Introduction to Artificial Intelligence

Homework 3

0510002

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1. 第一題

|  |  |  |
| --- | --- | --- |
|  | L | R |
| A | 0 | 0 |
| B | 0 | 0 |

1. Episode 1

Q(A, R) ← Q(A, R) + 0.5[10 – Q(A, R)] = 0 + 0.5[10 – 0] = 5

|  |  |  |
| --- | --- | --- |
|  | L | R |
| A | 0 | 5 |
| B | 0 | 0 |

1. Episode 2

Q(A, L) ← Q(A, L) + 0.5[0 + max(Q(B, L), Q(B, R)) – Q(A, L)] = 0 + 0.5[0 + 0 – 0] = 0

|  |  |  |
| --- | --- | --- |
|  | L | R |
| A | 0 | 5 |
| B | 0 | 0 |

Q(B, R) ← Q(B, R) + 0.5[-1000 – Q(B, R)] = 0 + 0.5[-1000 – 0] = -500

|  |  |  |
| --- | --- | --- |
|  | L | R |
| A | 0 | 5 |
| B | 0 | -500 |

1. Episode 3

Q(A, L) ← Q(A, L) + 0.5[0 + max(Q(B, L), Q(B, R)) – Q(A, L)] = 0 + 0.5[0 + 0 – 0] = 0

|  |  |  |
| --- | --- | --- |
|  | L | R |
| A | 0 | 5 |
| B | 0 | -500 |

Q(B, L) ← Q(B, L) + 0.5[200 – Q(B, L)] = 0 + 0.5[200 - 0] = 100

|  |  |  |
| --- | --- | --- |
|  | L | R |
| A | 0 | 5 |
| B | 100 | -500 |

1. Episode 4

Q(A, L) ← Q(A, L) + 0.5[0 + max(Q(B, L), Q(B, R)) – Q(A, L)] = 0 + 0.5[0 + 100 – 0] = 50

|  |  |  |
| --- | --- | --- |
|  | L | R |
| A | 50 | 5 |
| B | 100 | -500 |

Q(B, R) ← Q(B, R) + 0.5[-100 – Q(B, R)] = -500 + 0.5[-100 + 500] = -300

|  |  |  |
| --- | --- | --- |
|  | L | R |
| A | 50 | 5 |
| B | 100 | -300 |

1. Episode 5

Q(A, R) ← Q(A, R) + 0.5[25 – Q(A, R)] = 5 + 0.5[25 – 5] = 15

|  |  |  |
| --- | --- | --- |
|  | L | R |
| A | 50 | 15 |
| B | 100 | -300 |

1. Episode 6

Q(A, L) ← Q(A, L) + 0.5[0 + max(Q(B, L), Q(B, R)) – Q(A, L)] = 50 + 0.5[0 + 100 – 50] = 75

|  |  |  |
| --- | --- | --- |
|  | L | R |
| A | 75 | 15 |
| B | 100 | -300 |

Q(B, L) ← Q(B, L) + 0.5[400 – Q(B, L)] = 100 + 0.5[400 - 100] = 250

|  |  |  |
| --- | --- | --- |
|  | L | R |
| A | 75 | 15 |
| B | 250 | -300 |

1. 第二題
2. Smoke ⇒ Smoke

|  |  |
| --- | --- |
| Smoke | Smoke ⇒ Smoke |
| T | T |
| F | T |

A: valid

1. Smoke ⇒ Fire

|  |  |  |
| --- | --- | --- |
| Smoke | Fire | Smoke ⇒ Fire |
| T | T | T |
| T | F | F |
| F | T | T |
| F | F | T |

A: neither

1. (Smoke ⇒ Fire) ⇒ (¬Smoke ⇒ ¬Fire)

= (¬Smoke ∨ Fire) ⇒ (Smoke ∨ ¬Fire)

= (Smoke ∧ ¬Fire) ∨ (Smoke ∨ ¬Fire)

= (Smoke ∨ Smoke ∨ ¬Fire) ∧ (¬Fire ∨ Smoke ∨ ¬Fire)

= Smoke ∨ ¬Fire

|  |  |  |
| --- | --- | --- |
| Smoke | Fire | Smoke ∨ ¬Fire |
| T | T | T |
| T | F | T |
| F | T | F |
| F | F | T |

A: neither

1. Smoke ∨ Fire ∨ ¬Fire

= Smoke

A: valid

1. ((Smoke ∧ Heat) ⇒ Fire) ⇔ ((Smoke ⇒ Fire) ∨ (Heat ⇒ Fire))

= (((Smoke ∧ Heat) ⇒ Fire) ⇒ ((Smoke ⇒ Fire) ∨ (Heat ⇒ Fire))) ∧ (((Smoke ⇒ Fire) ∨ (Heat ⇒ Fire)) ⇒ ((Smoke ∧ Heat) ⇒ Fire))

= ((¬Smoke ∨ ¬Heat ∨ Fire) ⇒ (¬Smoke ∨ Fire ∨ ¬Heat)) ∧ ((¬Smoke ∨ Fire ∨ ¬Heat) ⇒ (¬Smoke ∨ ¬Heat ∨ Fire))

