Artificial Intelligence

SCALAB

Grupo de Inteligencia Artificial

Universidad Carlos III de Madrid

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Production Systems – Exercises

Exercise 1

In a production system we have introduced the following rules:

- R1: IF a(X) and b(Y) THEN c(Y)
- R2: IF a(X) and c(X) THEN d(X)

The database contains the following facts:

a(manuel), b(manuel), b(john), c(alberto)

1. Which INSTANCES of what rule are activated in the first cycle of execution?
2. If the system operates under a first rule (FIFO) or last rule (LIFO) conflict resolution strategy (CS), considering the order of rules and facts, show the sequence of rules carried out and the data on the Working Memory (WM) for each cycle

Exercise 2

In a production system we have introduced the following rules:

- R1: IF a(X) and b(Y) THEN c(Y)
- R2: IF a(X) and c(Y) THEN d(Y)
- R3: IF a(X) and c(X) THEN e(X)

The database contains the following facts:

a(manuel), b(john), c(manuel)

If the system operates under a first rule (FIFO) or last rule (LIFO) conflict resolution strategy (CS), considering the order of rules and facts, show the sequence of rules carried out and the data on the Working Memory (WM) for each cycle

Exercise 3

In a production system we have the following rules:

- R1: $A \wedge B \rightarrow C$
- R2: $A \rightarrow D$
- R3: $C \wedge D \rightarrow E$
- R4: $B \wedge E \wedge F \rightarrow G$
- R5: $A \wedge E \rightarrow H$
- R6: $D \wedge E \wedge H \rightarrow I$

The WM contains: A,B,F

How can H be deduced using the following methods:

1. Forward chaining
2. Backward chaining

Exercise 4a. Library

We have a library system with the following rules: when a person asks for a book the library will lend the book to that person if the book is available. If the book has been borrowed by somebody else, then the person reserves the book and waits for it to become available. When a person borrows a book, that person keeps the book until somebody else makes a reservation on it, and when that happens the book is returned. Each book can only have one reservation at any time.

Recap: Space-state representation problem

Model of a physical system as a set of variables and state constants related by first-order rules. Example: If the age of a patient is less than 10 years, s/he has red spots and fever then s/he has chicken pox.

- Variables: p1, 10, fever, red-spots, chicken-pox
- Constants: patient, symptom, disease, age.
- Rule: patient(p1),age(p1,10), symptom(p1,fever), symptom(p1,red-spots) -> disease(p1,chicken-pox)

Exercise 4b – Library

- The WM contains the following facts
  1. asks(student1, book1)
  2. asks(student2, book1)
  3. asks(student3, book1)
  4. available(book1)
- Execute the system under a FIFO conflict resolution strategy for 5 cycles. Show the WM, the CS and the executed rule for each cycle.

Exercise 5. Board game

- Our game is played on a 4x4 board in which the opponents (White and Black) start with two tokens each. White starts at the bottom left and top right, and Black in the other two corners.
- A square on the board is *k-adjacent* to another if exactly k movements (horizontal, vertical, diagonal or a combination of them) are required to go from first to second.
- In each turn the player can make one of the following actions
  - Copy a token to a 1-adjacent square
  - Move a token to a 2-adjacent square
- The game ends when no player can move. The winner is the player with more tokens in the board
- How can we formalize the world of this game in a production system?
- Hint: draw the game

Recap: Space-state representation problem

1. Identify initial state
2. Identify operators (successor function): describes possible actions from one state to another (state transformation)
3. Identify reachable states from initial state. Defined by 1 and 2.
4. Identify final states.
5. Identify cost: sum of the number of actions (operators) performed.
6. Solution from initial to final states.
7. There can be priorities in rules.

Recap: Space-state representation problem 2

Abstract the problem as much as possible

- Describe just the strictly necessary
- State: describe de location of each token in the board
- Operators should be as general as possible. We want to reduce the number of rules. Example of the 8-puzzle:
  - We could have 9!x4 operators to go to each possible state. That is all possible permutations of numbers in board 4x4. X
  - We could have 8x4 operators that move each number (there are 8 numbers) and 4 movements. X
  - We could have just 4 operators that move the empty space: up, down, left, right. ✓

Recap: Space-state representation problem 3

8 puzzle example: operators