Departamento de Informática
Universidad Carlos III de Madrid

Grado en Ingeniería en Informática

Artificial Intelligence
Partial exam

March 2014

General indications

- Time assigned to the exam is **2 hours**
- You cannot leave the classroom during the exam, unless you have finished it
- Exams cannot be answered using a pencil

Exercise 1

Consider the Bayesian network in Figure 1

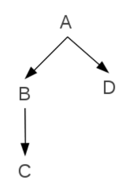

Figure 1: Bayesian network.

- Define how the full joint distribution factorizes in for this network.
- Imagine all variables are binary and we define the following probabilities: $P(A) = (0{,}5, 0{,}5)$; $P(B = true/A = true) = 0{,}6$; $P(B = true/A = false) = 0{,}3$; $P(C = true/B = true) = 0{,}2$; $P(C = true/B = false) = 0{,}7$; $P(D = true/A = true) = 0{,}8$; $P(D = true/A = false) = 0{,}3$. **Define how to compute** $P(A/B = true)$**;** $P(A/C = true)$ **in terms of these probabilities.**

Exercise 2

A Hidden Markov Model (HMM) is a common way to model the probabilities of receiving a corrupted packet in a wireless network. It supposes that the wireless channel is either jammed or not (e.g. because of some kind of interference). The status of the channel modifies the probability of packet loss.

Imagine we know the following probabilities:

- The probability of a jammed channel is 0.1 while the probability of a not jammed channel is 0.9.
- When the channel is not jammed, the probability of reaching a jammed wireless state is 0.2.
- When the channel is jammed, the probability of reaching a not jammed wireless state is 0.3.
- When the channel is not jammed, the probability of having packet loss is 0.1. However, if the channel is jammed, this probability is 0.8.

1. Define an HMM to model this problem.
2. What is the probability that we have a jammed channel in the first three time steps?
3. What is the probability of packet loss in the first time step?
4. If we observe packet loss for three consecutive time steps, what is the probability that the wireless is not jammed for these steps?

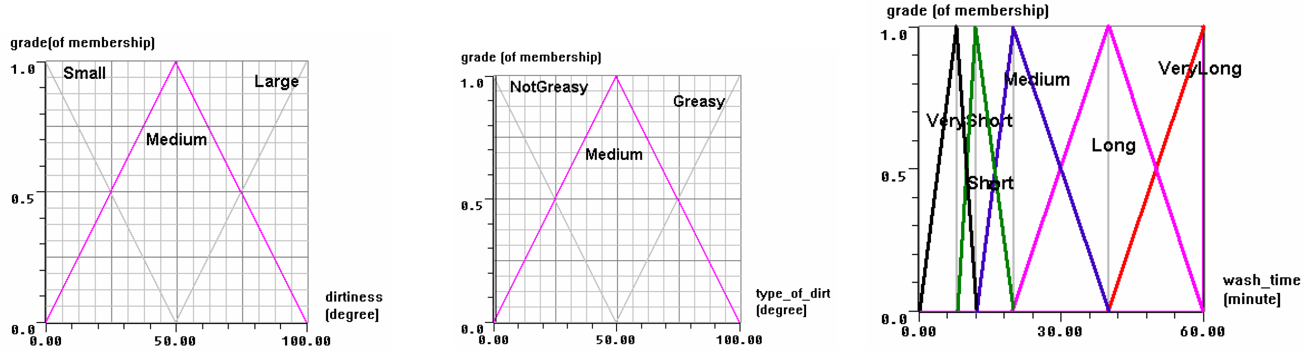

Figure 2: Definition of dirtiness, type of dirt and wash time.

Exercise 3

We have a fuzzy controller for a washing machine. It is used to select the length of wash time. This time is determined by the type and degree of dirt of the cloths. These three variables (type of dirt, dirtiness and wash time) are modelled using the fuzzy sets in Figure 2.

The system is composed by nine rules:

- IF dirtiness is Large and type_of_dirt is Greasy THEN wash_time is VeryLong
- IF dirtiness is Medium and type_of_dirt is Greasy THEN wash_time is Long
- IF dirtiness is Small and type_of_dirt is Greasy THEN wash_time is Long
- IF dirtiness is Large and type_of_dirt is Medium THEN wash_time is Long
- IF dirtiness is Medium and type_of_dirt is Medium THEN wash_time is Medium
- IF dirtiness is Small and type_of_dirt is Medium THEN wash_time is Medium
- IF dirtiness is Large and type_of_dirt is NotGreasy THEN wash_time is Short
- IF dirtiness is Small and type_of_dirt is NotGreasy THEN wash_time is VeryShort

Currently we have some cloths to wash. They have a degree of dirtiness of 75 % and a degree of type_of_dirt of 100 %. Show the execution of the fuzzy controller to determine the wash time.

Exercise 4

In the map of Figure 3 a robot at Room 1. Its goal is to reach Room 4. The robot can move only to adjacent rooms. The probability of success in a move is 0.7; but with a probability of 0.3 the robot remains in the same room. The cost of a move in terms of battery is 10. However, the floor between Room 2 and 4 is made of a different material so that moves between these two rooms have a cost of 60.

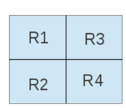

Figure 3: Configuration of rooms.

1. Model formally the MDP for this problem and draw the transition diagram.
2. Define the Bellman equations for the states of this problem.
3. Compute the expected value $V(S)$ for the first two iterations. What would be the policy after these two iterations? Is that the optimal policy? Why?