= 1 ∧ 1

= 1

A: valid

1. Big ∨ Dumb ∨ (Big ⇒ Dumb)

= Big ∨ Dumb ∨ ¬Big ∨ Dumb

= Dumb

A: valid

1. (Big ∧ Dumb) ∨ ¬Dumb

= (Big ∨ ¬Dumb) ∧ (Dumb ∨ ¬Dumb)

= Big ∨ ¬Dumb

|  |  |  |
| --- | --- | --- |
| Big | Dumb | Big ∨ ¬Dumb |
| T | T | T |
| T | F | T |
| F | T | F |
| F | F | T |

A: neither

1. 第三題
2. Propositional-Logic
3. R1: A
4. R2: A ∧ D
5. R3: (A ∧ B ∧ ¬D) ∨ (A ∧ ¬B ∧ D) ∨ (¬A ∧ B ∧ D)
6. R4: D
7. R5: (A ∧ B ∧ ¬C) ∨ (A ∧ ¬B ∧ C) ∨ (¬A ∧ B ∧ C)
8. R6: (B ∧ ¬C) ∨ (¬B ∧ C)
9. CNF
10. R1: A
11. R2: A ∧ D
12. (A ∧ B ∧ ¬D) ∨ (A ∧ ¬B ∧ D) ∨ (¬A ∧ B ∧ D)

= [A ∧ ((B ∧ ¬D) ∨ (¬B ∧ D))] ∨ (¬A ∧ B ∧ D)

= [A ∧ (B ∨ D) ∧ (¬B ∨ ¬D)] ∨ (¬A ∧ B ∧ D)

= (¬A ∨ ¬B ∨ ¬D) ∧ (¬A ∨ B ∨ D) ∧ (A ∨ B) ∧ (B ∨ D) ∧ (A ∨ D)

R3: (¬A ∨ ¬B ∨ ¬D) ∧ (¬A ∨ B ∨ D) ∧ (A ∨ B) ∧ (B ∨ D) ∧ (A ∨ D)

1. R4: D
2. (A ∧ B ∧ ¬C) ∨ (A ∧ ¬B ∧ C) ∨ (¬A ∧ B ∧ C)

= [A ∧ ((B ∧ ¬C) ∨ (¬B ∧ C))] ∨ (¬A ∧ B ∧ C)

= [A ∧ (B ∨ C) ∧ (¬B ∨ ¬C)] ∨ (¬A ∧ B ∧ C)

= (¬A ∨ ¬B ∨ ¬C) ∧ (¬A ∨ B ∨ C) ∧ (A ∨ B) ∧ (B ∨ C) ∧ (A ∨ C)

R5: (¬A ∨ ¬B ∨ ¬C) ∧ (¬A ∨ B ∨ C) ∧ (A ∨ B) ∧ (B ∨ C) ∧ (A ∨ C)

1. (B ∧ ¬C) ∨ (¬B ∧ C)

= (B ∨ C) ∧ (¬B ∨ ¬C)

1. Truth Value
2. A is true because of R1
3. D is true because of R4
4. (¬B ∨ ¬C), (A ∨ C) => (A ∨ ¬B)

(¬A ∨ ¬B ∨ ¬D), (A ∨ ¬B) => (¬B ∨ ¬D)

D, (¬B ∨ ¬D) => ¬B

B is false

1. (¬A ∨ ¬B ∨ ¬D), (¬A ∨ B ∨ C) => (¬A ∨ C ∨ ¬D)

(A ∨ C), (¬A ∨ C ∨ ¬D) => (C ∨ ¬D)

D, (C ∨ ¬D) => C

C is true

1. 第四題
2. Sentence
3. ∀x ¬At(Wumpus, x) ∧ ¬Pit(x) ⇔ Safe(x)
4. ∀x (∃y Pit(y) ∧ Adjacent(x, y)) ⇔ Breezy(x)
5. ∀x (∃y At(Wumpus, y) ∧ Adjacent(x, y)) ⇔ Smelly(x)
6. ∀x At(Wumpus, x) ⇒ ¬Pit(x)
7. Proof
8. The square (1, 1) is safe

Safe(s11)

1. The square (2, 1) is smelly

Smelly(s21)

1. The square (1, 2) is smelly

Smelly(s12)

1. CNF of sentence 1

∀x ¬At(Wumpus, x) ∧ ¬Pit(x) ⇔ Safe(x)

= > [¬At(Wumpus, x) ∧ ¬Pit(x) ⇒ Safe(x)] ∧ [Safe(x) ⇒¬At(Wumpus, x) ∧ ¬Pit(x)]

= > [At(Wumpus, x) ∨ Pit(x) ∨ Safe(x)] ∧ [¬Safe(x) ∨ (¬At(Wumpus, x) ∧ ¬Pit(x))]

