Fall 2023 - CSC751 Semantic Web - Assignment 3

Due date: 10/31/2023, 11 a.m., upload a PDF file to a folder named 'assignment3' from your SVN home directory.

[10 points] This assignment tests your understanding of the $\mathcal{ALC}$ tableaux algorithm.

1. **[2.0 points]** Using the $\mathcal{ALC}$ tableaux algorithm, show that the following knowledge base is satisfiable. (Hint: Keep applying rules until the algorithm terminates with no more rules to apply. You can use single-letter symbols to represent the conceptualization.)

$$\begin{aligned} Student &\sqsubseteq \exists attends.Lecture \\ Lecture &\sqsubseteq \exists isAttendedBy.(Student \sqcap Eager) \\ Student(paul) & \\ \neg Eager(paul) & \end{aligned}$$

Let,

$$\begin{aligned} S &\sqsubseteq \exists a.L \\ L &\sqsubseteq \exists b.(S \sqcap E) \\ S(p) & \\ \neg E(p) & \end{aligned}$$

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2. **[2.0 points]** Using the $\mathcal{ALC}$ tableaux algorithm, show that the following knowledge base is unsatisfiable.

$$\begin{aligned} Unicorn &\sqsubseteq Animal \\ Unicorn &\sqsubseteq Fictitious \\ Fictitious \sqcap Animal &\sqsubseteq \bot \\ Unicorn(cloverJollyBridle) & \end{aligned}$$

Let,

$$\begin{aligned} U &\sqsubseteq A \\ U &\sqsubseteq F \\ F \sqcap A &\sqsubseteq \bot \\ U(c) & \end{aligned}$$

3. **[2.0 points]** The $\mathcal{ALC}$ knowledge base consists of the following axioms:

$$\begin{aligned} A &\sqsubseteq B \sqcap C \\ C &\sqsubseteq D \end{aligned}$$

Using the $\mathcal{ALC}$ tableaux algorithm, show that $A \sqsubseteq D$ is a logical consequence of this knowledge base.

$NNF(K') = \{\neg A \sqcup (B \sqcap C), \neg C \sqcup D, (A \sqcap \neg D)(a)\}$

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4. **[2.0 points]** Using the $\mathcal{ALC}$ tableaux algorithm, show that $\exists speaksWith.\top \sqsubseteq Primate$ is a logical consequence of the following knowledge base:

$$\begin{aligned} Home &\sqsubseteq Primate \\ \exists speaksWith.\top &\sqsubseteq Home \end{aligned}$$

$NNF(K') = \{\neg H \sqcup P, \forall s.\bot \sqcup H, (\exists s.\top \sqcap \neg P)(a)\}$

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5. **[2.0 points]** You are given the following knowledge base.

$$\begin{aligned} RRated &\sqsubseteq CatMovie \\ CatMovie &\sqsubseteq Movie \\ RRated &\equiv (\exists hasScript.ThrillerScript) \sqcup (\forall hasViolenceLevel.High) \\ Person &\sqsubseteq \neg Movie \\ \exists hasViolenceLevel.\top &\sqsubseteq Movie \end{aligned}$$

Using $\mathcal{ALC}$ full tableaux algorithm, show that $Person \sqsubseteq \bot$ is a logical consequence of this knowledge base.

$NNF(K') = \{\neg R \sqcup C,\ \neg C \sqcup M,\ \neg R \sqcup ((\exists a.S) \sqcup (\forall b.H)),\ (\forall a.\neg S \sqcap \exists b.\neg H) \sqcup R,\ \neg P \sqcup \neg M,\ \forall b.\bot \sqcup M,\ (P \sqcap \top)(a)\}$