Intelligent Agents
2007
Final Exam
29. January 2008

- place your student ID card (carte de legitimation) on the desk in front of you.
- this is a closed-book examination (no documents allowed). However, one sheet of notes is allowed, either printed and one-sided, or hand-written and two-sided (or two one-sided sheets).
- if possible, write your answers in the spaces provided right after the question. If you need to use extra sheets, use a separate one for each question.
- the examination is graded on a point basis and points are indicated with each subquestion. The entire exam is worth 100 points.
- Bonne chance!

Copy No:

1 Planning and Cooperation (40 points)

You want to build a personal agent for a busy executive that has to travel a lot. A major task is to find flights, hotels and plan meetings.

1.1 Planning trips with decision processes (25 points)

Given a set of meetings $m_1, m_2, .., m_k$, you need to plan a trip to attend as many of them as possible. Each meeting m_i takes place in a city $c(m_i)$. We assume that the meetings are relatively short and that the executive can do all meetings in a given city in the same day. In the evening, he can travel to the next city where he has to stay overnight in a hotel, and he will then be in that city on the next day ($next(date)$).

Assume that you have the following functions available (for example through web services or a database):

- find-flight(from,to,date): returns true if there is an acceptable flight on that date.
- find-hotel(city, date): returns true if there is an acceptable hotel on that date.
- possible(meeting,date): returns true if the date is possible for the meeting.

1. (5 points) What is a Markov decision process? What elements are needed to specify a Markov decision process?

2. (10 points) Show how the trip planning problem above can be formulated as a Markov decision process! Just explain what elements are needed and how they can be specified, without writing them out in detail.

3. (5 points) For k meetings, l cities and d dates, give an estimate of the number of states that are needed.

4. (5 points) Given that the starting city is known, would you solve this problem with a reactive or a deliberative agent architecture? Would your answer be different if the starting city was not known, or if there was uncertainty such as possibilities of flights being cancelled?

1.2 Planning trips with factored representations (15 points)

Formulate the trip planning problem above as a planning problem using the STRIPS formalism. Your agent needs to build up the necessary operators, either during planning or before. Note that an agent might have to wait in a city for the next meeting.

1. (5 points) What are the goals?

2. (5 points) What operators achieve the goals? How are they specified (make up notation as required)?

3. (5 points) What other operators do you need? (Hint: combine flight and following hotel stay into a single operator to simplify).

2 Negotiation (30 points)

Consider a network of information agents that gather information on the world wide web in response to user requests. They might want to cooperate to share their results and thus avoid duplication of their work.

Two agents, A and B, are asked to respond to the following queries:

- A has to find the average price of hotels in Zermatt in January 2008, and is paid CHF 30 for this.
- B has to find the minimum price of hotels in Zermatt in January 2008, and is paid CHF 20 for this.

Both construct a plan:

- A: get all hotel prices in Zermatt for January 2008 (cost=15 CHF), then take the average (cost=5 CHF).
- B: get all hotel prices in Zermatt for January 2008 (cost=12 CHF), then take the minimum (cost=5 CHF).

Obviously they could benefit by sharing some work.

1. (5 points) What process could be used to merge the plans to construct a joint plan where the data gathering step is done only once? Give a possible joint plan and explain how it could be found in this case.

2. (5 points) Explain the concepts of *utility* and *rationality*. What are the agent's utilities for their standalone plans as well as a joint plan in this situation?

3. (5 points) What is a Nash bargaining solution? (You do not need to reproduce the axioms, give an informal characterization).

4. (5 points) What is the Nash bargaining solution in this case, and what is the corresponding plan? Remember to consider mixed deals.

5. (10 points) What is a negotiation protocol that would reach this solution? Give an example of how it might work in this example!

3 General questions (5 points each)

1. What is a strategy for a Markov decision process? What is a strategy in game theory? What is the difference between a pure and mixed strategy?

2. What search algorithm would you use to plan moves in a game with an adversary such as chess? How does this algorithm choose moves and what is the assumption it makes about the adversary?

3. How does the contract net protocol deal with several simultaneous requests? Does it always find a solution when there is one?

4. What is a Nash equilibrium? Are there games that do not have one?

5. For rational, risk-neutral agents with completely private values, can an auctioneer expect a higher revenue in an English auction or in a Dutch auction? What if the the values are correlated or commmon?

6. What is the main architectural difference between Corba and Web Services?