KMM Tutorial 2 Description Logic and OWL

1. Paraphrase the following ALC logical expressions in English. For necessary definitions (A$\sqsubseteq$B) say 'A is a subclass of B', for necessary and sufficient definitions (A$\equiv$B) say 'A necessary and sufficient definition of a(n) A is B'. State the right-hand expression in Manchester syntax.

a) Person $\sqsubseteq$ Mammal
b) Man $\sqsubseteq$ Person
c) Woman $\equiv$ Person $\sqcap \neg$Man
d) Mother $\equiv$ Woman $\sqcap \exists$hasChild.Person
e) Father $\equiv$ Man $\sqcap \exists$hasChild.Person
f) Parent $\equiv \exists$hasChild.Person

2. Draw a class hierarchy diagram for Mammal and the 6 classes defined in 1. based on your understanding of the definitions a-f.

3. Express the following statements in ALC, use the hasSibling relationship where needed. The Manchester version of the English is given in parentheses:

a) A necessary and sufficient definition of a Grandfather is a Man who has some child that is a Father (a Man that hasChild some Father)
b) A necessary and sufficient definition of a Brother is a Man who has some sibling that is a Person (a Man that hasSibling some Person).
c) A necessary and sufficient definition of a Sister is a Person, who is not a Brother, and who has some sibling that is a Person (a Person and (not Brother) and hasSibling some Person).
d) A necessary and sufficient definition of a LuckyBrother is a Man whose only siblings are Sisters (a Man that hasSibling only Sister).

4. Add the 4 classes from 3. to the class hierarchy.

5. Draw the FACT tableaux for the following propositions. If the tableaux has a clash it means the concept you begin with can never have any instances.

a) Man and Woman are disjoint. (Assume Man is an atomic concept with no definition.)

b) Brother and Sister are disjoint. (Assume Person is an atomic concept with no definition.)

c) Father is subsumed by (is a subclass of) Parent.

d) LuckyBrother is subsumed by (is a subclass of) Brother?

6. Using Protege 4 as described in Tutorial 1, enter the 11 concepts and 2 relations defined above. Include the necessary and sufficient conditions. hasChild and hasSibling are object properties and should have domain and range Thing.

7. Using Protege, examine the OWL/RDF source for these definitions (under View/Ontology views select the RDF/XML rendering).

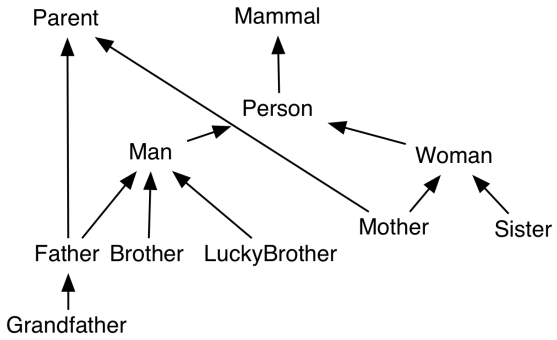
Tutorial 2 Description Logic and OWL - Answers

1. a) Person $\sqsubseteq$ Mammal
A Person is a Mammal.
b) Man $\sqsubseteq$ Person
A Man is a Person.
c) Woman $\equiv$ Person $\sqcap \neg$Man
A Woman is necessarily a Person who is not a Man.
d) Mother $\equiv$ Woman $\sqcap \exists$hasChild.Person
A Mother is necessarily a Woman who has some child that is a Person (a Woman that hasChild some Person).
e) Father $\equiv$ Man $\sqcap \exists$hasChild.Person
A Father is necessarily a Man who has some child that is a Person (a Man that hasChild some Person).
f) Parent $\equiv \exists$hasChild.Person
A Parent is necessarily has some child that is a person (hasChild some Person).

see 3.

2. a) Grandfather $\equiv$ Man $\sqcap \exists$hasChild.Father
b) Brother $\equiv$ Man $\sqcap \exists$hasSibling.Person
c) Sister $\equiv$ Person $\sqcap \neg$Brother $\sqcap \exists$hasSibling.Person
d) LuckyBrother $\equiv$ Man $\sqcap \forall$hasSibling.Sister

3. Class hierarchy.



4 a) Man and Woman are disjoint?

