M2R Exam
Fundamentals of data processing and distributed knowledge
Semantics of Distributed Knowledge part

Duration : 3h

All documents allowed – *No* communication device allowed

January 2023

Note: Read all the questions carefully before answering. Justify your answers with respect to the semantics: this is the semantics that justifies their correctness.

Time and points are indicative.

Course questions [Expectation: 30mn; 4pts]

> Here I give only three examples, but it should be around 10 questions, the answers are in the course in general.

Answers to these questions are generally short (if the answer is more than three sentences, it is probably wrong, except for the last one). They are related to the course content.

1. For what is it useful to query different sources?

2. What does it means for a structure (formula, theory, network, etc.) to be inconsistent?

3. In modal logic, is $S \models S'$ defined by $\forall M, M \models S \Rightarrow M \models S'$ or by $\forall M, \forall w \in W_M, M, w \models S \Rightarrow M, w \models S'$? Does one expression implies the other? Why?

Application [Expectation: 2h; 14pts]

Triple/graphs

Here is a set of triples (called G):

$$G$$

d:Ringo o2:likes d:Laura
d:Ringo o2:likes d:Max
d:Max o2:likes d:Laura
d:Laura o2:likes d:Max
d:Laura o2:likes d:Julia

d:Laura o2:hobby d:SurfRidingChamrousse
d:Laura o2:hobby d:ReadingMadameBovary
d:Ringo o2:hobby d:DrumPlaying
d:Max o2:hobby d:HorseRidingCamargue

4. Draw the RDF graphs corresponding to G.

Ontologies

Consider the three ontologies O_1, O_2 and O_3 ($\sqsubseteq$ = rdfs:subClassOf, $\bot$ = owl:disjointWith):

<div align="center">

O_1 O_2

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o1:InDoorSport $\sqsubseteq$ o1:Sport

o1:OutDoorSport $\sqsubseteq$ o1:Sport

o1:WinterSport $\sqsubseteq$ o1:OutDoorSport

o2:Person $\sqsubseteq$ foaf:Person

o2:hobby rdfs:domain o2:Person

o2:hobby rdfs:range o2:Activity

o2:Entertainment $\sqsubseteq$ o2:Activity

o2:Sport $\sqsubseteq$ o2:Activity

o2:Person $\sqsubseteq$ $\exists_{=1}$o2:hobby.o2:Activity

o2:Sportperson $\sqsubseteq$ o2:Person $\sqcap$ $\exists_{\geq 1}$o2:hobby.o1:Sport

o2:Geek $\sqsubseteq$ o2:Person $\sqcap$ $\exists_{\geq 1}$o2:hobby.o3:Art

o2:SportFanatic $\sqsubseteq$ o2:Sportperson $\sqcap$ $\forall$o2:likes.o2:SportPerson

<div align="center">

O_3

</div>

o3:PerformingArt $\sqsubseteq$ o3:Art

o3:Literature $\sqsubseteq$ o3:Art

o3:Gaming $\sqsubseteq$ o3:Art

and its connection to G ($\equiv=$ rdf:type):

<div align="center">

O_1 O_2 O_3

</div>

d:SurfRidingChamrousse $\equiv$ o1:WinterSport

d:HorseRidingCamargue $\equiv$ o1:OutDoorSport

d:SailingPaladru $\equiv$ o1:OutDoorSport

d:Laura $\equiv$ o2:Person

d:Ringo $\equiv$ o2:Person   d:ReadingMadameBovary $\equiv$ o3:Literature

d:Max $\equiv$ o2:Person   d:DrumPlaying $\equiv$ o3:PerformingArt

d:Julia $\equiv$ o2:Person

5. Is $G \cup O_2$ consistent? Either provide a model or discuss the constraints that could prevent one to exists and why they are violated or not.

6. Does $G \cup O_2 \models_{RDF}$ d:SurfRidingChamrousse owl:sameAs d:ReadingMadameBovary?

7. Does $G \cup O_2 \models_{OWL}$ d:SurfRidingChamrousse owl:sameAs d:ReadingMadameBovary?

8. Does $G \cup O_2 \models_{OWL}$ d:Max rdf:type o2:SportFanatic?

9. Does $G \cup O_2 \models_{OWL}$ d:Ringo rdf:type o2:SportFanatic?

10. Does $G \cup O_2 \models_{OWL}$ d:Laura rdf:type $\neg$o2:SportFanatic?

11. Does $O_2 \models_{OWL}$ o2:SportFanatic $\sqsubseteq$ o2:Sportperson?

12. Does $O_2 \models_{OWL}$ o2:Sportperson $\sqsubseteq$ o2:SportFanatic?

Alignments

Consider the following alignments:

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A_{12} A_{23}

o1:Sport $\leq$ o2:Sport   o2:Entertainment $\geq$ o3:Art

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13. Does $A_{23} \models_{\Delta}$ o2:Activity $\geq$ o3:PerformingArt?

14. Does $A_{12} \models_{\Delta}$ o2:Sportperson $\sqsubseteq$ o2:Person $\sqcap$ $\exists_{\geq 1}$o2:hobby.o2:Sport?

Belief revision

Consider that we add:

<div align="center">

o2:Sport owl:disjointWith o2:Entertainment.

</div>

to O_2.

15. Does this make $G \cup O_2$ inconsistent? Why?

16. Does $\langle \{O_1, O_2 \cup G, O_3\} \{A_{12}, A_{23}\}\rangle \models_\Delta$ o1:Sport $\perp$ o3:Art?

17. Does this make $\langle \{O_1, O_2 \cup G, O_3\} \{A_{12}, A_{23}\}\rangle$ inconsistent? Why?

18. What are the statements that can be suppressed to restore consistency?

Epistemic logic

19. Model the ontologies (without the last axiom added to O_2) and alignments in epistemic logic as in Section 7.6 of the course (Modelling the alignment repair game). This means that three agents are considered each one having an ontology.

20. What would the effect of the announcement of o2:Sport owl:disjointWith o2:Entertainment be?

Open question   [Expectation: 20mn; 3pts]

A type of belief revision is partial meet revision which computes the intersection between selected maximal consistent subtheories. One problem is to define how to select these subtheories. Cultural knowledge evolution applies a simple adaptation operator (similar to selecting one theory) to restore local consistency. Could you image how to use the cultural knowledge evolution approach to 'perform' partial meet revision?