Semantic Web Assignment 3

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$k = (T_1, A_1)$

$T_1 = \{ \exists_R . A \sqsubseteq B,$

$A \sqcap D \equiv E,$

$A \sqsubseteq \neg \exists Q . D \}$

$A_1 = \{ y : A, (x,y) : R, (y,z) : Q \}$

Student (class)

AMAN Cinstance

Domain : {Set of instances}

$\mathcal{I} = (\Delta^{\mathcal{I}}, \cdot^{\mathcal{I}})$

Interpretation function:

eg: $\Delta^{\mathcal{I}} = \{$ AMAN, AMIT, ABHSHEK $\}$

$Brothers^{\mathcal{I}} = \{$ Aman, Amit, ABISHEK $\}$

$ElderBrother^{\mathcal{I}} = \{$ (AMAN, AMIT) $\}$

Answer 1.1

$\Delta^{\mathcal{I}} = \{ x_1, x_2, x_3, x_4, x_5, x_6 \}$

$A^{\mathcal{I}} = \{ x_1, x_2 \}$

$D^{\mathcal{I}} = \{ x_2, x_3, x_4 \}$

$E^{\mathcal{I}} = \{ x_2 \}$

$R^{\mathcal{I}} = \{ (x_5, x_1) \}$

$B^{\mathcal{I}} = \{ x_5 \}$

$Q^{\mathcal{I}} = \{ (x_1, x_6) \}$

Answer 1.2

Let's take each item in t-box(T_1)

1) $\exists_R . A \sqsubseteq B,$

There is atleast one element who is related to A by R should be B,

as we see that in $R^{\mathcal{I}} = \{ (x_5, x_1) \}$

x_5 is related to A,

and x_5 is also in B, $B^I = \{x_5\}$

2) $A \sqcap D \equiv E$

$A^I = \{x_1, x_2\}$

$D^I = \{x_2, x_3, x_4\}$

$A^I \sqcap D^I = \{x_2\} = E$

$\therefore$ it is also satisfied

3) $A \sqsubseteq \neg\exists Q.D$

A is one who does not have any relation Q with D,

$A^I = \{x_1, x_2\}$

$D^I = \{x_2, x_3, x_4\}$

$Q^I = \{(x_1, x_6)\}$

as we can see that x_1 which is A, have relation with x_6, which is not in D,

$\therefore$ A does not have any relation Q with D

2) A box (A_1):

$A_1 = \{ y : A, (x,y) : R, (y,z) : Q \}$
 ① ② ③

if y is A,

then x is related to y by R

& y is related to z by Q

in our Interpretation:

$A^I = \{x_1, x_2\}$

$R^I = \{(x_5, x_1)\}$

$Q^I = \{(x_1, x_6)\}$

x is related to x_6, by Q, rule 3

x_5 is related to x_1 by R, rule 2

x_1 is in A, Rule 1

Answer 2 Tableau Algorithm

$\mathcal{K}_2 = (T_2, A_2)$

$T_2 = \{ \quad A \sqsubseteq D,$
$\neg(B \sqcup \neg D) \sqsubseteq E,$
$D \sqsubseteq \neg\exists R.E,$
$B \sqcap E \sqsubseteq \bot,$
$\neg\neg D \sqsubseteq E \}$

$A_2 = \{ x : \neg(\neg D \sqcap \neg E), y : A \sqcap B, (y,x) : R \}$

Answer 2.1

NNF $T_2 = \{ \quad A \sqsubseteq D,$
$\neg B \sqcap D \sqsubseteq E,$
$D \sqsubseteq \forall R(\neg E)$
$B \sqcap E \sqsubseteq \bot,$
$D \sqsubseteq E$
$\}$

$A_2 = \{ \; x : D \sqcup E,$
$y : A \sqcap B,$
$(y,x) : R \; \}$

Answer 2.2

$S = \{ \{ x : D \sqcup E, y : A \sqcap B, (y,x) : R \} \}$

1) $S = \{ \quad \{ x : D, y : A \sqcap B, (y,x) : R \},$
$\{ x : E, y : A \sqcap B, (y,x) : R \} \}$

$\boxed{\text{Applying } \sqcup \text{ rule for: } x : D \sqcup E}$

2) $S = \{ \{ x:D, y:A, y:B, (y,x):R \},$
$\{ x:E, y:A, y:B, (y,x):R \} \}$

Applying $\sqcap$ rule for:
$y: A \sqcap B$

3) $S = \{ \{ x:D, y:A, y:B, (y,x):R, y:\neg A \sqcap B \},$
$\{ x:E, y:A, y:B, (y,x):R, y:\neg A \sqcap B \} \}$

