

LOGICS FOR DATA AND KNOWLEDGE REPRESENTATION
Midterm Exam - Thursday 16-04-2009

SURNAME: **NAME:** **N.**

1. Write what you know about the “Levels of Formalization” in modeling of data and knowledge.
2. What are the most typical reasoning tasks, or services, provided by logic? Explain and elaborate.
3. What is the problem of the “semantic gap” of any representation language? Explain and elaborate.
4. Draw the “fundamental diagram” of modeling, and explain each component in the details of one of the logics we have seen so far (i.e., PL, ClassL, FOL).
5. 1. What is the “expressiveness” of a representation language? Provide some examples across the logics we have seen so far.
 2. Effective and efficient: define, discuss, and compare.
6. Describe the main steps of the DPLL procedure for deciding the SAT problem of propositional logic.
7. What diagram models the extension of the following proposition?

$$(A \rightarrow B) \wedge (B \rightarrow A) \wedge \neg (A \wedge B).$$

8. For all formulas $p = p(x, y)$:
- | | | |
|---|------------------------------|-----------------------------|
| 1. Is $\forall x \forall y p(x, y) \models \forall y \forall x p(x, y)$? | yes <input type="checkbox"/> | no <input type="checkbox"/> |
| 2. Is $\exists x \exists y p(x, y) \models \exists y \exists x p(x, y)$? | yes <input type="checkbox"/> | no <input type="checkbox"/> |
| 3. Is $\exists x \forall y p(x, y) \models \forall y \exists x p(x, y)$? | yes <input type="checkbox"/> | no <input type="checkbox"/> |
| 4. Is $\forall x \exists y p(x, y) \models \exists y \forall x p(x, y)$? | yes <input type="checkbox"/> | no <input type="checkbox"/> |

For each case either prove your answer or provide a counterexample.

9. 1. Represent in FOL the following database DB . In particular, (a) specify the alphabet of the FO-language L you intend to use, and (b) write the L -theory T_{DB} which models the database.

Results-LDKR

ID	Name	N.	Written	Oral	Final Mark
1.	A Jonny	128349	28		30
2.	B Gabriele	128839	20		23
3.	C Massimo	128705	27		29
4.	D Mir Shahidul	130850	27		24
5.	E Jeffrey	130882	25		30

2. Define the answer set A_q for a query q represented by the formula:

$$\exists x \forall y \exists z \text{ResultsLDKR}(x, y, z, 27, 30).$$

10. Translate into a suitable \mathcal{AL} -description logic the sentence “All students who have done at least one exam but that have not done LDKR”. (Specify concepts and roles.)

11. Let AL^* -concept C of the form $\leq nR$ (“at-most number restriction”) be given. Define the first-order formula $\tau(C)$ such that C is coherent (i.e., it has a model) iff $\tau(C)$ is satisfiable.

12. Are the following concepts equivalent? yes no

C1. Student $\sqcap \geq n \text{hasdoneExam}$;

$C2. \leq n \text{ hasdoneExam} \sqcup \neg \text{Student}$

13. Verify the following concept equivalences:

1. $\neg(C \sqcap D) \equiv \neg C \sqcup \neg D$.
2. $\neg \forall R.C \equiv \exists R. \neg C$.

14. Let $KB = \{\text{Body} \sqsubseteq \exists \text{isPartOf}.\text{Human}, \text{Men} \sqsubseteq \text{Human}, \text{Men}(\text{John}), \text{isPartOf}(\text{head}, \text{John}), \text{Head}(\text{head})\}$.

1. Prove that $KB \models \text{Head} \sqsubseteq \exists \text{isPartOf}.\text{Body}$.
2. Is $KB \cup \{\text{isDirectPartOf} \sqsubseteq \text{isPartOf}\} \models \exists \text{isDirectPartOf}.\text{Body} \sqcap \text{Head} \sqsubseteq \perp$?

15. Suppose there is a set of objects that are Trees and a binary relation hasBranch between objects that leads from a tree to its subtrees. Then the binary trees are the trees with at most two subtrees that are themselves binary trees.

1. How you represent this in DL?
2. Define the concept “Array” as a sequence of cells of length n .

16. (Optional) An AL-concept C is coherent if there is an interpretation (Δ, I) such that $I(C) \neq \emptyset$. Let τ be the mapping from any language in the AL* family of attributive languages to a first-order language we have seen in class. Prove that every AL*-concept C is coherent iff the first-order formula $\tau(C)$ is satisfiable.