Intelligent Systems: Reasoning and Recognition

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ENSIMAG 2 / MoSIG M1 Final Exam - May 2013

Conditions: You have the right to use any notes or written material. You may answer questions in English or in French. When appropriate, illustrate your answer with mathematics. Your written answers must be clear and legible. Illegible text will not be graded. Duration: 3 hours.

1) (4 points) Explain Baye's rule for someone who has a phobia of mathematics. Under what circumstances can it be used? Under what circumstances will it give incorrect results? Can Baye's rule be used with symbolic features such as color or favorite music?

2) (2 points) You have been hired to write a program to provide the fastest route through a subway (metro) network using heuristic search. What cost function would you propose? Can you propose a heuristic for which the search is optimal? If yes, provide the conditions for optimality. If no, explain why not.

3) (2 points) Provide a definition and an explanation for the ROC curve. How is it calculated? For what can it be used?

4) (4 points) You have been given a results from a questionnaire of 100 persons with 3 professions: C_1: factory worker, C_2: teacher, C_3: salesman. You know that this data contain results from 50 factory workers, 10 teachers and 40 salesmen, but you do not know the profession for the person who completed each questionnaire. You also know the following
- Factory workers earn an average salary of 20 Euros/hour, with standard deviation of 2 euros/hour.
- Teachers earn an average of 30 euros an hour with a standard deviation of 4 euros/hour.
- Salesmen earn an average salary of 20 Euros an hour with a standard deviation of 6 euros/hour.

a) How can you can you use the salary to determine the probability that a person from the training set belongs to each of the three classes.
b) What is the probability of error for deciding that the person belongs to the most likely class.
c) What kind of classifier would you propose to detect salesmen in this data? Why?
d) Is there a Bayesian classifier that can detect teachers in this data? If yes, then which one. If no, why not?

5) (8 points) You are asked to program a system for temporal reasoning using rules written in CLIPS 6. Your system should use the following templates for RELATIONS and TEMPORARY. The table of transitivity is defined by the deffacts named TABLE-OF-TRANSITIVITY listed below. You will use the functions UNION and INTERSECTION listed below.

In the list of temporal relations, the symbols ">", "<", and "=" correspond to CLIPS keywords. These must be replaced with "b" (before), "bi" (before-inverse) and "e" (equals).

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(deftemplate RELATIONS (slot int1) (slot int2) (multislot relations))
(deftemplate TEMPORARY (slot name) (slot int1) (slot int2)
            (multislot relations))

(deftemplate TABLE  (slot r1)  (slot r2) (multislot relations) )
(deffacts TABLE-OF-TRANSITIVITY
      (TABLE (r1 b) (r2 b) (relations b))
      (TABLE (r1 b) (r2 bi) (relations b bi d di o oi m mi s si f fi e))
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...
      (TABLE (r1 fi) (r2 fi) (relations fi))
)

(deffunction UNION (?r1 ?r2)
   (progn$ (?e ?r1)
      (if (not (member ?e ?r2)) then (bind ?r2 (insert$ ?r2 1 ?e))))
   (return ?r2)
)

(deffunction INTERSECTION (?r1 ?r2)
   (bind ?r3 (create$))
   (progn$ (?e ?r1)
      (if (member ?e ?r2) then (bind ?r3 (insert$ ?r3 1 ?e)) ))
   (return ?r3)
)
```

Suppose that you have three intervals, A, B, and C as well as a list of possible relations RAB from A to B, and a list of possible relations RBC from B to C. The generation of the list of relations from A to C will be performed by three rules named R1, R2 and R3.

a) For each pair of relations (rab, rbc) such that rab ∈ RAB and rbc ∈ RBC, the rule R1 will generate a fact of type TEMPORARY using the table of transitivity. Write the rule R1.

b) Whenever there exists two facts of type TEMPORARY with the same value for int1 and int2, but with different names, the lists of relations given by these facts must be combined using the function UNION. Write the rule R2 that deletes the two facts and creates a new fact of type TEMPORARY, in which the list of possible relations is the UNION of the lists from the two facts.

c) When all of the facts of type TEMPORARY have been combined, the resulting list should be used to create a fact of type RELATIONS. Write the rule R3 that creates this new fact. This same rule should delete the fact of type TEMPORARY. Be careful that all of the TEMPORARY lists have been fused before this rule fires.

d) Write the rule R4 that detects when two lists of relations have been generated for the same pair of intervals. This rule should delete the two facts of type RELATIONS and create a new fact with the intersection of the possible set of temporal relations.