify the weak spots in both the own teams play, and the opponents play, and as a result can decide to change tactics or substitute. This information is then forwarded to the whole team and also to the referee in case it concerns a substitution.

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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 An Automated Blackjack Agent

For the popular casino game of blackjack the rules are rather simple. The game involves a deck of cards which includes four suits: diamonds, clubs, hearts, and spades. For each of these suits a variety of cards are present: numeric cards ranging from 2 to 10 and cards with pictures, namely the Jack, Queen, King, and the Ace. Each of the cards is associated with a particular value. The numeric cards have the same value as their number (e.g. the 5 of spades has a value of 5) whereas the Jack, Queen, and King each represent a value of 10. Finally, the Ace can count either as 1, or as 11, which can be freely selected. *In this case we assume that the Ace can only count as 11 for the sake of simplicity.* When the game starts, the dealer places two cards in front of the agent, and the agent now has to decide two things: whether it wants to raise the stakes or not, and whether it wants to have an additional card. Note that the agent merely focuses on this situation, with the two cards presented by the dealer, and not on the later stages with potentially more cards.

When deciding on the additional card in this situation with two cards, the agent decides to take such a card when the combined value of the two cards it has received is smaller than 17. In case the value is higher than or equal to 17 no more card is requested.

For the betting, things are a bit more difficult. If the combined value of the two cards is 19 or more the agent decides to raise the stakes. If the value is below 10, it does not raise the stakes. Furthermore, in case the combined value is 10 or 11, it raises the stakes, and all values higher than 11 and lower than 19 do not result in a raise.

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Appendix 3: Answersheet for exercise 3.

Input (1)	[current_country(china), next_country(netherlands)]
Output after revision but before reasoning	
Output after reasoning	
Input (2)	[current_country(china), next_country(indonesia)]
Output after revision but before reasoning	
Output after reasoning	
Input (3)	[current_country(netherlands), next_country(belgium)]
Output after revision but before reasoning	
Output after reasoning	

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Appendix 4: Answersheet for Exercise 4.

	term	atom	ground atom	well-formed
H:HOTEL_CHAIN				
has_cost(hilton, expensive)				
hotel_with_chain(motel_6_la, motel_6)				
has_brand(sheraton)				
cheap				
has_cost(hotel_with_chain(hilton_hawaii, hilton), cheap)				
has_brand(hi_express_ny)				
hotel_with_chain(has_cost(I:INFO_ELEMENT, cheap))				
has_cost				