CS 4811
March 29, 2017
Wednesday (1)

logic

- model checking
  expensive, complete
-
- forward checking
  cheap, not complete
  (linear)
- resolution
  inbetween
  (search for a proof)

$p \Rightarrow q$ prove q

p

done

forward checking works only on Horn clauses

1 of 2 things must be negative

$p \vee q \vee r$

at most one positive literal in the clause

a disjunction

resolution works only on

$p \rightarrow q$

$\neg p \vee q$

$(p \wedge r) \rightarrow q \equiv \neg(p \wedge r) \vee q$

$\neg p \vee \neg r \vee q$

resolution: clauses

$$\frac{p \vee q \qquad \neg q}{p}$$

$$\frac{p \vee q \qquad \neg q \vee r}{p \vee r}$$

$$\frac{a_1 \vee a_2 \vee a_3 \vee \dots \vee a_n \vee q \qquad \neg q \vee b_1 \vee b_2 \vee \dots \vee b_m}{a_1 \vee a_2 \vee \dots \vee a_n \vee b_1 \vee b_2 \vee \dots \vee b_m}$$

$p \rightarrow q$

p

want to prove q

$(\neg p \vee q) \wedge$

$(p) \wedge$

$(\neg q)$

put the negation of the sentence to be proven into the knowledge base (KB) and show that this will make the KB inconsistent

know q

prove q

$\left.\begin{array}{l} q \\ \neg q \end{array}\right\rangle \bot$

$$\begin{array}{ccccc} \neg p \vee q & & p & & \neg q \\ & q & & & \\ & & \bot & & \end{array}$$

Given $p \rightarrow q$

$r \rightarrow s$

$(p \vee r) \Rightarrow (q \vee s)$

Prove

step 0 negate the sentence to be proven

step 1 put everything in clause form

1. $p \rightarrow q$
2. $r \rightarrow s$
3. $\neg[(p \vee r) \Rightarrow (q \vee s)]$

put all 3 in clause form

rules you need to know

$p \rightarrow q \equiv \neg p \vee q$

$p \leftrightarrow q \equiv (p \rightarrow q) \wedge (q \rightarrow p)$

$\equiv (\neg p \vee q) \wedge (\neg q \vee p)$

$\neg(p \wedge r) \equiv \neg p \vee \neg r$

$\neg(p \vee r) \equiv \neg p \wedge \neg r$

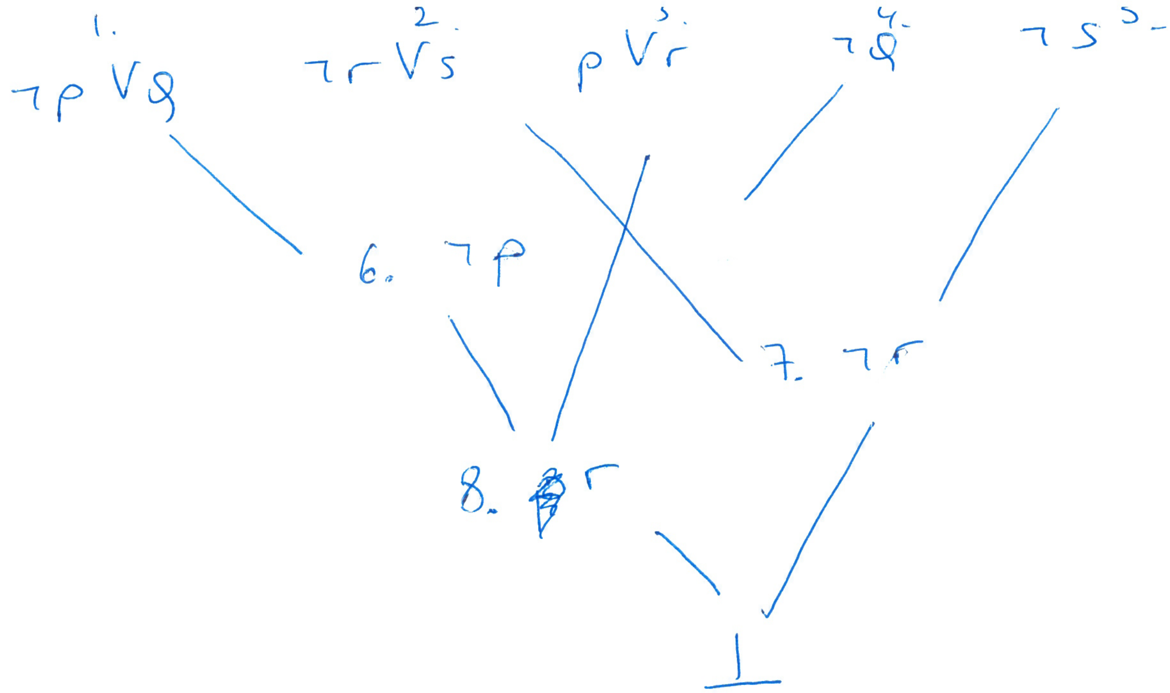
1. $\neg p \vee q$ $\wedge$
2. $\neg r \vee s$ $\wedge$ hidden
3. $p \vee r$ $\wedge$
4. $\neg q$ $\wedge$
5. $\neg s$