Applying $\sqsubseteq$ Rule in:
$A \sqsubseteq D$,
as y is A
$\therefore$ $y: \neg A \sqcap B$

4) $S = \{ \{ x:D, y:A, y:B, (y,x):R, y:\neg A, y:B \},$
$\{ x:E, y:A, y:B, (y,x):R, y:\neg A, y:B \} \}$

Applying $\sqcap$ rule in
$y: \neg A \sqcap B$

$S = \{ \{ x:D, \underline{y:A}, y:B, (y,x):R, \underline{y:\neg A}, y:B \},$
$\{ x:E, \underline{y:A}, y:B, (y,x):R, \underline{y:\neg A}, y:B \} \}$

y cannot be A & $\neg$A at the Same time, $\therefore$
Both A box are false,

$\therefore$ $S = \phi$

K_2 is not consistent

Answer 3: Consistency and Inference

Converting T-box into NNF

$T_3 = \{ A \equiv \neg E \sqcap \neg F,$

$B \sqcup D \sqsubseteq A,$

$E \sqsubseteq \exists P G,$

$A \sqcap \exists P.G \sqsubseteq \bot,$

$E \sqcup F \sqsubseteq \forall Q (\neg G) \}$

$A_3 = \{ x : G \}$

$(y, x) : Q$

$x : G, (y, x) : Q,$

$S = \{ \{ x : G, (y, x) : Q \}$

$S = \{ \{ x : G, (y, x) : Q, x : \neg(A \sqcap \exists P G) \sqcup \bot \} \}$

[using $\sqsubseteq$ Rule in $A \sqcap \exists P.G \sqsubseteq \bot$]

$S = \{ \{ x : G, (y, x) : Q, x : \neg(A \sqcap \exists P.G) \},$

$\{ x : G, (y, x) : Q, x : \bot \} \}$ ← this is not consistent, as ~~its~~ saying the

[using $\sqcap$ rule]

$S = \{ \{ x : G, (y, x) : Q,$

$x : \neg(A \sqcap \exists P.G) \} \}$

x is $\perp$, G at some time

$S = \{ \{ x : G, (y,x) : Q, x : \neg A \sqcup \forall p(\neg G) \} \}$

$S = \{ \{ x : G, (y,x) : Q, x : \neg A \},$
$\{ x : G, (y,x) : Q, x : \forall p(\neg G) \} \}$

$S = \{ \{ x : G, (y,x) : Q, x : \neg A \},$ ①
$\{ x : G, (y,x) : Q, x : \forall p(\neg G),$ ②
$(x, t') : P, t' : \neg G \} \}$

$\sqsubseteq$ rule is now applicable to t', algorithm will not stop

solving ① Abox

as $x \equiv \neg(E \sqcap F)$

$= \{ x : G, (y,x) : Q, x : \neg A,$
$x : \neg(\neg(E \sqcup F)) \}$

$= \{ x : G, (y,x) : Q, x : \neg A, \underline{x : E \sqcup F} \}$ using $\sqcup$ rule

$= \begin{cases} \{ x : G, (y,x) : Q, x : \neg A, x : E \} \\ \{ x : G, (y,x) : Q, x : \neg A, x : F \} \end{cases}$

$= \left\{ \begin{array}{l} \{x:G, (y,x):Q, x:\neg A, x: \neg(E \sqcup \exists_Q \ldots \\ \{x:G, (y,x):Q, x:\neg A, x:\neg(E \sqcup F) \sqcup \neg\exists_Q.G\} \end{array} \right.$

$\left\{ \begin{array}{l} \{x:G, (y,x):Q, x:\neg A, x:\neg(E \sqcup F)\} \\ \{x:G, (y,x):Q, x:\neg A, x:\neg\exists_Q.G\} \end{array} \right\}$

