COMP718: Ontologies and Knowledge Bases Exercises Lecture 4—hints for the answers

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March 4, 2012

Reasoning

- Instance classification and KB consistency. The answers for the university1.owl exercises can be found at http://owl.man.ac.uk/2005/07/sssw/university.html.
- Cleaning up a 'dirty' ontology. Let us randomly have a look at a deduction and its explanation (click on the "?" right from the deduction in Protégé) as a first step toward figuring out why so many classes are unsatisfiable (i.e., equivalent to Nothing, or \perp). Take the explanation for CS_StudentTakingCourses:

00			
	Iighlight unsatisfiable class	ses	
Subclass axiom symbol	C 🛟		
Equivalent classes axiom symbol	=		
Disjoint classes axiom symbol	C ¬ 🛟		
	🔲 Obfuscate entity names	View justification entailments	
	🗹 Use ordering	Extract ontology	
Explanation 1 🕘 🚯			
CS_StudentTakingCourses =	Nothing	08	
CS_StudentTakin	gCourses 🗉 CS_Student	\otimes	
CS_Stu	dent ⊑ takesCourse only <mark>CS</mark> _	Course 🛛 😣	
•	CS_Course Gottin so	me CS_Department 🛛 🛞	
•	● CS_Department ⊑ affiliatedWith some CS_Library 😒		
Transitive: affiliatedWith			
•	CS_Li	brary 🗆 affiliatedWith some EE_Librar😣	
CS_StudentTakin	CS_StudentTakingCourses c takesCourse min 1 Thing		
CS_Department □ ¬ EE_Department €			
EE_Department = affiliatedWith some EE_Library			
		Stop	

This CS_StudentTakingCourses has a long explanation of why it is unsatisfiable, and we see that some of the axioms that it uses to explain the unsatisfiability also have unsatisfiable classes. Hence, it is a good idea to set this aside for a while, as it is a knock-on effect of the others that are unsatisfiable.

Let us have a look at the unsatisfiability regarding departments.

$\Theta \bigcirc \bigcirc$		
	🗹 Highlight unsatisfiable classes	
Subclass axiom symbol	c 🛟	
quivalent classes axiom symbol	=	
Disjoint classes axiom symbol	C ¬ 🛟	
	Obfuscate entity names	View justification entailments
	🗹 Use ordering	Extract ontology
Explanation 1 🔘 🔁		
Al_Dept = Nothing		08
AI_Dept = CS_Dept	partment and hasResearchArea va	lue Al 🛛 📀
CS_Dep	oartment ⊑ affiliatedWith some C	S_Library 🛛 🔇
	Transitive: affiliatedWith	6
•	CS_Library ⊑ affiliatedWith so	me EE_Library 🛛 🖸
	- EE Department	6
CS_Department	- EE_Department	

So, the AI_Dept is unsatisfiable because its superclass CS_Department is, i.e., it is a knock-on effect from CS_Department. Does this give sufficient information as to say why CS_Department is inconsistent? In fact, it does. See the next screenshot, which is the same as lines 3-7, above.

. \varTheta 🔿 🔿		
	🗹 Highlight unsatisfiable classe	25
Subclass axiom symbol	C 🗘	
Equivalent classes axiom symbol	=	
Disjoint classes axiom symbol	C - 🛟	
	🔲 Obfuscate entity names	View justification entailments
	🗹 Use ordering	Extract ontology
Explanation 1 🕘 🔂		
CS_Department = Nothing		08
CS_Department CS_D Epartment CS_D	affiliatedWith some CS_Libra	iry 🛛 😣
Transitiv	e: affiliatedWith	8
CS_Lib	rary ⊑ affiliatedWith some EE_	Library 🛛 🛛 🛛
CS_Department	□ ¬ EE_Department	8
EE_Department =	affiliatedWith some EE_Librar	y 😣
		Stop

CS_Department is unsatisfiable, because it is affiliatedWith some CS_Library that, in turn (by transitivity), is affiliatedWith some EE_Library that belongs to the EE_Department, which is disjoint from CS_Department. Two 'easy' options to get rid of this problem are to remove the transitivity or to remove the disjointness. Alternatively, we could revisit the domain knowledge; e.g., CS library may not be affiliatedWith EE library, but is, adjacentTo or disjoint with the EE library.

