

AI2 Module 4
Tutorial 3: Notes on Solutions
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1 Logical Agents: Extending the expressive Power

1.1 Definition for Predicates

a) $\forall i. \forall j. \forall q. Adj(\langle i, j \rangle, q) \Leftrightarrow (q = \langle i - 1, j \rangle \vee q = \langle i + 1, j \rangle \vee q = \langle i, j + 1 \rangle \vee q = \langle i, j - 1 \rangle)$

Diagnostic Rules:

$$Adj(\langle i, j \rangle, q) \Rightarrow (q = \langle i - 1, j \rangle \vee q = \langle i + 1, j \rangle \vee q = \langle i, j + 1 \rangle \vee q = \langle i, j - 1 \rangle)$$

Causal Rules:

$$(q = \langle i - 1, j \rangle \vee q = \langle i + 1, j \rangle \vee q = \langle i, j + 1 \rangle \vee q = \langle i, j - 1 \rangle) \Rightarrow Adj(\langle i, j \rangle, q)$$

b) $\forall p. B(p) \Leftrightarrow \exists q. Adj(p, q) \wedge P(q)$

Diagnostic Rules:

$$B(p) \Rightarrow Adj(p, a(p))$$

$$B(p) \Rightarrow P(a(p))$$

Causal Rules:

$$P(q) \wedge Adj(p, q) \Rightarrow B(p)$$

1.2 Interrogating a FOL KB

- (0) $\Rightarrow OK(\langle 3, 1 \rangle)$
- (1) $W(\langle i, j \rangle) \wedge OK(\langle i, j \rangle) \Rightarrow$
- (2) $S(p) \Rightarrow Adj(p, a(p))$
- (3) $\Rightarrow S(\langle 2, 1 \rangle)$
- (4) $S(p) \Rightarrow W(p, a(p))$
- (5) $Adj(\langle i, j \rangle, q) \Rightarrow (q = \langle i - 1, j \rangle \vee q = \langle i + 1, j \rangle \vee$
 $q = \langle i, j + 1 \rangle \vee q = \langle i, j - 1 \rangle)$
- (6) $(x = y_1 \vee x = y_2 \vee x = y_3 \vee x = y_4) \wedge W(x)$
 $\Rightarrow (W(y_1) \vee W(y_2) \vee W(y_3) \vee W(y_4))$
- (7) $W(\langle 1, 1 \rangle) \Rightarrow$
- (8) $W(\langle 2, 0 \rangle) \Rightarrow$
- (9) $W(\langle 2, 2 \rangle) \Rightarrow$
- (10) $\Rightarrow Adj(\langle 2, 1 \rangle, a(\langle 2, 1 \rangle))$ by (2) & (3)
- (11) $\Rightarrow (a(\langle 2, 1 \rangle) = \langle 1, 1 \rangle \vee a(\langle 2, 1 \rangle) = \langle 3, 1 \rangle \vee$
 $a(\langle 2, 1 \rangle) = \langle 2, 2 \rangle \vee a(\langle 2, 1 \rangle) = \langle 2, 0 \rangle)$ by (5) & (10)
- (12) $\Rightarrow W(\langle 2, 1 \rangle, a(\langle 2, 1 \rangle))$ by (3) & (4)
- (13) $\Rightarrow W(\langle 1, 1 \rangle) \vee W(\langle 3, 1 \rangle) \vee W(\langle 2, 2 \rangle) \vee W(\langle 2, 0 \rangle)$ by (6), (11) & (12)
- (14) $\Rightarrow W(\langle 3, 1 \rangle)$ by (7)–(9) & (13)
- (15) \Rightarrow by (14), (1) & (0)

2 The Situation Calculus

2.1 Effect and Frame Axioms in the Wumpus World

a) $\forall dir1, dir2, x, s. Heading(dir1, s) \wedge Newdir(dir1, x, dir2) \Rightarrow Heading(dir2, Result(turn(x), s))$

b) $\forall sq1, dir, sq2, s. At(sq1, s) \wedge Heading(dir, s) \wedge Next(sq1, dir, sq2) \wedge Wumpus(sq2, s) \Rightarrow \neg Wumpus(sq2, Result(Shoot, s))$

c) $\forall sq1, dir, sq2, sq3, s. At(sq1, s) \wedge Heading(dir, s) \wedge Next(sq1, dir, sq2) \wedge Wumpus(sq3, s) \wedge sq2 \neq sq3 \Rightarrow Wumpus(sq3, Result(Shoot, s))$