Question Paper

3b)

I i) Every real number has its corresponding negative

$\forall x (RealNumber(x) \rightarrow \exists y (RealNumber(y) \wedge Negative(y) \wedge corresponds(x, y)))$

ii) Everybody loves somebody

$\forall x \exists y loves(x, y)$

iii) There is somebody whom no one loves

$\exists x \forall y \neg loves(y, x)$

iv) Susan brought everything that Ronald bought

$\forall x (Bought(Ronal, x) \rightarrow Brought(Susan, x))$

v) Parrot is green while rabbit is not

$Green(Parrot) \wedge \neg Green(Rabbit)$

II i) $W1 = \{P(a, x, f(g(y))), P(z, f(z), f(u))\}$

$\{x \rightarrow f(z), z \rightarrow a, y \rightarrow u\}$

ii) $W = \{Q(f(a), g(x)), Q(y, y)\}$

$\{y \rightarrow f(a), g(x) \rightarrow f(a)\}$

4 a)

John likes all kinds of food:

$\forall x (Food(x) \rightarrow likes(John, x))$

Apples are food:

$Food(Apples)$

Chicken is Food:

$Food(Chicken)$

Anything anyone eats isn't killed by is food

$\forall x \forall y (Eats(x, y) \wedge \neg KilledBy(x, y) \rightarrow Food(y))$

Sue eats everything Bill eats

$\forall x (Eats(Bill, x) \rightarrow Eats(Sue, x))$

Bill eats peanut and is still alive:

Eats (Bill, Peanuts) $\wedge$ $\neg$ KilledBy(Bill, Peanuts)

Proof using Forward chaining:

$\rightarrow$ Eats (Bill, Peanuts) $\wedge$ $\neg$ KilledBy (Bill, Peanuts)

$\rightarrow$ Food (Peanuts)

$\rightarrow$ Food (Peanuts) $\rightarrow$ likes (John, Peanuts)

$\rightarrow$ likes (John, Peanuts)

Proof using Backward Chaining

To prove likes (John, Peanuts) check Food (Peanuts)

(4) $\Rightarrow$ Food(y) is true

Eats (x, y) $\wedge$ $\neg$ KilledBy (x, y)

(5) $\Rightarrow$ Eats (Bill, Peanuts) $\wedge$ $\neg$ KilledBy (Bill, Peanuts)

Food (Peanuts) $\Rightarrow$ true

likes (John, Peanuts) is satisfied because Food (Peanuts) is true

$\therefore$ John likes peanuts

4b) leaf node values:

8, 2, 10, 11, 3, 12, 4, 6, 9, 16, 14, 12, 20, 2

level 2 (min nodes)

D = min (8, 2) = 2

E = min (10, 11) = 10

F = min (3, 12) = 3

G = min (4, 6) = 4

L = min (9, 16) = 9

M = min (14, 12) = 12

N = min (20, 2) = 2

level 1 (max Nodes)

B = max (3, 10, 3, 4) = 10

C = max (9, 12, 2) = 12

Root Node

A = max (10, 12) = 12

Tree Values:

level 0: A = 12

level 1: B = 10, C = 12

level 2: D = 2, E = 10, F = 3, G = 4, L = 9, M = 12, N = 2

leaf Nodes: 8, 2, 10, 11, 3, 12, 4, 6, 9, 16, 14, 12, 20, ?

Algorithm Pseudocode:

```
function minimax (node, depth, isMaximizingPlayer):
  if node is a leaf node:
    return node.value
  if isMaximizingPlayer:
    best = -∞
    for each child of node:
      val = minimax (child, depth + 1, false)
      best = max (best, val)
    return best
  else:
    best = +∞
    for each child of node:
      val = minimax (child, depth + 1, true)
      best = min (best, val)
    return best
```

3a)

Represent statements in FOL

1) If someone suffers from allergies, they sneeze:
   $\forall x$ (suffersfromAllergies(x) → sneezes(x))

2) If someone lives with a cat and is allergic.
   $\forall x \forall y$ (livesWith(x,y) ∧ Cat(y) ∧ AllergicTo(x,y)
   → suffersfromAllergies(x))

3) Tom is a cat
   Cat(Tom)

4) Mary is allergic to cats:
   $\forall y$ (Cat(y) → AllergicTo(Mary, y))

5) Mary lives with Tom:
   livesWith(Mary, Tom)

Negated Goal: ¬sneezes(Mary)

from ①
1) ¬suffersFromAllergies(x) ∨ sneezes(x)

from ②
2) ¬livesWith(x,y) ∨ ¬Cat(y) ∨ ¬AllergicTo(x,y) ∨
   suffersfromAllergies(x)

from ③
3) Cat(Tom)

from ④
4) ¬Cat(y) ∨ AllergicTo(Mary, y)

from ⑤
5) livesWith(Mary, Tom)

6) ¬sneezes(Mary)

Resolution

from ⑥ and ①

- suffersfromAllergies (Mary)

x = Mary y = Tom

¬ livesWith (Mary, Tom) ∨ ¬ Cat(Tom) ∨ ¬ Allergic(Mary, Tom)

∨ SuffersfromAllergies (Mary)

using ⑤ and ③

¬ AllergicTo (Mary, Tom) ∨ SuffersfromAllergies (Mary)

from ④ with y = Tom

¬ Cat (Tom) ∨ AllergicTo (Mary, Tom)

using ③

AllergicTo (Mary, Tom)

SuffersfromAllergies (Mary)

∴ Sneezes (Mary) ⇒ True

12/12/24