FACOLTÀ DI INGEGNERIA DELL'INFORMAZIONE

Artificial Intelligence 2010–11

Test 2 – 14th July 2011

You have 75 minutes to complete the test: be accurate, but concise!
You can answer in English or Italian
You can use no texts, notes, computers, calculators, mobile phones, etc.
Please write your name and student ID on all sheets
Please answer Questions 4 and 5 (Logic) on a separate sheet to speed up marking

1. State Space Search (5 points)

Explain the difference between uninformed and informed search strategies. Then explain the structure of the heuristic function used by the A* strategy, analysing all its components. Finally state the optimality conditions for tree-search A* and for graph-search A*.

2. CSP (5 points)

List and briefly describe the three main structural heuristics used to solve CSPs.

3. Planning (10 points)

Consider the planning problem stated below:

> There is an apartment with three rooms. A doorway connects the first room with the second, and another doorway connects the second room with the third. Initially, the two doors are closed, and the agent is in first room, at the doorway.
> At any moment the agent is in one of the rooms, at one of the doorways. It can: walk from a doorway to another doorway in the same room; cross a doorway (provided that the agent is at the doorway and the door is open); open a door (provided that the agent is at the doorway and the door is closed).
> The agent's goal is to reach the third room.

Adopting the STRIPS approach, you are requested to:

- define a suitable set of predicates and constants, briefly describing their intuitive meanings;
- define a suitable set of action schemes;
- represent the initial state and the goal;
- write a plan that achieves the goal (you do not have to explain how STRIPS would build the plan).

The action schemes should be as general as possible, and in particular should not depend on the number of rooms and on the disposition of the doorways: these will be specified as part of the initial state.

4. Logic (theory) (6 points)

Answer the following questions:

1. What is a clause?
2. What is a logical consequence of a set of formulae?
3. Given that formula a' is obtained from a with an inference rule r, is $a \Leftrightarrow a'$ always true? Why?

5. Logic (exercise) (6 points)

Translate the following sentences into logical formulae:

a) The coin is either in my left hand or my right hand.
b) If there's no coin in either of my hands, I cheated.
c) There's no coin in my right hand.
d) Either the coin is in my left hand, or I cheated.

Prove that d is a logical consequence of {a; b; c}.

One possible solution of problem 3

Predicates:

Connects(x,y,z)	door x connects room y and room z
Open(x)	door x is open
InRoom(x)	the agent is in room x
AtDoor(x)	the agent is at door x

Constants:

R1, R2, R3	the rooms
D12, D23	the doors

Initial state:

{Connects(D12,R1,R2),
Connects(D12,R2,R1),
Connects(D23,R2,R3),
Connects(D23,R3,R2),
InRoom(R1),
AtDoor(D12)}

Goal:

{InRoom(R3)}

Action schemes:

walk(room,door1,room1,door2,room2)

preconditions InRoom(room) ∧ AtDoor(door1)
∧ Connects(door1,room,room1) ∧ Connects(door2,room,room2)

effects ¬AtDoor(door1) ∧ AtDoor(door2)

cross (door,room1,room2)

preconditions InRoom(room1) ∧ AtDoor(door) ∧ Connects(door,room1,room2) ∧ Open(door)

effects ¬InRoom(room1) ∧ InRoom(room2)

open (door)

preconditions AtDoor(door) ∧ ¬Open(door)

effects Open(door)

Plan:

open(D12);
cross(D12,R1,R2);
walk(R2,D12,R1,D23,R3);
open(D23);
cross(D23,R2,R3)

Some solutions for exercise 4

2. What is a logical consequence of a set of formulae?
   No inference rule is involved in this concept! Just models and truth values.
3. Given that formula a' is obtained from a with an inference rule r, is $a \Leftrightarrow a'$ always true? Why?
   "if a then a'" is always true if the inference rule is sound.
   "a if and only if a'" is not always true, even if the rule is sound.
   Example: p OR q inferred from p with OR-introduction.