LODE

Basic Concepts

Solution **6.1**

1. is false because it is atomic.
2. is true because it is correct with respect to the BNF given in lecture.
3. is false because it is a complex formula rather than an atomic one.
4. is false because it is a $\mathcal{LOE}$ formula.
5. is true because it is correct with respect to the BNF given in lecture (nesting).

Solution **6.2**

- P and Q are satisfiable with respect to $\mathcal{T}$ if and only if $\mathcal{T} \models \mathrm{P} \wedge \mathrm{Q}$
- $\mathcal{T} \models \neg\ (\mathrm{P} \subseteq \mathrm{Q})$ is a logical consequence of $\mathcal{T} \models \mathrm{P} \cap \mathrm{Q} \subseteq \bot$
- $\mathcal{T} \models \neg((\mathrm{Q} \subseteq \mathrm{P}) \cup (\mathrm{P} \subseteq \mathrm{Q})$ is a logical consequence of $\mathcal{T} \models \mathrm{P} \cap \mathrm{Q} \subseteq \bot$

Solution **6.3**

- $I(\mathrm{C}_1 \subseteq \mathrm{C}_2)=\top$ iff $I(\mathrm{C}_1)=\top$ and $I(\mathrm{C}_2)=\top$
- $\mathcal{T} \models \mathrm{C}$ if there exists an interpretation I so that $I \models \mathrm{C}_i$ for all $\mathrm{C}_i \in \mathcal{T}$ and $I(\mathrm{C})=\top$

Solution **6.4**

1. True: as defined.
2. True: nodes and arcs are added by extending the initial Entity Graph.
3. False: each existential quantifier always creates an arc.
4. False: the arc generated by an existential quantifier does not allow the target entity to be identified, as it always generates an anonymous node.

Translation

Solution **6.5**

Solution **6.6**

1. Person $\sqcap$ Happy
2. Person $\sqcap$ Happy $\sqcap \exists$owns.Animal
3. Person $\sqcap \forall$owns.Cat
4. Person $\sqcap \neg$Happy $\sqcap \exists$owns.(Animal $\sqcap$ Cat $\sqcap$ Old)
5. Person $\sqcap \exists$owns.Animal $\sqcap \forall$owns.(Cat $\sqcup$ Fish)

Solution **6.7** The solution is the figure below:

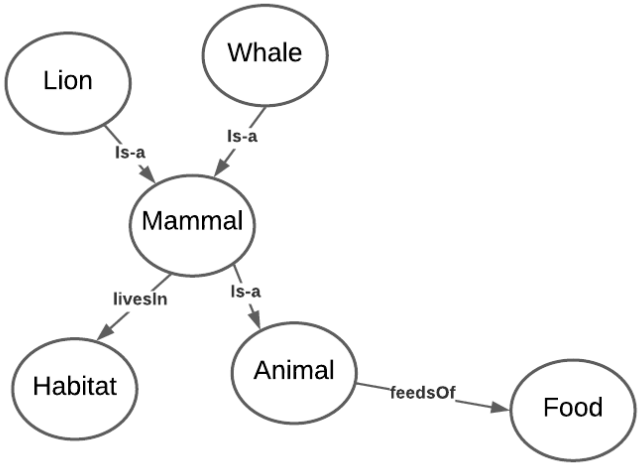

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Fig. 0.1: Schema Knowledge Graph

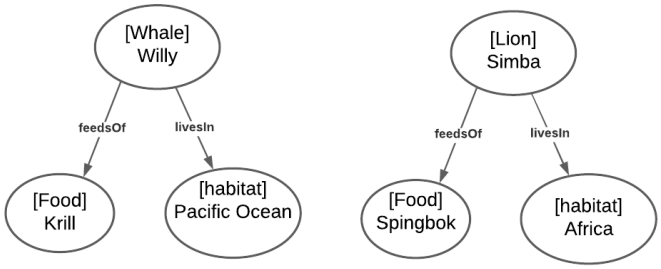

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Fig. 0.2: Data Knowledge Graph

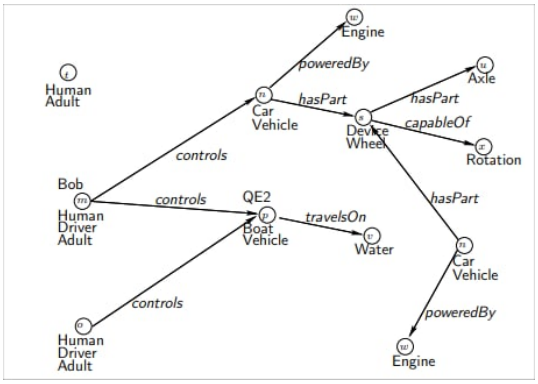


Fig. 0.3: Data knowledge Graph

Solution **6.8** Answer:

- – Person ⊑ ∃Drives.Car ⊓ ∃HasHobby.SportCar ⊓ ∃HasHobby.Opera
  – Student ⊑ Person
  – SportCar ⊑ Car
- – Student(Ralf)
  – Opera(DonCarlos)

