Learning objectives and exam content

Knowledge Representation (Vrije Universiteit Amsterdam)

Learning objectives and exam content

Knowledge Representation as Logic Engineering

KR in a nutshell: We expect you to explain the following general properties of formal language

- Syntax - inductive definitions
- Semantics - inductive definitions
- Interpretations and models
- Entailment
- Calculus
- Soundness, Completeness and Termination
- Decidability

You will have to be able to understand and describe the core notions of a logical system mentioned above. There are some practical skills you should be able to demonstrate:

- Given a simple application problem you should be able to determine which syntax and semantics belong to a logical system that would address the problem.
- Given a simple new logical system you will have to identify (and describe) the syntax and semantics of this language informally.
- You should be able to recognise whether a given algorithm is sound and complete for the system.

You will NOT have to design a new logic yourself.

Propositional Logic

We expect you to be familiar with the following notions (be able to explain) in the context of Propositional Logics. There will be reproduction and knowledge questions about those topics (probably mostly Multiple Choice).

- Syntax
- Propositionalization
- Clause Normal Form
- Semantics
- Interpretations (Truth assignments), models
- Semantic notions: Entailment, validity, satisfiability, logical equivalence
- Truth Tables, Davis Putnam (DPLL)
- GSAT
- Hardness of reasoning problems: phase transitions,
- MaxSat
- (NOT lectures of Frank)

You need to be able to define the basic notions defined above. You should be able to fulfill the following tasks:

- Translate a natural language text or the description of a simple problem into a PL representation (like a simple game)
- Calculate the clause normal form of a PL formula (Rules will be given in the exam)

- Give the truth table for a new logics operator
- Check formulas for entailment, validity, satisfiability and equivalence
- Calculate models for (set of) formula(s)
- Show satisfiability and entailment of a (set of) PL formula(s) using DPLL
- Apply the different heuristics from the slides to a DPLL procedure
- Transform a Natural Language description to a MaxSat problem

While you will have to show that you understand the other basic concepts (such as propositionalization, GSAT, Hardness, etc, you will NOT have to calculate anything.

Description Logics

We expect you to be familiar with the following formal notions for Description Logics. There will probably be a number of reproduction questions about those topics in the form of Multiple Choice questions.

- Syntax: Concepts, ABoxes, TBoxes
- Negation Normal Form (NNF)
- Semantics
- Interpretations: (domains + set theoretic interpretation function (classes as sets, instances as objects, roles as relations), models
- Semantic notions: Entailment, satisfiability, logical equivalence
- Tableau Calculus
    - Properties: Soundness, Completeness and Termination, Canonical model
- Tableau with TBoxes: blocking

You will have to be able to perform the following tasks:

- Model a problem described in natural language as DL concepts and axioms.
- Calculate the NNF of a concept or KB.
- Determine whether an interpretation is a model or not. Find a model for a KB, or an interpretation that is NOT a model.
- Prove satisfiability of a concept, entailment of subsumption relations and consistency of an ABox with a Tableau calculus (possibly wrt a TBox).

PGMs

You should understand, and be able to reproduce the knowledge about the following topics and apply this knowledge on some practical exercises.

- Probability Calculus with Possible Worlds
- Conditional Independence
- d-Separation, Interaction graphs (elimination orders)
- Computing Prior/Posterior Marginals given a Bayesian Network
- Network Pruning
- MAP and MPE inference (knowing what they exactly are about)