M2R Exam – Semantic web: from XML to OWL
Semantics of Distributed Knowledge part

Duration : 2h
All documents allowed – *No* communication device allowed

January 2021

Note: Read all the questions carefully before answering. Do not hesitate to justify your answers.
Time and points are indicative.

Course questions [Expectation: 25mn; 5pts]

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: 1h10; 10pts]

After the pandemic had settle down, Alan and Bianca enjoy going to the aquarium to observe the marvellous fishes on display there. They represent these fishes with respect to what impress them most: Alan deeply enjoys their bright colors and patterns; Bianca is fascinated by their size and the variety of their diet.

They tend to classify them in this way ($\equiv$=owl:equivalentClass,$\oplus$=owl:disjointFrom, $\sqcap$=owl:intersectionOf, $\sqcup$=owl:unionOf, $\exists$=owl:someValuesFrom, etc.):

O_{Alan}

$$\begin{aligned}
\texttt{oa:PatternedFish} &\equiv \texttt{oa:Fish} \\
&\sqcap \exists \texttt{oa:skin}.\{\texttt{pyjama}, \texttt{striped}\} \\
\texttt{oa:MonocolorFish} &\equiv \texttt{oa:YellowFish} \\
&\sqcup \texttt{oa:BlueFish} \sqcup \texttt{oa:RedFish} \\
\texttt{oa:PatternedFish} &\oplus \texttt{oa:MonocolorFish} \\
\texttt{oa:BlueFish} &\equiv \texttt{oa:PaleBlueFish} \\
&\sqcup \texttt{oa:BrightBlueFish} \\
\texttt{oa:YellowFish} &\equiv \texttt{oa:Fish} \\
&\sqcap \exists \texttt{oa:skin}.\{\texttt{yellow}\} \\
\texttt{oa:RedFish} &\equiv \texttt{oa:Fish} \\
&\sqcap \exists \texttt{oa:skin}.\{\texttt{red}\} \\
\texttt{oa:PaleBlueFish} &\equiv \texttt{oa:Fish} \\
&\sqcap \exists \texttt{oa:skin}.\{\texttt{paleblue}\} \\
\texttt{oa:BrightBlueFish} &\equiv \texttt{oa:Fish} \\
&\sqcap \exists \texttt{oa:skin}.\{\texttt{brightblue}\}
\end{aligned}$$

O_{Bianca}

$$\begin{aligned}
\texttt{ob:SmallFish} &\equiv \texttt{ob:Fish} \sqcap \exists \texttt{ob:size}.\{\texttt{small}\} \\
\texttt{ob:LargeFish} &\equiv \texttt{ob:Fish} \sqcap \exists \texttt{ob:size}.\{\texttt{large}\} \\
\texttt{ob:SmallFish} &\oplus \texttt{ob:LargeFish} \\
\texttt{ob:Carnivorous} &\equiv \texttt{ob:Fish} \\
&\sqcap \exists \texttt{ob:eats}.\{\texttt{meat}\} \\
\texttt{ob:Herbivorous} &\equiv \texttt{ob:Fish} \\
&\sqcap \exists \texttt{ob:eats}.\{\texttt{plant}, \texttt{algae}\} \\
\texttt{ob:Crustivorous} &\equiv \texttt{ob:Fish} \\
&\sqcap \exists \texttt{ob:eats}.\{\texttt{crustacea}, \texttt{worm}\} \\
\texttt{ob:Planctivorous} &\equiv \texttt{ob:Fish} \\
&\sqcap \exists \texttt{ob:eats}.\{\texttt{plancton}\} \\
\texttt{ob:Omnivorous} &\equiv \texttt{ob:Carnivorous} \sqcap \texttt{ob:Herbivorous}
\end{aligned}$$

Here is a table of fishes that they saw in the aquarium (each line of the table corresponds to a fish in each of the ontologies):

Id	Name	size	eats	skin	area
A	Gourami	small	crustacea		southam
B	Puffer	large	meat,plant	pyjama	asia
C	Piranha		meat	paleblue	asia
D	Betta	small	algae,meat	brightblue	asia
E	Snapper	large		red	europe
F	Tang		algae,worm	stripped	europe

4. Attach each reported fish (species) to its class(es) in each of the classifications.

5. Describe a model of Bianca's ontology (and available fishes).

6. Show that this model entails that $\texttt{ob:Omnivorous} \sqsubseteq \texttt{ob:Fish}$

In order to communicate, Alan and Bianca have created the alignment made of the following correspondences:

$$\begin{aligned}
\texttt{oa:Fish} &\leq \texttt{ob:Fish} & \texttt{oa:Fish} &\geq \texttt{ob:Fish} \\
\texttt{oa:BlueFish} &\leq \texttt{ob:SmallFish} & \texttt{oa:PatternedFish} &\geq \texttt{ob:Crustivorous}
\end{aligned}$$

7. Now Bianca has query $q[x] = \texttt{SELECT}\ x\ \texttt{WHERE}\ (\texttt{ob:Carnivorous} \sqcap \texttt{ob:SmallFish})(x)$ what is the answer to this query in Bianca's base?

8. What are the results if she wants to take advantage of the alignment and Alan's base?

9. Can Alan also take advantage of this alignment to complete his knowledge? How?

Their friend Clarisse has only been able to look into fishes in the encyclopedia. They are also fascinating. She reports a new fish to her friends.

Id	Name	size	eats	skin	area
G	Dartfish	large	crustacea	brightblue	asia

10. What is the consequence of adding this fish within Bianca's data? Within Alan's data? within both aligned ontologies?

11. How could Alan and Bianca react to this problem?

12. Is there a way to check that the modifications are minimal? How would you measure it?

General ideas [Expectation: 25mn; 4pts]

What would be your thoughts about modelling (some part of) cultural evolution with dynamic epistemic logic?

Cultural evolution means that beliefs can be transmitted from agents to agents both in a vertical way (from parents to offspring) and in a horizontal way (from peer to peer). Cultural selection may take various forms, but the most basic one is that agents try to preserve only consistent sets of beliefs.

Dynamic epistemic logics offer ways to express agent beliefs ($B_a\phi$) and announce formulas ($!\phi$ or $\uparrow \phi$). It can also constrain consistency: $(\neg(B_a\phi \wedge B_a\neg\phi))$.

What elements do you think should be added to dynamic epistemic logics to model cultural evolution? How the model presented during the course could be extended? Can you criticise it?

Note that the information about fishes is not accurate...