EECS 4401/5326 Assignment 2 Solutions WI 22

1) a) $KB = \{ \forall x.\ LatinAm(x) \wedge \neg Ab_{LA}(x) \supset SpanSpkr(x),$
$\forall x.\ Brazilian(x) \supset LatinAm(x),$
$\forall x.\ Brazilian(x) \wedge \neg Ab_B(x) \supset \neg SpanSpkr(x),$
$Brazilian(Joao) \}$

In all minimal interpretations of KB $\mathcal{I}$
$\mathcal{I} \models Brazilian(Joao) \wedge LatinAm(Joao)$
But the interpretation $\mathcal{I}_1 = \langle D_1, I_1 \rangle$
where $D_1 = \{ Joao \}$, $I_1(Joao) = Joao$,
$I_1(Ab_B) = I_1(Brazilian) = I_1(LatinAm) = \{ Joao \}$
$I_1(SpanSpkr) = I_1(Ab_{LA}) = \{ Joao \}$
is minimal and $\mathcal{I}_1 \not\models \neg SpanSpkr(Joao)$
So $KB \not\models_{\leq} \neg SpanSpkr(Joao)$

b) Let $KB' = KB \cup \{ \forall x Brazilian(x) \supset Ab_{LA}(x) \}$
Then in all interpretations of KB' $\mathcal{I}$
$\mathcal{I} \models Brazilian(Joao) \wedge LatinAm(Joao) \wedge Ab_{LA}(Joao)$
The interpretation satisfy $\forall x\ \neg Ab_B(x)$ and
$\neg SpanSpkr(Joao)$

On the other hand for $KB'' = KB \cup$
$\{ \forall x.\ Brazilian(x) \wedge \neg Ab_B(x) \supset Ab_{LA}(x) \}$
$\mathcal{I}_1$ mentioned in a is still a minimal interpretation
of KB' and $KB'' \not\models_{\leq} \neg SpanSpkr(Joao)$

1 c) KB is the default theory $(\{b, b \supset l\}, \{b \Rightarrow \neg s, l \Rightarrow s\})$

There are 2 extensions

$$E_1 = \{\phi \mid b \wedge l \wedge \neg s \models \phi\} \quad (\Delta = \{\neg s\})$$

and

$$E_2 = \{\phi \mid b \wedge l \wedge s \models \phi\} \quad (\Delta = \{s\})$$

It is easy to check that these satisfy the definition of extension

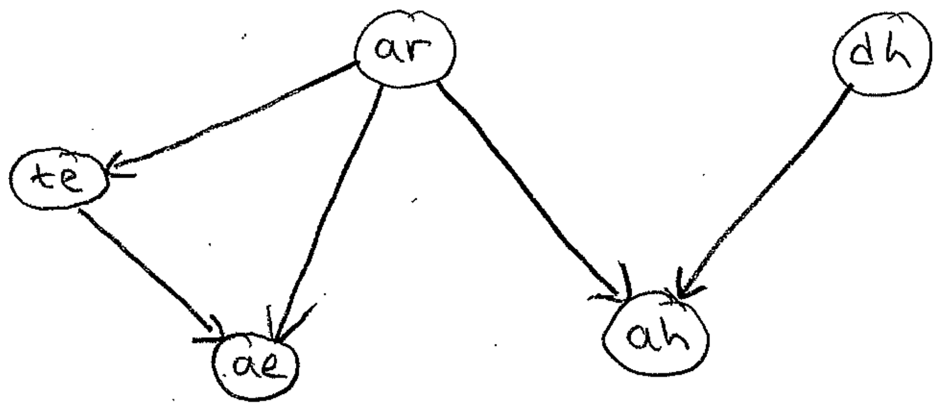
d) For $KB' = (\{b, b \supset l\}, \{\frac{l : \neg b}{s}, b \Rightarrow \neg s\})$ $\left(\frac{l : \neg b \wedge s}{s} \text{ is also ok}\right)$

there is only 1 extension

$$E = \{\phi \mid b \wedge l \wedge \neg s \models \phi\} \quad (\Delta = \{\neg s\})$$

since the non-normal default rule is not applicable as $\{b, b \supset l\} \models q \wedge \neg\neg q$ so $\neg\neg q \in E$ and then $\neg q$ is not consistent