= > [At(Wumpus, x) ∨ Pit(x) ∨ Safe(x)] ∧ [¬Safe(x) ∨ ¬At(Wumpus, x)] ∧ [¬Safe(x) ∨ ¬Pit(x))]

1. CNF of sentence 2

∀x (∃y Pit(y) ∧ Adjacent(x, y)) ⇔ Breezy(x)

= > [(∃y Pit(y) ∧ Adjacent(x, y)) ⇒ Breezy(x)] ∧ [Breezy(x) ⇒ (∃y Pit(y) ∧ Adjacent(x, y))]

= > [¬Pit(y) ∨ ¬Adjacent(x, y) ∨ Breezy(x)] ∧ [¬Breezy(x) ∨ (Pit(G(x)) ∧ Adjacent(x, G(x)))]

= > [¬Pit(y) ∨ ¬Adjacent(x, y) ∨ Breezy(x)] ∧ [¬Breezy(x) ∨ Pit(G(x))] ∧ [¬Breezy(x) ∨ Adjacent(x, G(x))]

1. CNF of sentence 3

∀x (∃y At(Wumpus, y) ∧ Adjacent(x, y)) ⇔ Smelly(x)

= > [(∃y At(Wumpus, y) ∧ Adjacent(x, y)) ⇒ Smelly(x)] ∧ [Smelly(x) ⇒ (∃y At(Wumpus, y) ∧ Adjacent(x, y))]

= > [¬At(Wumpus, y) ∨ ¬Adjacent(x, y) ∨ Smelly(x)] ∧ [¬Smelly(x) ∨ (At(Wumpus, G(x)) ∧ Adjacent(x, G(x)))]

= > [¬At(Wumpus, y) ∨ ¬Adjacent(x, y) ∨ Smelly(x)] ∧ [¬Smelly(x) ∨ At(Wumpus, G(x))] ∧ [¬Smelly(x) ∨ Adjacent(x, G(x))]

1. CNF of sentence 4

∀x At(Wumpus, x) ⇒ ¬Pit(x)

= > ¬At(Wumpus, x) ∨ ¬Pit(x)

1. Solution

From Smelly(s21), [¬Smelly(x) ∨ At(Wumpus, G(x))] 得At(Wumpus, G(s21)) 其中x/s21

From Smelly(s21), [¬Smelly(x) ∨ Adjacent(x, G(x))] 得Adjacent(s21, G(s21)) 其中x/s21

From Smelly(s12), [¬Smelly(x) ∨ At(Wumpus, G(x))] 得At(Wumpus, G(s12)) 其中x/s12

From Smelly(s12), [¬Smelly(x) ∨ Adjacent(x, G(x))] 得Adjacent(s12, G(s12)) 其中x/s12

Adjavent(s21, y) ⇒ (y=s11) ∨ (y=s22) ∨ (y=s31) 得 ¬Adjavent(s21, y) ∨ (y=s11) ∨ (y=s22) ∨ (y=s31)

From Adjacent(s21, G(s21)), ¬Adjavent(s21, y) ∨ (y=s11) ∨ (y=s22) ∨ (y=s31) 得 (G(s21)=s11) ∨ (G(s21)=s22) ∨ (G(s21)=s31)

From (G(s21)=s11) ∨ (G(s21)=s22) ∨ (G(s21)=s31), At(Wumpus, G(s21)) 得At(Wumpus, s11) ∨ At(Wumpus, s22) ∨ At(Wumpus, s31)

同樣方式找s12的得 At(Wumpus, s11) ∨ At(Wumpus, s22) ∨ At(Wumpus, s13)

From Safe(s11), [¬Safe(x) ∨ ¬At(Wumpus, x)] 得 ¬At(Wumpus, s11) 其中x/s11

From ¬At(Wumpus, s11), At(Wumpus, s11) ∨ At(Wumpus, s22) ∨ At(Wumpus, s31) 得 At(Wumpus, s22) ∨ At(Wumpus, s31)

From ¬At(Wumpus, s11), At(Wumpus, s11) ∨ At(Wumpus, s22) ∨ At(Wumpus, s13) 得 At(Wumpus, s22) ∨ At(Wumpus, s13)

From negation goal(¬At(Wumpus, s22)), At(Wumpus, s22) ∨ At(Wumpus, s31) 得 At(Wumpus, s31)

From negation goal(¬At(Wumpus, s22)), At(Wumpus, s22) ∨ At(Wumpus, s13) 得 At(Wumpus, s13)

只有一個wumpus

∀x, y At(Wumpus, x) ∧ At(Wumpus, y) ⇒ (x = y)

CNF of it: ¬At(Wumpus, x) ∨ ¬At(Wumpus, y) ∨ (x = y)

From At(Wumpus, s31), At(Wumpus, s13), ¬At(Wumpus, x) ∨ ¬At(Wumpus, y) ∨ (x = y) 得 (s31 = s13) 其中x/s31, y/s13

Square是unique的

¬ (s31 = s13)

From (s31 = s13), ¬ (s31 = s13) 得 empty

= > KB ∧ negation goal unsatisfiable

= > KB entails At(Wumpus, s22)