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# CONTINUATION EXAM IN

### TDT4136 Logic and reasoning systems

### Wedesday 10. August 2011, Hours 09:00 - 13:00

Assignments are prepared by Tore Amble and 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: August 31, 2011.

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) A function f is said to be continuous at a point x if for all epsilon there exists a delta such that

|f(s) - f(x)| < epsilon for all s where |x - s| < delta

Use the predicates P and Q given by

P(x, s, delta) : |x - s| < delta

Q(x, s, epsilon) : |f(s) - f(x)| < epsilon.

and formulate the definition of a continuous function as an expression in first order predicate logic.

**b)** A function f is said to be discontinuous at a point x if there exists an epsilon such that for all delta there exists an s such that

|x - s| < delta and not |f(s) - f(x)| < epsilon

Use the same predicates P and Q as above and formulate the definition of a discontinuous function as an expression in first order predicate logic.

c) Show that a function g cannot be both continuous and discontinuous. That shall be done by formulating the assertion

"g is a continuous function and g is a discontinuous function"

in first order predicate logic, convert this to clausal form and derive a contradiction by means of a Resolution proof.

## TASK 2 (20 %)

- a) What is meant by a semantic net?
- b) Draw a semantic net for the following knowledge base:

All robots are agents. Robots typically moves using legs. Door robots are robots. Door robots dont move. Door robots work at day and at night. All delivery robots are robots. Delivery robots work at day. Cleaning robots are robots. Cleaning robots move by wheels. Cleaning robots work at night. Marvin is a delivery robot. Jimmy is a door robot. Billy is a cleaning robot.

- c) Explain how property inheritance can be done in a semantic net.
- d) Formulate the semantic net by means of a logical knowlegde base.
- e) Formulate the property inheritance in such a way that we get verified the following statements from the knowledge base:
  - i) Delivery robots move by legs
  - ii) Billy works at night
  - iii) Billy moves by wheels.

### **OPPGAVE 3 (20 %)**

A robot shall solve the following problem:

On two platforms P1 and P2, there are two stacks of read and blue boxes. See Figure 1 as an example of a start situation. The task is to move all boxes to another platform (P3) such that all the blue boxes are below all the red boxes. The robot can only move one box at a time. The task is to move the boxes to right positions by a minimum number of moves.



Figur 1 Example of a start situation

a) Describe how one can formulate this problem as a heuristic search problem.

- b) What is meant by an admissible heuristic, and why is the concept important?
- c) What is meant by a monotone (consistent) heuristics, and why is the concept important?
- d) Formulate a good heuristics for this problem that is admissible and monotone.

### **OPPGAVE 4 (20 %)**

In a storage house in Kristiansand, they have a manual system where storage assistant Julius Apeland by means of a truck moves boxes. The problem is to move boxes as described in Task 3.

The truck can do the following operations:

- Lift the uppermost box of a stack
- Put the box down on a box or on a free platform.

In order to save money, an intelligent machine TRUC1 has been acquired which is to be mounted on the truck, and control this. We assume that TRUC1 has a TV-camera with a computer vision program which gives TRUC1 a complete overview of the situation in the form of facts.

- a) Explain in general what is characteristics for a Production system (Production System).
- b) Explain shortly what is characteristics for the Production system PROXY.
- c) Make a rule base in PROXY that solves the problem above. There are no claims at all that the task shall be solved with a minimum number of moves.

## **OPPGAVE 5 (20 %)**

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

The floor is divided in fields (WA,NT,Q,SA,NSW,V) as shown in Figure 2. Only the colours Red(R), Blue(B) and Green(G) shall be used. Two neighbouring fields must not have the same colour.



- a) Formulate in general terms what is meant by a Constraint satisfaction problem, (CSP).
- **b)** Formulate the problem above as a CSP that uses a Constraint graph.
- c) Discuss very shortly the following method for solving CSP's.

Backtracking search for CSP.

- d) Explain some of the strategies for improving the search of choice of variables for assignment, and choice of values for these assignments.
- e) Illustrate one or more strategies by an example from this problem.