2 a) [B+L ch 12 exercise 4]



b) $Pr(te \mid ar, dh) = Pr(te \mid ar)$

$Pr(ab \mid ar, dh, te, ae) = Pr(ah \mid ar, dh)$

...

c) $J(AR, DH, TE, AE, AH) =$

$Pr(AR) \cdot Pr(TE \mid AR) \cdot Pr(AE \mid AR, TE)$

$\cdot\ Pr(DH) \cdot Pr(AH \mid AR, DH)$

2 d) (a) $Pr(ar) = .001$

$Pr(dh) = .01$ ⇐ most likely

$Pr(te) = Pr(te \mid ar) \cdot Pr(ar) +$

$Pr(te \mid \neg ar) \cdot (1 - Pr(ar))$

$= .0001 \cdot .001 + .01 \cdot .999$

$.0000001 + .00999 = .0099901$

2 d) (b)

$$Pr(av \mid ae) = \frac{Pr(av) \cdot Pr(ae \mid av)}{Pr(ae)}$$ by Byesrule

$Pr(av) = .001$

$$Pr(ae \mid av) = Pr(av) \cdot Pr(te \mid av) \cdot Pr(ae \mid av, te) + Pr(av) \cdot (1 - Pr(te \mid av)) \cdot Pr(ae \mid av, \overline{te})$$

$= .001 \cdot .0001 \cdot .1 + .001 \cdot .9999 \cdot .99 =$

$= 1 \times 10^{-8} + .000989901 = .00099$

$$Pr(ae \mid \overline{av}) = (1 - Pr(av)) \cdot Pr(te \mid \overline{av}) \cdot Pr(ae \mid te, \overline{av}) + (1 - Pr(av)) \cdot (1 - Pr(te \mid \overline{av})) \cdot Pr(ae \mid \overline{te}, \overline{av})$$

$= .999 \cdot .01 \cdot .99 + .999 \cdot .99 \cdot .0001$

$= .0098901 + .0000989 = .009989989$

$Pr(ae) = Pr(ae \mid av) + Pr(ae \mid \overline{av})$

$= .0108898$

So

$$Pr(av \mid ae) = \frac{.001 \cdot .00099}{.0108898} = \frac{.00000099}{.0100\,8898} \approx .000$$

2 d)(b) continued

$$Pr(te \mid ae) = \frac{Pr(te) \cdot Pr(ae \mid te)}{Pr(ae)} \quad \text{by Bayes Rule}$$

$$Pr(te) = Pr(te \mid ar) \cdot Pr(ar) + Pr(te \mid \overline{ar}) \cdot (1 - Pr(ar))$$

$$= .001 \cdot .00001 + .999 \cdot .01 \approx .0099$$

$$Pr(ae \mid te) = Pr(ar) \cdot Pr(te \mid ar) \cdot Pr(ae \mid ar, te) + (1 - Pr(ar)) \cdot Pr(te \mid \overline{ar}) \cdot Pr(ae \mid \overline{ar}, te)$$

