

EXAMINATION IN
TDT4136 Logic and reasoning systems
Thursday 10. December 2009, Hours 09:00 – 13:00

Assignments prepared by teacher Tore Amble. Quality assured by Lester Solbakken.

Contact person during exam: Tore Amble (phone 73594451)

Language : English

Allowed aids: D

No printed or handwritten material is allowed to be used.

An approved simple calculator is allowed to be used.

Results deadline: 11 January 2010.

Read the text of each assignment carefully. Make sure that you understand the assignment.

If you consider the information given in an assignment *incomplete* or *inaccurate*, then make a note of the assumptions you find necessary to make in order to solve the assignment.

TASK 1 (20 %)

a) Given the following sentences:

No mothers can fly

No stones can fly

MorLille is a mother

No stones can cry

MorLille can cry

MorLille is a stone

The sentence shall be expressed in first order predicate logic by means of the predicates:

$M(x)$ x is a mother

$S(x)$ x is a stone

$F(x)$ x can fly

$G(x)$ x can cry

b) Convert the sentences to clausal form. Show the steps in the conversion.

c) Show by means of a resolution proof that the sentences are inconsistent.

d) Suppose that the last sentence is removed.

Is it possible to prove that *MorLille is a stone* ?

Explain!

TASK 2 (20 %)

	NT	Q	
WA			
		NSW	
	SA	V	

A robot shall move through Australia from the territory WA to V via the territories NT, Q og NSW.

The robot runs on gasoline and has a fuel tank. In addition it can have a load of 2 fuel cans which each takes a full fuel tank.

The robot can only run from one territory to another on a full fuel tank.

At the start, the robot is in WA with an empty fuel tank, where it is 6 full fuel cans.

The task of the robot is to go from WA to V where it shall remain.

Suppose that the robot has sensors that makes it able to ases the truth or falsity of the following predicates.

$Atrobot(x)$ Robot is at x

$At(r, x)$ Fuel can r is at x

$Fueled$ Robot is filled with fuel

$Carrying(u)$ Roboten is carrying fule can u

$Cango(x, y)$ Roboten can go from x to y

Robot has the following action repertoire:

$refuel(u, x)$ fills robot with a fuel can u at x

$pickup(u, x)$ loads a fuel can u at x

$putdown(u, x)$ unloads a fuel tank u at x

$goto(x, y)$ brings roboten from x to y if possible

- a) Manually, make a plan that solves the task, and verify that the plan can be executed.
- b) Explain what is meant by a planning wirh resource constraints (Job shop Scheduling)
- c) Formulate the problem above as such a problem.

TASK 3 (20 %)

At a storage room in Kristiansand Zoo, they have a manual system where a a storage assistant Julius Apeland by means of a truck moves boxes that are entered into the storage room to their respective places.

The truck can do the following tasks:

- Lift the topmost box of a stack
- Drive with any load to a given place
- Put down a box on a given place, either on top of a stack or on the floor.

In order to save money, one has purchases an intelligent machine TRUC1 which shal be mounted on the truck in order to control it. We suppose that TRUC1 has a TV-camera which together with a vision program gives TRUC1 a complete overview of the situation in the form of facts.

To simplify the task, we can suppose the following:

The storage room is a quadratic room that is partitioned into 8 X 8 squares. The squares can be described as coordinates (X,Y). In one square, there can be no box, one box or a stack of boxes. We can disregard the space requirements of the robot.

There are 4 types of boxes: Tomato boxes (red), banana boxes (yellow) apple boxes (green) and grape boxes (blue). They have their fixed places in respective corner squares.

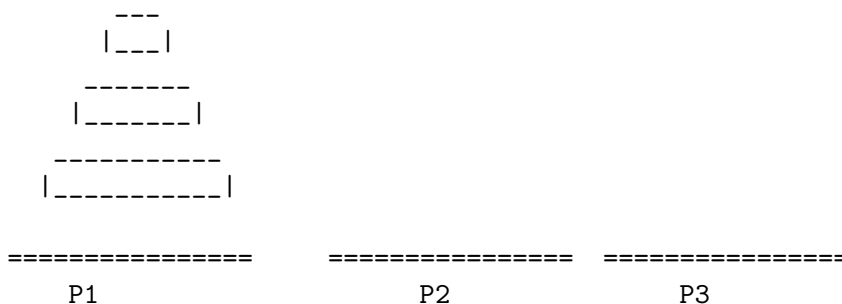
The boxes are delivered inside and stacked arbitrary and unsorted on free places in the room. Therafter, they shall be placed in their respective places.

- a) Explain shortly what in general are the characteristics of a Production System.
- b) Explain shortly what are the characteristics of the production system PROXY.
- c) Make a rule base in PROXY that solves the problem above.

TASK 4 (20 %)

A robot shall solve the Tower of Hanoi (TOH) problem.

The task is, as you may know, to move a stack of N discs from a platform (P1) to another platform (P3), and it is only allowed to move one disc at a time to another stack or platform, and it is not allowed to move a bigger disc onto a smaller disc.



- a) Describe how one can formulate this problem a heuristic search problem.
- b) Suppose it is known that the TOH -problem demands $2^N - 1$ moves.
Describe the complexity of the search work under the condition that we don't have a non-trivial heuristics at our disposal.
- c) Propose a non-trivial heuristics for the problem solution.

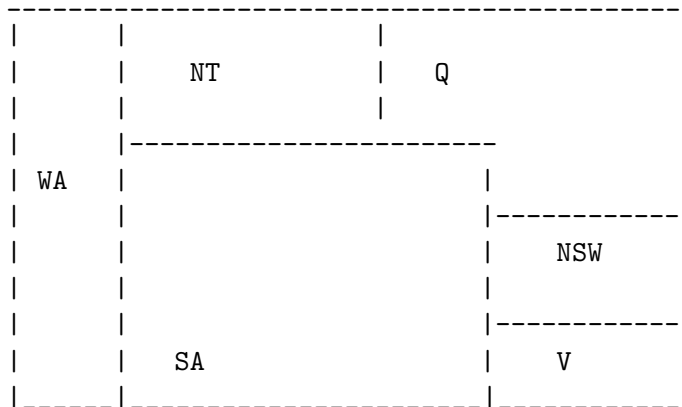
TASK 5 (20 %)

The floor in the corridor of the Department of I (DAI) shall be coloured according to the following principles:

The floor is divided into fields (WA,NT,Q,SA,NSW,V) as in the figure.

Only the colours red(R), Blue(B) and Green(G) shall be used.

Two neighbouring fields shall not have the same colour.



- Formulate in general terms what is meant by a Constraint Satisfaction Problem (CSP)
- Formulate the problem above as a CSP that utilises a constraint graph.
- Discuss very briefly the following method to solve CSP's:
Local search for CSP.
- Illustrate the method by presuming a given set of start values, f.ex.

WA=R
 NT=G
 SA=G
 Q=B
 NSW=G
 V=R