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Draw

View

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Text Mode



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Assignment 3

Sunday, April 28, 2024

3:51 PM

#1 a) YES

A	B	$\neg(A \wedge B)$	$(\neg A \vee \neg B)$
T	T	F	F
T	F	T	T
F	T	T	T
F	F	T	T

b) YES

P	R	$(P \rightarrow R)$	$(\neg R \rightarrow \neg P)$
T	T	T	T
T	F	F	F
F	T	T	T
F	F	T	T

c) NO

P	R	$(P \rightarrow R)$	$(\neg P \rightarrow \neg R)$
T	T	T	T
T	F	<u>F</u>	<u>T</u>
F	T	<u>T</u>	<u>F</u>
F	F	T	T

d) YES

P	Q	$(P \rightarrow Q)$	$\neg P \vee Q$
T	T	T	T
T	F	F	F
F	T	T	T
F	F	T	T

#2

A	B	C	$A \vee B$	$\neg C \vee A$
T	T	T	T	T
T	T	F	T	T
T	F	T	T	T
T	F	F	T	T
F	T	T	T	F
F	T	F	T	T
F	F	T	F	F
F	F	F	F	T



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#3 $S = A \wedge C$ is not entailed by KB

Ex: $A = T, B = T, C = F$ is T for both models in the KB,
but is F for S

A	C	$A \wedge C$
T	T	T
<u>T</u>	<u>F</u>	<u>F</u>
F	T	F
F	F	F

Note: KB logically entails S if all the models that evaluate KB to be true ALSO evaluate S to True

#4 $S = A \vee B \vee C$ is not entailed by KB

Ex: $A = F, B = F, C = F$ is T for $\neg C \vee A$,
but F for S

A	B	C	$A \vee B \vee C$
T	T	T	T
T	T	F	T
T	F	T	T
T	F	F	T
F	T	T	T
F	F	T	T
F	T	F	T
<u>F</u>	<u>F</u>	<u>F</u>	<u>F</u>

#5 Proof by Resolution

KB: $P \vee Q, P \rightarrow R, Q \rightarrow R$

Query: R

Inference → sound - derives only sentences entailed by KB
complete - derives any sentence entailed by KB

a) Put $KB \wedge \neg S$ into CNF (Conjunctive Normal Form): $(P \vee Q) \wedge (\neg P \vee R) \wedge (\neg Q \vee R) \wedge \neg R$

b) Perform sequence of inferences, concluding KB does not entail S:

#1 $(P \vee Q) \wedge (\neg P \vee R) \wedge (\neg Q \vee R) \wedge \neg R$

#2 $(P \vee Q) \wedge \neg P \wedge \neg Q \rightarrow \text{Nothing!!}$ Thus, empty C) and KB entails S

#6 Proof by Resolution

KB: $P \rightarrow Q, \neg P \rightarrow R$ Query: $\neg Q \rightarrow \neg R$ a) Put $KB \wedge \neg S$ into CNF (Conjunctive Normal Form): $(\neg P \vee Q) \wedge (P \vee R) \wedge (Q \wedge R)$

b) Perform sequence of inferences, concluding KB does not entail S:

#1 $(\neg P \vee Q) \wedge (P \vee R) \wedge (Q \wedge R)$

#2 $(Q \vee R) \wedge (Q \wedge R) \rightarrow \text{No way to get an empty C), KB does not entail S}$

Home

Insert

Draw

View

Class Notebook

Text Mode

Lasso Select

Insert Space

but F for S

A	B	C	$A \vee B \vee C$
T	T	T	T
T	T	F	T
T	F	T	T
T	F	F	T
F	T	T	T
F	T	F	T
F	F	T	T
F	F	F	F

#5 Proof by Resolution

KB: $P \vee Q$, $P \rightarrow R$, $Q \rightarrow R$ Query: R

Inference \rightarrow sound - derives only sentences entailed by KB
 complete - derives all sentences entailed by KB

a) Put $KB \wedge \neg S$ into CNF (Conjunctive Normal Form):

$$(P \vee Q) \wedge (\neg P \vee R) \wedge (\neg Q \vee R) \wedge \neg R$$

b) Perform sequence of inferences, concluding KB does not entail S:

$$\#1 \quad (P \vee Q) \wedge (\neg P \vee R) \wedge (\neg Q \vee R) \wedge \neg R$$

$\rightarrow \neg P$
 $\rightarrow \neg Q$

#2 $(P \vee Q) \wedge \neg P \wedge \neg Q \rightarrow$ Nothing!! Thus, empty C) and KB entails S

#6 Proof by Resolution

KB: $P \rightarrow Q$, $\neg P \rightarrow R$ Query: $\neg Q \rightarrow \neg R$ a) Put $KB \wedge \neg S$ into CNF (Conjunctive Normal Form):

$$(\neg P \vee Q) \wedge (P \vee R) \wedge (Q \wedge R)$$

b) Perform sequence of inferences, concluding KB does not entail S:

$$\#1 \quad (\neg P \vee Q) \wedge (P \vee R) \wedge (Q \wedge R)$$

#2 $(Q \vee R) \wedge (Q \wedge R) \rightarrow$ No way to get an empty C), KB does not entail S

#7 Proof by Resolution

KB: $(P \rightarrow Q) \vee (R \rightarrow S)$ Query: $\neg(P \rightarrow S) \vee (R \rightarrow Q)$ a) Put $KB \wedge \neg S$ into CNF (Conjunctive Normal Form):

$$(\neg P \vee Q) \vee (\neg R \vee S) \wedge (P \wedge \neg S) \wedge (\neg R \wedge \neg Q)$$

b) Perform sequence of inferences, concluding KB does not entail S:

$$\#1 \quad (\neg P \vee Q) \vee (\neg R \vee S) \wedge (P \wedge \neg S) \wedge (\neg R \wedge \neg Q)$$

$\rightarrow (\neg P \wedge \neg R)$
 $\rightarrow (\neg R \wedge P)$

$$\#2 \quad (\neg P \wedge \neg R) \wedge (\neg R \wedge P)$$

\rightarrow No way to get an empty C), KB does not entail S