



**KTH Microelectronics  
and Information Technology**

## **Example solutions for Exam in 2G1524 Distributed Artificial Intelligence and Intelligent Agents, 2004-12-15, 14:00-18:00**

### **Rules**

This exam is “closed book” and you are not allowed to bring any material or equipment (such as laptops, PDAs, or mobile phones) with you. The only exceptions are an English to “your favorite language” dictionary and pencils.

### **Instructions**

- ☐ Please read the entire exam first!
- ☐ Write clearly
- ☐ Each sheet of paper must contain your name, ”personnummer”, Problem number and a unique sheet number
- ☐ Write only on one page of a sheet. Do not use the back side
- ☐ Only one Problem must be reported on each sheet
- ☐ If more than one sheet is needed the continuation should be clearly noted on the beginning of each sheet and the sheet numbers used should be consecutive
- ☐ Always motivate your answers. Lack of clearly stated motivation can lead to a reduction in the number of points given
- ☐ The tasks are not necessarily sorted in order of difficulty. If you get stuck it might be a good idea to go on to the next task.

### **Grading**

The grades depend on the sum of exam and bonus points  $n$ :

$n < 50$  fail (U)

$50 \leq n < 67$  grade 3

$67 \leq n < 84$  grade 4

$84 \leq n$  grade 5

**GOOD LUCK!**

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### Problem I. What is an agent?

a) The availability of TV channels will be greatly extended in the information society. Media experts forecast that soon every household will be able to receive between 300 and 500 television programs. A quick estimate shows that a systematic search for interesting TV programs would take so much time that there would be hardly any time left to view the selected broadcasts.

Assume that you are supposed to help in solving this problem and to create an intelligent agent for that. List all possible agent properties the intelligent TV agent will have and illustrate these properties by examples.

(18p)

Answer:

- The user informs the agent of his TV preferences: delegation Manchester United games and X-files serial, agent searches in available digital TV programs on behalf of the user and then informs user what will be shown on TV concerning Manchester United and X-files.
- Agent acts autonomously - without intervention from user, the agent continuously follows the new broadcasts and television programs and could provide the user with new information on his areas of interest.
- Pro-activity - the agent may not only inform user about TV broadcast of Manchester United games or X-files but also about programs with interview with Manchester United players (X-files actors) or inform about games of Manchester United competitors.
- Reactivity - the agent can react to changes in TV schedule.
- Social ability - the agent can communicate to other (TV) agents and ask their opinion about some programs or knowledge of related subjects or help - if I can't find a program for some channel then I can ask for other agents or trying to contact brokers.
- Mobility - the agent can move from one computer to another when traversing the TV programs.
- Benevolence - the agent will always try to do what is asked of it.
- Veracity - the agent will not reply with false information.
- Rationality - the agent has a purposeful behavior - to inform user about interested programs. Its rationality is oriented to optimal satisfaction of user's preferences, f/e scheduling trying to avoid collisions in watching favorite programs (by finding the same program on different channels in different time).

### Problem II. Agent theory

a) Formalize the following statements in the logic of knowledge (we consider logic of knowledge as a modal logic with  $K_i$  operator):

i) Agent B knows that Agent C wants to find out the cost of football tickets.

(5p)

Answer:  $K_b W$

ii) If Agent A does not know the cost of football tickets then Agent B knows that Agent A does not know the cost

(5p)

Answer:  $\neg K_a p \rightarrow K_b \neg K_a p$

iii) Agent B doesn't know whether Agent C knows that Agent B doesn't know that Agent A wants to find out the cost of football tickets.

(10p)

Answer:  $\neg K_b \neg (K_c \neg K_b W) \wedge \neg K_b \neg (\neg K_c \neg K_b W)$

b) What is relation between knowledge and belief in the works on agent theory? Discuss appropriateness of the Modal logics axioms D, T, 4 and 5 for logics of knowledge and belief.

