Name: _____ Student ID: _____

HW 2

CS 205 - 2024 Winter

First Order Logic (FOL)

1. Write the following statement in FOL, using only the predicates listed, "you can fool some people all of the time, and all people some of the time, but not all of the people all of the time."

person(x) - x is a person
time(t) - t is a time
fools(x, y, t) - x fools y at time t
you - a constant, a person

2. Use the following predicates (and standard equality constructs) to write "97 is prime" in FOL.

natural(x) - x is a natural number
product(x,y) - a function that yields the product of x and y
1, 97 - constants

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3. Negate the following statement and then simplify it such that you only have negations of simple statements*. That is, you may not have negations in front of quantifiers or complex statements. Show your work, step by step.

$\forall x.\ (p(x) \rightarrow \exists y.\ (q(x) \wedge r(y)))$

*For example, $\neg(\exists y.\ (q(x) \wedge r(y))$ is not simplified enough, whereas, $\forall x.\ (q(x) \wedge \neg r(y))$ is. There are some great slides and tutorials on how to simplify FOL expressions, as well as the textbook.

4. Next to each FOL formula, write the corresponding statement in natural language.

$\neg \exists x.\ \forall y.\ sees(x,y)$

$\forall x.\ \exists y.\ \neg sees(x,y)$

$\forall x.\ \neg \exists y.\ sees(x,y)$

5. Very briefly state what's wrong with the following attempt for the statement "there are exactly two solutions" and then provide the correct one?

$\exists x.\ \exists y.\ solution(x) \wedge solution(y)$

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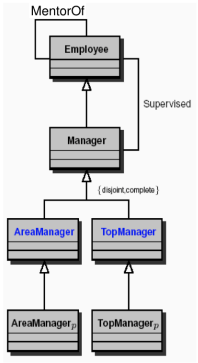
6. Explain very briefly and concisely why the substitution {x\Yuanjie} is a valid solution for Anai's example in this fictional object-relational model. You should mention the open world assumption.

Anais's Example (Cont.)



Employee

EmployeeID
Anais
Yuanjie
Amir
Omar

Manager

EmployeeID
Anais
Omar
Amir

AreaManager$_P$

EmployeeID
Omar

TopManager$_P$

EmployeeID
Amir

Supervised

EmployeeID	SupervisorID
Yuaniie	Amir
Yuanjie	Anais

MentorOf

EmployeeID	OfcmateID
Anais	Omar
Amir	Anais

Who is supervised by a top manager that is a mentor of an area manager?

Q(x) :- Supervised(x,y), TopManager(y), MentorOf(y,z), AreaManager(z)

7. Explain very briefly and concisely why the following entailment is true, given the facts provided. That is, IOKASTE is such a person who satisfies the query. You may want to read more about the famous story of Oedipus, to help you understand this situation better.

hasChild(IOKASTE, OEDIPUS)
hasChild(IOKASTE, POLYNEIKES)
hasChild(OEDIPUS, POLYNEIKES)
hasChild(POLYNEIKES, THERSANDROS)
Patricide(OEDIPUS)
¬Patricide(THERSANDROS)

Fig. 2.5. The Oedipus ABox $\mathcal{A}_{oe}$.

$\mathcal{A}_{oe} \models (\exists \mathsf{hasChild}.(\mathsf{Patricide} \sqcap \exists \mathsf{hasChild}.\neg \mathsf{Patricide}))(\mathsf{IOKASTE})$?

8. Every student but Samir smiles. Explain briefly why the following FOL is wrong and then fix it.

$\forall x ((\text{student}(x) \,\&\, x \neq \text{Samir}) \rightarrow \text{smile}(x))$