$$= .001 \cdot .00001 \cdot .1 + .999 \cdot .01 \cdot .99$$

$$\approx .0098901$$

$$Pr(te \mid ae) = \frac{.0099 \cdot .0098901}{.018898} = .005181$$

$$Pr(dh \mid ae) = Pr(dh) = .01 \Leftarrow \text{most likely}$$

2 d) (c) sketch $Pr(ar \mid ah, ae)$

$Pr(dh \mid ah, ae)$

$Pr(te \mid ah, ae)$

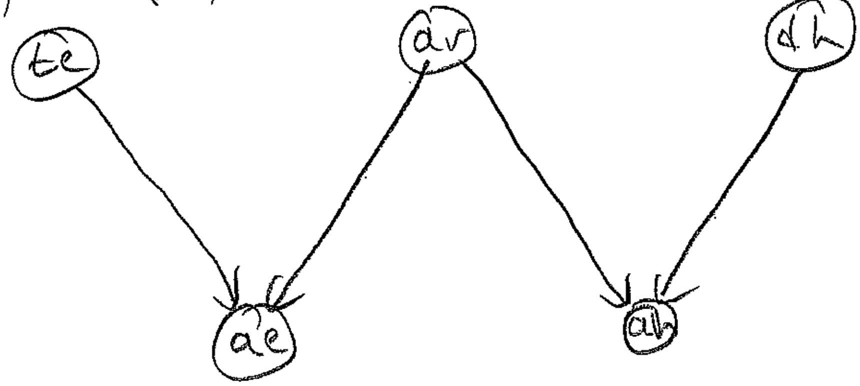
$$Pr(ar \mid ah, ae) = \frac{Pr(ar \cap ah \cap ae)}{Pr(ah \cap ae)}$$

$$
\begin{aligned}
Pr(ar \cap ah \cap ae) &= \sum J(ar, DH, TE, ae, ah) \\
&= J(ar, dh, te, ae, ah) + \\
&\quad J(ar, dh, \overline{te}, ae, ah) + \\
&\quad J(ar, \overline{dh}, te, ae, ah) + \\
&\quad J(ar, \overline{dh}, \overline{te}, ae, ah) \\
&= Pr(ar) \cdot Pr(te \mid ar) \cdot Pr(ae \mid ar, te) \cdot Pr(dh) \cdot \\
&\quad Pr(ah \mid ar, dh) + \\
&\quad Pr(ar) \cdot (1 - Pr(te \mid ar)) \cdot Pr(ae \mid ar, \overline{te}) \cdot Pr(dh) \cdot \\
&\quad Pr(ah \mid ar, dh) + \\
&\quad Pr(ar) \cdot Pr(te \mid ar) \cdot Pr(ae \mid ar, te) \cdot \\
&\quad (1 - Pr(dh)) \cdot Pr(ah \mid ar, \overline{dh}) + \\
&\quad Pr(ar) \cdot (1 - Pr(te \mid ar)) \cdot Pr(ae \mid ar, \overline{te}) \cdot \\
&\quad (1 - Pr(dh)) \cdot Pr(ah \mid ar, \overline{dh})
\end{aligned}
$$

other conditional probabilities can be computed in a similar way

Sketch

2 d)(d) $Pr(te) = .00999$ $\quad Pr(ar) = .001$ $\quad Pr(dh) = .01$ most likely



Then

$$J(AR, DH, TE, AE, AH) =$$
$$Pr(AR) \cdot Pr(DH) \cdot Pr(TE) \cdot Pr(AE \mid AR, TE) \cdot Pr(AH \mid AR, DH)$$

conditional probabilities can be calculated as before

Ch 14 Blocks World example exercises

3 a) $Poss(puton(x,y),s) \equiv x \neq y \wedge$
$\neg \exists z\, On(z,y,s) \wedge \neg \exists z\, On(z,x,s)$

$Poss(putonTable(x),s) \equiv \neg \exists z\, On(z,x,s)$

b) $On(x,y,do(puton(x,y),s))$

$\neg On(x,y,do(putonTable(x),s))$

$z \neq y \supset \neg On(x,y,do(puton(x,z),s))$

$OnTable(x,do(putonTable(x),s)$

$\neg OnTable(x,do(puton(x,y),s))$

c)

$$On(x, y, do(a, s)) \equiv$$
$$a = puton(x, y) \lor$$
$$On(x, y, s) \land \neg \exists z (a = puton(x, z) \land z \neq y)$$
$$\land\ a \neq putonTable(x)$$

$$OnTable(x, do(a, s)) \equiv a = putOnTable(x) \lor$$
$$OnTable(x, s) \land \neg \exists y\ a = puton(x, y)$$

d) I - argue that Effects $\not\models$ SSA with counter e.g.

