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Q1] 1. Man(Marcus)
2. Pompeian(Marcus)
3. $\forall x(Pompeian(x) \rightarrow Roman(x))$
4. Ruler(Caesar)
5. $\forall x(Roman(x) \rightarrow (LoyalTo(x, Caesar) \vee Hates(x, Caesar)))$
6. $\forall x \exists y(LoyalTo(x, y))$
7. $\forall x \forall y(Ruler(y) \wedge \neg LoyalTo(x, y)) \rightarrow TryAssassinate(x, y))$
8. TryAssassinate(Marcus, Caesar)
9. $\forall x: man(x) \rightarrow person(x)$ [amplied]

Query1: was marcus loyal to Caesar

nil

↓(1)

man(Marcus)

↓(9)

person(Marcus)

↓(8)

person(Marcus) ∧ try Assassinate {Marcus, Caesar}

↓(4)

person(Marcus ∧ try Assassinate {Marcus, Caesar} ∧ ruler (Caesar)

↓(7, substitution)

¬loyalTo(Marcus, Caesar)

Query 2: ~~Do~~ Marcus does not hate Caesar.

Nil

↓

¬loyalTo (Marcus, Caesar) [already proved in query 1]

↓ (2)

Pompeian (Marcus), ¬loyalto (Marcus, Caesar)

↓ (3)

Roman (Marcus), ¬loyalto (Marcus, Caesar)

↓ (5)

hate (Marcus, Caesar)

Q2] Step(2) 1. $\forall x$ (Mary loves x → FootballStar (x))

2. $\forall y$ (¬Passes (y) → ¬Plays(y))

3. Student (John)

4. $\forall z$ (¬Studies (z) → ¬Passes (z))

5. $\forall w$ (¬Plays(w) → FootballStar (w))

6. ¬Studies (John) → ¬loves (Mary, John)

To prove → if John does not study, then Mary does not love John.

Step (1) → Negate the statement to be proved.

John does not study and Mary loves John.

we ~~cand~~ can add the following to set of facts

6. ¬Studies (John)

7. Loves (Mary, John).

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We can then use resolution to derive a contradiction.

8. ¬FootballStar (John) [from 1 and 7]
9. ¬Passes (John) [from 2 and 8]
~~10. ¬Studies (John) [from 9 and 10]~~
10. ¬Studies (John) → ¬Passes (John) (from 4)
11. ¬Studies (John) (from 9 and 10)
12. FootballStar (John) → Plays (John) (from 5)
13. FootballStar (John) (from 1 and 7)
14. ¬~~Passes (John~~ Plays (John) (from 12 and 13)
15. ¬Passes (John) → ¬Plays (John) (from 2)
16. ¬Plays (John) (from 9 and 15)
17. ⊥ (contradiction from, 14 and 16)

Since we have derived a contraction, the negation of the conclusion is unsatisfiable which means that the original inference is valid. Therefore, we have shown that if John does not study, then Mary does not love John.

Q3] ~~Consider the~~

Conclusion :- If John is not a lawyer, then Mary does not date John.

After negating the conclusion, we got :-

Mary ~~does not~~ dates John and John is not a lawyer.

1. $\forall x \forall y\ ((Rides(x,y) \wedge Harley(y)) \rightarrow RoughCharacter(x))$
2. $\forall z \exists y\ (Biker(z) \rightarrow (Rides(z,y) \wedge Harley(y) \vee BMW(y)))$
3. $\forall x \forall y\ ((Rides(x,y) \wedge BMW(y)) \rightarrow Yuppie(x))$
4. $\forall x\ (Yuppie(x) \rightarrow Lawyer(x))$
5. $\forall x \forall y\ ((NiceGirl(x) \wedge RoughCharacter(y)) \rightarrow \neg Dates(x,y))$
6. NiceGirl(Mary)
7. Biker(John)
8. $\neg$Lawyer(John)
9. Dates(Mary, John)

We can then use resolution to derive a contradiction

10. Yuppie(John) (from 3 and 7)
11. Lawyer(John) (from 4 and 10)
12. $\perp$ contradiction (from 8 and 11)

Since we have derived a contradiction, the negation of the conclusion is unsatisfiable, which means that the original inference is valid. Therfore, we have shown that if John is not a lawyer, then Mary does not date John.