Let us now consider why $\texttt{CS_course}$ is unsatisfiable:

$\Theta \bigcirc \odot$		
	🗹 Highlight unsatisfiable classes	
Subclass axiom symbol	c 🛟	
Equivalent classes axiom symbol	=	
Disjoint classes axiom symbol	C ¬ 🛟	
	Obfuscate entity names	View justification entailments
	🗹 Use ordering	Extract ontology
Explanation 1		
CS_Course = Nothing		0 0
● CS_Course ⊑ offe	redIn some CS_Department	\otimes
CS_Dep	artment 🗉 affiliatedWith some C	CS_Library 🛛 😣
	Transitive: affiliatedWith	\otimes
•	CS_Library ⊑ affiliatedWith so	me EE_Library 🛛 😣
CS_Department 🕻	¬ EE_Department	8
EE_Department =	affiliatedWith some EE_Library	8
		Stop

We have again that the real problem is CS_Department; fix that one, and CS_course is satisfiable, too.

There is a different issue with AIStudent. From the explanation in the next screenshot, we can see immediately it has something to do with the inconsistency of HCIStudent.

$\Theta \bigcirc \odot$		
	☑ Highlight unsatisfiable classe	5
Subclass axiom symbol	C 🗘	
Equivalent classes axiom symbol	=	
Disjoint classes axiom symbol	C ¬ 🛟	
	🔲 Obfuscate entity names	View justification entailments
	🗹 Use ordering	Extract ontology
Explanation 1		
●AlStudent = Nothing		08
● AlStudent ⊑ hasA	dvisor some ProfessorInHClor	AI 🛛
-	advisorOf inverseOf hasAd	visor 🛛 🕄
ProfessorInHClorAl		
AlStudent C ¬ HCIStudent		
		Stop

But looking at HCIStudent for a clue does not help us further in isolating the problem:

00		
	☑ Highlight unsatisfiable classes	
Subclass axiom symbol	C 🗘	
Equivalent classes axiom symbol	=	
Disjoint classes axiom symbol	C ¬ 🗘	
	Obfuscate entity names	View justification entailments
	🗹 Use ordering	Extract ontology
Explanation 1 🕘 🚯		
HCIStudent = Nothing		08
	Advisor some ProfessorInHClor	rAl 😣
	advisorOf inverseOf hasAdvi	isor 🛛 😣
Profess	sorInHClorAl 🗆 advisorOf only A	lStudent 🛛 😒
AlStudent C ¬ HC	IStudent	\otimes
		Stop

Considering the axioms in the explanation only, one can argue that the root of the problem is the disjointness between AIStudent and HCIStudent, and remove that axiom to fix it. However, does it really make sense to have the union ProfessorInHCI*or*AI? Not really, and therefore it would be a better fix to change that one into two separate classes, ProfessorInHCI and ProfessorInAI and have them participating in ProfessorInHCI $\sqsubseteq \forall advisorOf.HCIStudent$ and ProfessorInAI $\sqsubseteq \forall advisorOf.AIStudent$, respectively.

Last, we have a problem of conflicting cardinalities with LecturerTaking4Courses: it is a subclass of TeachingFaculty, which is restricted to taking at most 3 courses, which is in conflict with the "exactly 4" of LecturerTaking4Courses. This can be fixed by changing the cardinality of either one, or perhaps a lecturer taking 4 courses is not a sub- but a sister-class of TeachingFaculty.

$\Theta \odot \odot$		
	🗹 Highlight unsatisfiable classes	5
Subclass axiom symbol	c 🛟	
Equivalent classes axiom symbol	=	
Disjoint classes axiom symbol	C - 🛟	
	Obfuscate entity names	View justification entailments
	🗹 Use ordering	Extract ontology
Explanation 1 🕘 🥵		
LecturerTaking4Courses = N	othing	08
LecturerTaking40	Courses 🗉 Lecturer	8
Lecturer □ TeachingFaculty ③		
● TeachingFaculty ⊑ takesCourse max 3 Thing ③		
LecturerTaking4Courses		
		Stop