Retake 2017-01-09

Knowledge Representation (Vrije Universiteit Amsterdam)

UNIVERSITY OF AMSTERDAM

Faculty of Science

Exam

Knowledge Representation

Master Artificial Intelligence

Hertentamen
Date: 9 January 2017
Time: 13-16 hours

Number of pages: 2 (including front page)
Number of open questions: 5
For each question the maximum number of points is indicated.Total number of points: 100

BEFORE YOU START

- Check if your version of the exam is complete.
- Write down **your name, student ID number**, and if applicable the **version number** on **each sheet** that you hand in. Also **number the pages**.
- Your **mobile phone** has to be switched off and be put in your coat or bag. Your **coat and bag** should be on the ground.
- **Tools allowed**: . Other tools are not allowed.

PRACTICAL MATTERS

- The first 30 minutes you are not allowed to leave the room, not even to visit the toilet.
- 15 minutes before the end, you will be warned that the time to hand in is approaching.
- If applicable, fill out the evaluation form at the end of the exam.
- You are obliged to identify yourself at the request of the examiner (or his representative) with a proof of your registration and a valid ID.
- During the examination it is not permitted to visit the toilet, unless the invigilator gives permission to do so.
- The exam paper must be handed in afterwards and may **not** be taken with you.

Good luck!

Propositional Logic (10pt)

Consider the propositional statement $(P \rightarrow (Q \vee R)) \rightarrow ((P \wedge Q) \rightarrow R)$. This statement is

A satisfiable but not valid
B Valid
C a contradiction
D none of the above

Choose one of the above options and justify your answer.

Satisfiability Solvers (25pts)

a.(10pts) Use the Davis-Putnam algorithm to show if the following set of clauses is satisfiable or not. Label each step the process with its proper name.

$(Q \vee R \vee \neg T)$, $(Q \vee \neg R)$, $(P \vee R \vee \neg S)$, T, $(\neg P \vee Q \vee R)$, $(R \vee \neg U)$, $(Q \vee \neg S \vee T)$, $(R \vee \neg T \vee U)$, $(\neg Q \vee R)$, $(P \vee \neg S \vee \neg T)$

b.(5pts) Give a pseudo-code description of the GSAT algorithm.

c.(5pts) What do we understand by a local minimum in GSAT

d.(5pts) Discuss two strategies to escape from local minima

Description Logic (25pts)

a.(10pts) Express the following in Description Logic (ALC, to be precise, but that's the only Description Logic you've seen). Use the concepts *Animal* and *Fish*, and the role *Eats*

- an animal that eats fish
- a vegetarian animal
- all fish eat only fish

b.(15pts) Use a tableau algorithm to test the satisfiability of $\exists S.C \sqcap \forall S.(\neg C \sqcup \neg D) \sqcap \exists R.C \sqcap \forall R.(\exists R.C)$

Constraint Solving (20pts)

a.(5pts) What is the reason to do arc consistency checking as part of constraint solving algorithms?

b.(10pts) Discuss the usefulness of the Minimal Remaining Value heuristic when solving a SAT problem as a constraint problem

c.(5pts) Mention and explain another heuristic for variable ordering in constraint solving algorithms

Qualitative reasoning (20pt)

a.(10pts) Qualitative Process Theory (QPT) represents causal relationships between two quantities using the notions *influence* and *proportionality* also referred to as *direct* and *indirect influences*, respectively. Describe these two relationships. Particularly, focus on the information propagated between quantities, and on the difference between these two notions.

b.(10pts) Consider the following equation from the area of population dynamics.

If $N_{(t+1)}$ is the number of individuals at time *t+1* then $N_{(t+1)} = N_{(t)} + (B + I) - (D + E)$
where $N_{(t)}$ is the number of individuals at time *t*, B is the number of individuals born, D the number that died, I the number that immigrated, and E the number that emigrated between time *t* and time *t+1*.

Rewrite this equation as a set of causal relationships between quantities using the above mentioned QPT primitives. For each relationship you include, explain what information is captured and why your representation is appropriate.