UCLA Samueli School of Engineering

CS161 WEEK7 DISCUSSION 1C

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Contributed by Shirley and Yewen’s course materials

Agenda

FOL INFERENCE

Midterm

ENTAIL VS IMPLY

- A entails B: B is true wherever A is true
  - It allows (A,B), (-A,B), (-A,-B)
- A implies B: -A v B
  - It allows (A,B), (A,-B), (-A,B)

$\boxed{KB \Rightarrow \alpha}$ X

F F T T

$$\frac{(\alpha \vee \beta),\ \neg\alpha \vee \gamma}{(\beta \vee \gamma)}$$

F

T

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FOL Inference

UNIVERSAL INSTANTIATION

$$\forall x \quad IsStark(x) \Rightarrow Die(x)$$

$$IsStark(Robb) \Rightarrow Die(Robb)$$

EXISTENTIAL INSTANTIATION

$$\exists x \quad IsStark(x) \land Alive(x)$$

$$IsStark(AI) \land Alive(AI)$$

FOL Inference

UNIFICATION

Unifier: an applicable substitution

- Teammate(LBJ, x), Teammate(LBJ, AD)
  - {x/AD}
- Notice: be careful when two sentences use the same variable
  - Teammate(LBJ, x), Teammate(x, AD) -> Cannot unify {x/LBJ, x/AD} X
  - Teammate(LBJ, x), Teammate(y, AD) -> {x/AD, y/LBJ} ✓
- You can also unify two variables
  - Assist(LBJ, x), Assist(y, z) -> {y/LBJ, z/x}

{y/LBJ x/Jones z/Jones} not general

{y/LBJ , z/x} more general

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FOL Inference

SYSTEMATICAL PROCEDURE

1 Build KB
2 Turn KB into CNF
3 Resolution

FOL Inference

PRACTICE

- Jack has a dog. All dog owners are animal lovers. No animal lover kills an animal. Either Jack or curiosity killed the cat named April.
- Did curiosity kill the cat?

FOL Inference

⑤ $Cat(April)$

⑥ $\forall(x)\ Cat(x) \Rightarrow Animal(x)$

$\neg Cat(x) \vee Animal(x)$

PRACTICE

- Build KB with Dog(), Owns(), Animallover(), Animal(), Kill(), Cat(). And convert to CNF

Jack has a dog.

$\exists x: Dog(x) \wedge Owns(Jack, x)$ ①

All dog owners are animal lovers

$\forall(x)\ (\exists y\ Dog(y) \wedge Owns(x, y)) \Rightarrow AnimalLover(x)$

$f(x)$ $f(x)$

$\neg Dog(y) \vee \neg Owns(x, y) \vee AnimalLover(x)$ ②

No animal lovers kill an animal

$\forall x, y\ AnimalLover(x) \wedge Animal(y) \Rightarrow \neg Kill(x, y)$

$\forall x\ AnimalLover \Rightarrow (\forall y\ Animal(y) \Rightarrow \neg Kill(x, y))$

$\neg AnimalLover(x) \vee \neg Animal(y) \vee \neg Kill(x, y)$ ③

Either Jack or curiosity kill April the cat.

$Kill(Jack, April) \vee Kill(c, April)$ ④

$(\neg Kill(C, April))$ $\quad$ $Kill(J, April) \vee Kill(C, April)$

$Kill(J, April)$ $\quad$ $\neg AnimalLover(x) \vee \neg Animal(y) \vee \neg Kill(x, y)$

$\neg AnimalLover(J) \vee \neg Animal(April)$ $\quad$ $Animal(z) \vee \neg Cat(z)$

Sometimes there are hidden rules in paragraph ☆

$\neg AnimalLover(J) \vee \neg Cat(April)$ $\quad$ $Cat(April)$

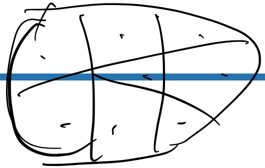
$(\neg AnimalLover(J))$ $\quad$ $\neg Dog \vee \neg Owns \vee AnimalLover$

$\neg Dog(y) \vee \neg Owns(J, y)$ $\quad$ $Dog(D1)$

$\neg Owns(J, D1)$ $\quad$ $Owns(J, D1)$

$\{\ \}$

HW6



LISP Coding – SAT solver for graph coloring problem

Similar to HW4

Some key points

- Use a list of length n*k to record the color. (n=# of nodes, k=# of total colors)
  - We do this because we finally need to turn to SAT solver
- ‘or’ inside a list, ‘and’ between lists

What about "at most"?

"At most one of A, B, C, D is True"

$\Updownarrow$

(All $(x \wedge y)$ are false) ☆

1	2	3	4	5	6 ......
$(x_1$	x_2	x_3	x_4	x_5	x_6 ......$)$
R	G	B	R	G	B
Node1			Node2		

colors(RGB)

$(4 \vee 5) \equiv$ Node2 is either R or G

$(4\ 5\ 6) \equiv$ Node2 has at least 1 color

$$\frac{(\neg\alpha,\ \beta)}{\alpha \Rightarrow \beta} \equiv \frac{(\neg\alpha)\ (\beta)}{(\neg\alpha \vee \beta)}$$

Q&A