Departamento de Informática
Universidad Carlos III de Madrid

Grado en Ingeniería en Informática

Artificial Intelligence
Partial exam 1

March 2015

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 (3 p)

Given the following rules of a production system that identifies fruits:

R1 IF Form= long **AND** Colour= yellow **THEN** Fruit= banana

R2 IF Form= round **AND** Diameter > 1.6 cm **THEN** classFruit= plant

R3 IF Form= round **AND** Diameter < 1.6 cm **THEN** classFruit= tree

R4 IF NumSeeds= 1 **THEN** classSeed= pit

R5 IF NumSeeds > 1 **THEN** classSeed= multiple

R6 IF classFruit= plant **AND** Colour= green **THEN** Fruit= watermelon

R7 IF classFruit= plant **AND** Colour= yellow **THEN** Fruit= melon

R8 IF classFruit= tree **AND** Colour= orange **AND** classSeed= pit **THEN** Fruit= apricot

R9 IF classFruit= tree **AND** Colour= orange **AND** classSeed= multiple **THEN** Fruit= orange

R10 IF classFruit= tree **AND** Colour= red **AND** classSeed= pit **THEN** Fruit= cherry

R11 IF classFruit= tree **AND** Colour= orange **AND** classSeed= pit **THEN** Fruit= peach

R12 IF classFruit= tree **AND** Colour= red **AND** classSeed= multiple **THEN** Fruit= apple

R13 IF classFruit= tree **AND** Colour= purple **AND** classSeed= pit **THEN** Fruit= plum

R14 IF classFruit= tree **AND** Colour= green **AND** classSeed= multiple **THEN** Fruit= apple

where

- As conflict resolution strategy we: deactivate rules that do not add new knowledge and we choose the first applicable rule (that is, the one with a smaller number)

1. (1.5p) Simulate a possible execution of the production system using a forward chaining method. Assume the initial working memory is:

$$\mathrm{WM}_0 = \{Diameter = 0{,}4cm, Form = round, NumSeeds = 1, Colour = red\}$$

For each cycle, show clearly the conflict set, the selected rule and the resulting working memory.

2. (1.5p) Simulate a possible execution of the production system using a backward chaining method where the goal is to find ANY fruit. Assume the initial working memory is:

$$\mathrm{WM}_0 = \{Diameter = 0{,}4cm, Form = round, NumSeeds = 1, Colour = red\}$$

$$Subgoals = \{(Fruit = ?)\}$$

For each cycle, show clearly the conflict set, the selected rule, the new subgoals and the resulting working memory.

Exercise 2 (3 p)

Consider the graph in Fig. 1, where A is the initial state and I, R, T, V and Y are goal states. Labels on arcs represent the cost of traversing them. Numbers on nodes represent the heuristic value to reach a goal state from the corresponding node.

Expand the search tree to obtain a path from A to a goal state for the following cases: (1) Breadth First search (0.5p); (2) Depth First search (0.5p); (3) Hill Climbing search (0.5p); (4) A* search (0.5p). Indicate beside each node its generation and expansion orders and all the necessary information to interpret correctly your solution. Check for repeated states and prune them whenever possible. Follow an alphabetical order to generate successors.

Answer the following questions:

1. (0.5p) Which of the above algorithms finds the optimal solution? Which one guarantees the optimal solution? Explain your answers.
2. (0.5p) In your opinion, which algorithm is more adequate to solve this kind of problems? Explain your answer.

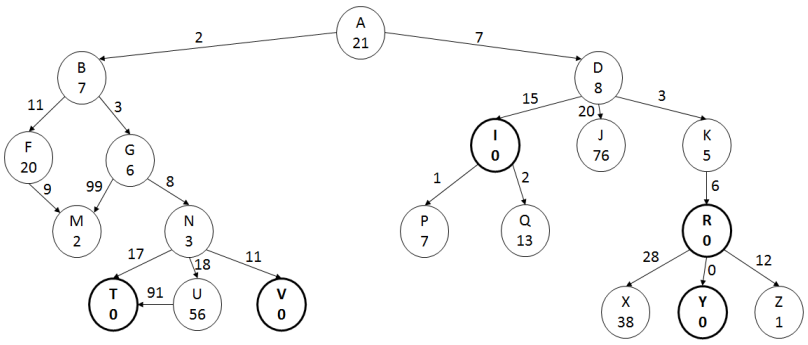

Fig. 1: Graph for exercise 2.

Exercise 3 (4 p)

We have two jugs, one of 4 litres and another one of 3 litres. Our goal is to have in the 4 litre jug exactly 2 litres. To do so we are able to use a tap to completely fill them, to empty them and to move water from one jug to another until one is full or the other one is empty. If the jugs are initially empty,

1. (0.25p) Represent the state space for this problem.
2. (0.25p) Represent the initial state and the goal state.
3. (1.0p) Represent the operators of this problem including their applicability conditions and result.
4. (0.25p) Propose a cost function
5. (0.5p) What of the studied algorithms will guarantee the optimal solution?
6. (0.5p) Propose a heuristic for the problem
7. (1.25p) Draw the solution tree, and search for a solution using a Breadth First search approach.