$\{x:G, (y,x):Q, x:\neg A, x:\forall_Q(\neg G)\}$

$\{x:G, (y,x):Q, x:\neg A, x:\forall Q(\neg G), (x,t'):Q, t':\neg G\}$

Answer 3.2

$S = \{A_4\}$

$S = \{ \{x:G, y:B, (y,x):P\}$

$S = \{ \{x:G, y:B, (y,x):P, y: \neg(B \sqcup D) \sqcup A\}\}$

{using $B \sqcup D \sqsubseteq A$}

$\sqcup$ rule applied

$$S = \left\{ \left\{ \{ \underline{x:G,\ y:B,\ (y,x):P,\ y:\neg B,\ y:\neg D} \} \right. \right.$$
$$\left. \left. \{ x:G,\ y:B,\ (y,x):P,\ y:A \} \right\} \right\}$$

inconsistent as
$y:B, \neg B$
at same time

$$S = \{ \{ x:G,\ y:B,\ (y,x):P,\ y:A \} \}$$

$$S = \{ \{ x:G,\ y:B,\ (y,x):P,\ y:A,\ y:\underline{\neg(\neg(E \sqcup F))} \} \}$$

$$= \{ \{ \underline{x:G,\ y:B,\ (y,x):P,\ y:A},\ y:E \},$$ [$\sqcup$ rule applied]
$$\{ x:G,\ y:B,\ (y,x):P,\ y:A,\ y:F \} \}$$

$$S = \{ \{ A \cup \{ y:E \} \}, \{ A \cup \{ y:F \} \} \}$$

$$A = \{ x:G,\ y:B,\ (y,x):P,\ y:A \}$$

$$S = \{ \{ A \cup y: \neg E \sqcup \exists P \cdot G) \},$$
$$\{ A \cup y: \neg(E \sqcup F) \sqcup \neg \exists a G \} \}$$

$$S = \{ \{A \cup \{y : \neg F\}\},$$
$$\{A \cup \{y : \exists P.G\}\},$$
$$\{A \cup \{y : \neg E, y : \neg F\}\},$$
$$\{A \cup \{y : \neg E, y : \neg F, y : \neg \exists Q.G\}\}\}$$

$$S = \{ \{A \cup \{y : \neg F\}\},$$
$$\{A \cup \{(y, t') : P, t' : G\},$$
$$A \cup \{y : \neg E, y : \neg F\},$$
$$A \cup \{y : \neg E, y : \neg F, y : \neg \exists Q.G,$$
$$(y, t'') : Q, t'' : \neg G\}$$

$$\boxed{\begin{array}{l} (y, t') : P \\ (y, x) : P \\ \therefore t' : x \\ x : G \end{array}}$$

$$\frac{A \cup \{(y, x) : P,\ x : G\}}{}$$

this statement cannot be expanded further, using T_3, ∴

it holds and the

Answer 3.3

$(y, x) : Q$

$x : G$

$x : \neg(A \sqcap \exists p . G) \sqcup \bot$

$x : \neg A$

$x : \bot$ (Not Consistent)

$x : E \sqcup F$ $[A \equiv \neg(E \sqcup F)]$

$x : \neg(EUF)$ (not consistent)

$x : \neg(\exists_Q . G)$

$\neg(x, t') : Q$

$\neg t' : G$

now we have $\neg(x, t') : Q$

also $(y, x) : Q$

$\therefore$ $y = \neg x$

$y \not\models \neg(\neg A)$ [as $x : \neg A$]

$y \not\models A$

$\therefore$ Proved

Answer 3.1

$x : G$

$(y, x) : Q$

(using $EUF \subseteq \neg\exists_Q . G$)

$x : \neg(E \sqcup F)$ $\qquad$ $x : \forall Q(\neg G)$

$x : \neg E$ $\qquad$ $x : \neg F$

this cannot be extended further, as there is no other rule in T box that can be applied here,

$\therefore\ K_2 = (T_2, A_2)$ is consistent

$\Delta^I = \{x_1, x_2, x_3\}$

$G^I = \{x_1\}$

$Q^I = \{(x_2, x_1)\}$ ✓

$E = \{x_2\}$

this

is

$F = \{x_2\}$

$A = \{x_1, x_3\}$

$B = \{x_1\}$

$D = \{x_3\}$

$P^I = \{(x_2), x_1\}$

Answer 3.2

$x : G$

$y : B$

$(y, x) : P$

$y : \neg(B \sqcup D)$

$y : \neg B,$

$y : \neg D$ Contradiction

$y : A$

$y : \neg(E \sqcup F)$

$y : \neg E,$

$y : \neg F$

$y : \neg E$

$y : \exists p.G$

$(y, t') : G$

$t' : G$

$t' : \neg(A \sqcap \exists P.G)$

$t' : \neg A$

$t' : \exists P.G$

$(t', t'') : P$

$(t'' : G)$