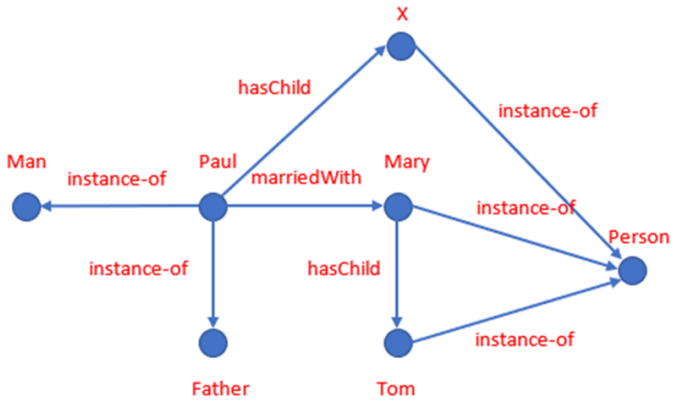
Solution **6.9** Answer:

- – Doctor ⊑ ¬cure.Patient ⊓ ¬work.Computer
  – cure ⊑ detected
  – work ⊑ detected
- – Doctor (Peter)
  – Patient (Smith)
  – cure(Peter, Smith)

Solution **6.10** SOLUTION: The A expansion of ABOX with respect to TBOX is:

$$\mathcal{A} = \begin{cases} \text{hasChild(Mary, Tom)} \\ \text{marriedWith(Paul, Mary)} \\ \text{Person(Mary)} \\ \text{Person(Tom)} \\ \text{Father(Paul)} \\ \text{Man(Paul)} \\ \text{hasChild(Paul, X)} \\ \text{Person(X)} \end{cases}$$

Consequently, The resulting EG is as follows: From which it follows trivially that the



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true ones are solely (2) and (5).

Solution **6.11** Only 2 is true. In fact, the unfolding of TBOX generates the following TBOX, where the definition of Father is the only one relevant to the expansion of ABOX.

$$\mathcal{T} = \begin{cases} \text{Mother} \equiv \text{Woman} \sqcap \exists \text{hasChild.Person} \\ \textbf{Father} \equiv \textbf{Man} \sqcap \exists \textbf{hasChild.Person} \\ \text{Wife} \equiv \text{Woman} \sqcap \forall \text{marriedWith.}(\text{Man} \sqcap \exists \text{hasChild.Person}) \\ \text{Husband} \equiv \text{Man} \sqcap \exists \text{marriedWith.}(\text{Woman} \sqcap \exists \text{hasChild.Person}) \end{cases}$$

ABOX's A expansion compared to the unfolded TBOX is:

$$\mathcal{A} = \begin{cases} \text{hasChild(Mary, Tom)} \\ \text{marriedWith(Paul, Mary)} \\ \text{Person(Mary)} \\ \text{Person(Tom)} \\ \text{Father(Paul)} \\ \text{Man(Paul)} \\ \text{hasChild(Paul, X)} \\ \text{Person(X)} \end{cases}$$

(1) is false because it is not in A and cannot be derived from the definitions of TBOX. (2) is true because Man(Paul) is in A. (3) and (5) are false because although marriedWith(Paul, Mary) is in A, we do not know if Mother(Mary). (4) is false because in the expansion we have an anonymous X that we cannot assign to Tom (we could have done so if there had been a universal quantifier in Husband's definition, instead of the existential).

Solution **6.12**

$$\mathcal{A}' = \begin{cases} B(1) \\ D(1) \\ F(1) \\ G(1) \end{cases}$$

Solution **6.13** The solution to the first part is:

- (legallyControls $\sqsubseteq$ controls) $\sqcap$ (Human $\sqcup \exists$ legallyControls.Car $\sqsubseteq$ Adult $\sqcup \exists$ owns.DrivingLicense)
- Vehicle $\sqcap \exists$hasPart.Broken $\sqsubseteq$ Broken
- Bob :($\exists$ controls.(Car $\sqcap \exists$hasPart.(Wheel $\sqcap \exists$hasPart.(Axle $\sqcap$ Broken))))

While to the second part is:

- true
- true
- true

Solution **6.14**

$$\mathcal{A}' = \begin{cases} B(1) \\ D(1) \\ F(1) \\ G(1) \end{cases}$$

Solution **6.15** Answer: StepMother(Mary), Woman(Mary), marriedWith(Mary, a1), Father(a1).

Solution **6.16** Answer: StepMother(Mary), Woman(Mary), marriedWith(Mary, Paul), Father(Paul).

Solution **6.17** Answer: The expansion of Lecturer (John) is Teaches(John, Logics), Course(Logics), ¬Undergrad(John), Professor(John). Therefore the answer is yes.

Solution **6.18** Answer: John, Paul. In fact, John is in the ABox, while Paul satisfies all the constraints in the definition of Lecturer.

Solution **6.19** Answer: Given that Paul satisfies all the constraints in the definition of Lecturer, the answer is Lecturer. Note that if we remove Professor(Paul), the answer becomes ¬Undergrad.