$\neg[(p \vee r) \rightarrow (q \vee s)]$

$\neg[\neg(p \vee r) \vee (q \vee s)]$

$(p \vee r) \wedge \neg(q \vee s)$

$(p \vee r) \wedge \neg q \wedge \neg s$



$p \rightarrow q$ prove q

p

$\forall x \; p(x) \rightarrow q(x)$

$\forall x \; p(x)$

$q(a)$

$\forall s \; \text{graduating}(s) \rightarrow \text{happy}(s)$

$\forall s \; \text{graduating}(s)$

$\text{happy}(\text{Jacob})$?

$\forall x \; \neg g(x) \vee h(x)$ $\wedge$

$\forall x \; g(x)$ $\wedge$

$h\cancel{g}(a)$

1. $\neg g(x) \lor h(x)$ 2. $g(x)$ 3. $\neg h\,\cancel{g}(a)$

$h(x)$

$\bot$

objects: $\cancel{a}$, a, b, c

$\forall x \; p(x)$ $p(a) \land p(b) \land p(c)$

taking (lisa, cs4811)

functions backpack (grayson, the black backpack on the front row)

backpack (grayson) $\xrightarrow{\text{return}}$

—	—	—	$p(x)$
0	0		
0	1		

$\forall x \; \cancel{\&}p(x)$

$\exists x \; p(x)$

$p(a_1) \land p(a_2) \land p(a_3)$

$p(a_1) \lor p(a_2) \lor p(a_3)$

(6)

1. $\forall x$ ~~object~~ thing$(x) \Rightarrow$ contains-atom(x)

2. $\forall x$ ~~object~~ thing$(x) \wedge$ contains-atom(x)

Are they the same?

1a. $\forall x$ $\neg$ ~~object~~ thing$(x) \vee$ contains-atom(x)

2. a_1 → tea-bottle, a_2 → happiness

[~~object~~ thing$(a_1) \wedge$ contains-atom(a_1)]

$\wedge$

[~~object~~ thing$(a_2) \wedge$ contains-atom(a_2)]

1a. $\neg$ thing$(a_1) \vee$ contains-atom(a_1)

$\wedge$

$\neg$ thing$(a_2) \vee$ contains-atoms(a_2)

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1. $\exists x$ [here$(x) \wedge$ has-green-t-shirt(x)]

2. $\exists x$ here$(x) \rightarrow$ has-green-t-shirt(x)

↓ all people here have green shirts

$\neg$here(michael)

has-green-t-shirt(michael)

$\exists$ $\wedge$

$\forall$ $\Rightarrow$

$\exists x \quad here(x) \wedge has\text{-}pink\text{-}t\text{-}shirt(x)$ 7

$\exists x \quad here(x) \longrightarrow has\text{-}pink\text{-}t\text{-}shirt(x)$