(10p)

Answer: see the text book p 277.

### Problem III. Negotiation

a) Give advantages and disadvantages of the use of Contract Net Protocol (CNP)

(3p)

Answer:

- Doesn't detect conflicts.
- Assumes benevolent and non-antagonistic agents.
- Still rather communication intensive.
- + Simple protocol.
- + Decentralized control.

b) What auction type(s) is/are most close to the basic CNP schema? Explain why.

(5p)

Answer: Sealed bid first-price auction: announcing, proposing bids, evaluation, awarding.

c) What is a bidder's dominant strategy in Vickrey auction? Prove your answer.

(7p)

Answer: To bid his true valuation: if he bids more than his valuation then he may end up with a risk of being awarded the good but at more than the amount of his private evaluation. If he bids less, there is a smaller chance of winning, but the winning price is unaffected.

d) Explain the notion of Nash equilibrium. Give an example.

(5p)

Answer: see text book p. 113, another example could be prisoner's dilemma.

### Problem IV. Communication

a) Can Agent Communication Language (ACL) be used as an agent development language? Explain. (5p)

Answer: No, it is an agent communication language and does not have features for presenting agent but only communication between agents.

b) Is it possible to write an ACL message where the content is also expressed in ACL? If no, justify. If yes, give an example.

(5p)

Answer: Yes, the content of ACL message could be written in every language including ACL. See also foil 47 from “Agent Communication” lecture notes

## Problem V. Agent Architectures

a) What are the basic types of layered agent architectures?

(3p)

Answer: Horizontal (all layers are connected with input and output) and vertical (not all layers connected to input and output) layers. Vertical can be one-pass or two-pass control.

b) What kind of a layered architecture is Brooks subsumption architecture? Explain.

(5p)

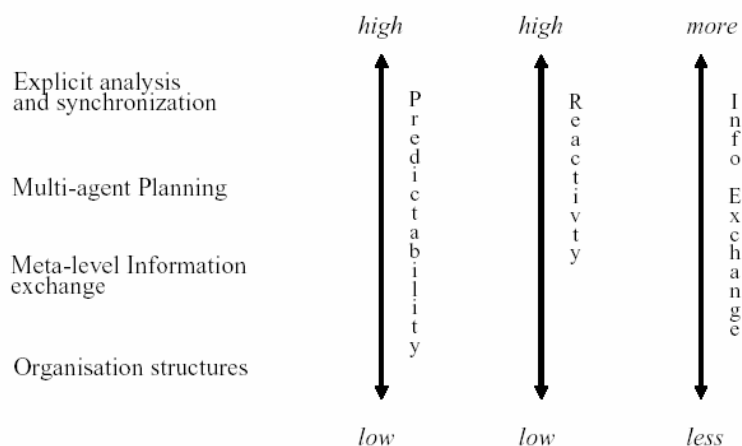
Answer: Horizontal - all layers are connected with inputs and outputs.

## Problem VI. Coordination

a) Describe common coordination techniques and compare them in terms of predictability, reactivity and amount of information exchange.

(5p)

Answer: The common coordination techniques are explicit analysis, multi-agent planning, meta-level exchange and organizational structures.



b) What are fundamental coordination processes? Give a brief explanation.

(5p)

Answer:

- Mutual adjustment - each party adjusts its behavior taking into consideration behavior of partner.
- Direct supervision - one agent becomes server another client, this is not centralization because of this is done dynamically.
- Standardization - e.g. traffic rules.

## Problem VII. Mobile Agents

a) What is/are the difference(s) between remote execution and a mobile agent?

(4p)

Answer:

- remote execution is a program, which is sent without execution state to remote CPU, executes there, possibly communicating with other CPUs and then terminates
- mobile agent is a program which carries execution state with it and is sent to a remote CPU executes there, possibly communicating with other CPUs, and then moves again to a third CPU or returns to its origin.

-----End of Exam-----