Here is one:

$On(A, B, S_0)$ $\qquad$ $x \neq y$ for all distinct $x, y \in \{A\,B\,C\,D\}$
$On(C, D, S_0)$
$\neg On(C, D, do(putonTable(A), S_0))$
$Ontable(B, S_0)$ $\quad$ $Ontable(D, S_0)$

This is consistent with the effects and precondition axioms, but it is inconsistent with the SSA.

e) explanation closure axioms written as frame axioms

$$On(x,y,s) \wedge a \neq putonTable(x) \wedge \neg\exists z\,(a = puton(x,z) \wedge z \neq y)$$
$$\supset on(x,y,do(a,s)))$$

$$\neg on(x,y,s) \wedge a \neq puton(x,y) \supset \neg on(x,y,do(a,s)))$$

$$Ontable(x,s) \wedge \neg\exists y\; a = puton(x,y) \supset Ontable(x, do(a,s))$$

$$\neg ontable(x,s) \wedge a \neq putOntable(x) \supset \neg ontable(x, do(a,s))$$

These are easily seen to be entailed by the SSAs.

4a) Goal

$\exists s. On(A,B,s) \land OnTable(B,s) \land On(D,C,s) \land$
$On(C,F,s) \land Ontable(F,s) \land Ontable(E,s)$

b) $e = do(putOn(D,C), do(putOn(C,F), S_0))$

c) Here I use a $Clear(x,s)$ predicate

$putOn(x,y,z)$
Pre: $Clear(x)$, $Clear(y)$, $On(x,z)$, $x \neq y \neq z$
Del: $On(x,z)$, $Clear(y)$
Add: $On(x,y)$, $Clear(z)$

$putOn(x,y)$
Pre: $Clear(x)$, $Clear(y)$, $OnTable(x)$, $x \neq y$
Del: $OnTable(x)$, $Clear(y)$
Add: $On(x,y)$

$putOntable(x,y)$
Pre: $Clear(x)$, $On(x,y)$, $x \neq y$
Del: $On(x,y)$
Add: $OnTable(x)$, $Clear(y)$

4d) $DB_0 = \{ Clear(A), Clear(C), Clear(E),$
$On(A,B), OnTable(B),$
$On(C,D), On(D,E), OnTable(E),$
$Ontable(F) \}$

Applicable operators + Progression of DB

- $putOn(A,C,B)$ $DB' = DB_0 \setminus \{On(A,B), Clear(C)\}$
  $\cup \{On(A,C), Clear(B)\}$
- $putOn(C,A,D)$ $DB' = DB_0 \setminus \{On(C,D), Clear(A)\}$
  $\cup \{On(C,A), Clear(D)\}$
- $putOn(A,F,B)$ $DB' = DB_0 \setminus \{On(A,B), Clear(F)\}$
  $\cup \{On(A,F), Clear(B)\}$
- $putOn(C,F,D)$ $DB' = DB_0 \setminus \{On(C,D), Clear(F)\}$
  $\cup \{On(C,F), Clear(D)\}$
- $putOn(F,A)$ $DB' = DB_0 \setminus \{ontable(F), Clear(A)\}$
  $\cup \{On(F,A)\}$
- $putOn(F,C)$ $DB' = DB_0 \setminus \{OnTable(F), Clear(C$
  $\cup \{On(F,C)\}$
- $putOntable(A,B)$ $DB' = DB_0 \setminus \{On(A,B)\}$
  $\cup \{Ontable(A), Clear(B)\}$
- $putOntable(C,D)$ $DB' = DB_0 \setminus \{On(C,D)\}$
  $\cup \{OnTable(C), Clear(D)\}$