Concepts	Man	Woman
1. Replace by definition	Man	Person ⊓ ¬Man
2. Construct goal	Man ⊓ (Person ⊓ ¬Man)	
3. Negation normal form	Man ⊓ (Person ⊓ ¬Man)	
4. Tableaux	Node/Edge	Label
	(a0)	{ Man ⊓ (Person ⊓ ¬Man) }
⊓ elimination	(a0)	{ Man, Person ⊓ ¬Man}
⊓ elimination CLASH	(a0)	{ Man, Person, ¬Man}

Answer: Yes.

5b) Brother and Sister are disjoint?

Concepts	Brother	Sister
1a. Replace by definition	Man ⊓ ∃hasSibling.Person	Person ⊓ ¬Brother ⊓ ∃hasSibling.Person
1b. Replace by definition	Man ⊓ ∃hasSibling.Person	Person ⊓ ¬(Man ⊓ ∃hasSibling.Person)⊓ ∃hasSibling.Person
2. Construct goal	(Man ⊓ ∃hasSibling.Person) ⊓ (Person ⊓ ¬(Man ⊓ ∃hasSibling.Person)⊓∃hasSibling.Person)	
3. Negation normal form	(Man ⊓ ∃hasSibling.Person) ⊓ (Person ⊓ (¬Man ⊔ ∀hasSibling.¬Person)⊓∃hasSibling.Person)	
4. Tableaux	Node/Edge	Label
	(a0)	{ (Man ⊓ ∃hasSibling.Person) ⊓ (Person ⊓ (¬Man ⊔ ∀hasSibling.¬Person)⊓ ∃hasSibling.Person)}
⊓ elimination 4 times	(a0)	{ Man, ∃hasSibling.Person, Person, ¬Man ⊔ ∀hasSibling.¬Person, ∃hasSibling.Person}
⊔ elimination CLASH	(a0)	{ Man, ∃hasSibling.Person, Person, ¬Man ∃hasSibling.Person)} OR { Man, ∃hasSibling.Person, Person, ∀hasSibling.¬Person, ∃hasSibling.Person}
∃ elimination ∀ elimination	(a0)	{ Man, ∃hasSibling.Person, Person, ∀hasSibling.¬Person, ∃hasSibling.Person}
add edge	hasSibling	
add new node (a1)	(a1)	{Person, ¬Person}
CLASH		

Answer: Yes.

5c) Father is a subclass of Parent?

Concepts	Parent	Father
1. Replace by definition	∃hasChild.Person	Man ⊓ ∃hasChild.Person
2. Construct goal	¬(∃hasChild.Person) ⊓ (Man ⊓ ∃hasChild.Person)	
3. Negation normal form	(∀hasChild.¬Person) ⊓ (Man ⊓ ∃hasChild.Person)	
4. Tableaux	Node/Edge	Label
	(a0)	{ (∀hasChild.¬Person) ⊓ (Man ⊓ ∃hasChild.Person) }
⊓ elimination	(a0)	{ ∀hasChild.¬Person, Man, ∃hasChild.Person}
∃ elimination	(a0)	{ ∀hasChild.¬Person, Man, ∃hasChild.Person}
add edge	hasChild	
add new node (a1)	(a1)	{ Person, ¬Person }
CLASH		

Answer: Yes.

5d) LuckyBrother is a subclass of Brother?

Concepts	Brother	LuckyBrother
1a. Replace by definition	Man ⊓ ∃hasSibling.Person	Man ⊓ ∀hasSibling.Sister
Note:		Sister should be expanded
2. Construct goal	¬(Man ⊓ ∃hasSibling.Person)⊓(Man ⊓ ∀hasSibling.Sister*)	
3. Negation normal form	(¬Man ⊔ ∀hasSibling.¬Person)⊓(Man ⊓ ∀hasSibling.Sister*)	
4. Tableaux	Node/Edge	Label
	(a0)	{ (¬Man ⊔ ∀hasSibling.¬Person)⊓ (Man ⊓ ∀hasSibling.Sister*) }
⊓ elimination	(a0)	{¬Man ⊔ ∀hasSibling.¬Person, Man, ∀hasSibling.Sister* }
⊔ elimination	(a0)	{¬Man, Man, ∀hasSibling.Sister* }
CLASH		OR
		{∀hasSibling.¬Person, Man, ∀hasSibling.Sister* }

No more rules apply and so the second disjunct remains open. Fully expanding the concept Sister (as in 5b) would not help.

Answer: No.