Q4] Conclusion - Scrooge is not a child.
Negation of conclusion is → Scrooge is a child.

FOL for facts are as follows-

1. $\forall x\ ((Child(x) \rightarrow Loves(x, Santa))$
2. $\forall y\ (Loves(y, Santa) \rightarrow \forall z\ (Reinder(z) \rightarrow loves(y,z)))$
3. Reindeer(Rudolph) $\wedge$ HasRedNose(Rudolph)
4. $\forall w\ (HasRedNose(w) \rightarrow (weird(w) \vee Clown(w)))$

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5. $\forall v$ (Reindeer $(v) \rightarrow \neg$ Clown(v))
6. $\forall u \forall t$ ((Scrooge $(u) \wedge$ Weird $(t)) \rightarrow$ love(u, t))
7. Child (Scrooge)

We can then use resolution to derive a contradiction:

8. loves (Scrooge, Santa) (from 1 and 7)
9. $\forall z$ (Reindeer$(z) \rightarrow$ loves (Scrooge, z)) (from 2 and 8)
10. loves (Scrooge, rodolph) (from 9 and 3)
11. HasRedNose (Rudolph) (from 3)
12. (Weird (Rudolph) $\vee$ Clown(Rudolph)) (from 4 and 11)
13. $\neg$Clown (Rudolph) (from 5 and 3)
14. Weird (Rudolph) (from 12 and 13)
15. $\neg$loves(Scrooge, Rudolph) (from 6 and 14)
16. $\perp$ contradiction (from 10 and 15)

Since we have derived a ~~contraction~~ contradiction, the negation of the conclusion is unsatisfiable which means that the original inference is valid.
Therefore, we have shown that Scrooge is not a child.

Q5] Conclusion - Fido will die
Negatation of conclusion - Fido will not die

FOL statements for above axioms are:-

1. $\forall x\,(Dog(x) \rightarrow Animal(x))$
2. $Dog(Fido)$
3. $\forall x\,(Animal(x) \rightarrow Die(x))$
4. $\neg Die(Fido)$

using resolution to prove negated statement.

5. $Animal(Fido)$ (from 1 and 2)
6. ~~All~~ $\forall x\,(Animal(x) \rightarrow Die(x))$ (from 3)
7. $Die(Fido)$ (from 5 and 6)
8. $\neg Die(Fido)$ (from 4)
9. $\perp$ (contradiction, from 7 and 8)

Since we have derived a contradiction, the negation of the statement "Fido will die" is unsatisfable, which means that the original statement "Fido will die" is true. Therefore, we have shown that Fido will die.

Q6] ~~Conclu~~ To prove John is happy
Negating above statement → John is not happy

FOL statements :-

1. $(PassHistoryExam(x) \wedge winslottetory(x)) \rightarrow Happ(x)$
2. $(Studies(x) \vee lucky(x)) \rightarrow (\forall y\ PassExams(x, y))$
3. $\neg Studies(John) \wedge Lucky(John)$
4. $Lucky(x) \rightarrow Winslottery(x)$
5. $\neg Happy(John)$

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FOL statements

6. (Studies(x) ∨ Lucky(x)) → PassesExams(x, History) (from 2)
7. ¬Studies(John) → Lucky(John) → PassExam(John, History) [from 6]
8. Lucky(John) → PassExam(John, History) (from 3 and 7)
9. Lucky(John) → WinsLottery(John) (from 4)
10. PassesExam(John History) ∧ WinsLottery(John) (from 3, 8 and 9)
11. Happy(John) (from 1 and 10)
12. ¬Happy(John) (from 5)
13. ⊥ (contradiction from 11 and 12)

Since we have derived a contradiction, the negation of the statement "John is not happy" is unsatisfiable, which means that the original statement "John is happy" is true. Therefore we have shown John is happy

~~Q6~~

Q7] The two tests named A and B are conducted from the detecting of virus. The statements to justify the problems are given below

P(Test A = + / virus = present) = 0.95

P(Test A = + / virus = absent) = 0.1

P(Test B = + / virus = present) = 0.9

$P(\text{Test } A = / \text{virus} = \text{absent}) = 0.05$
$P(\text{Virus} = \text{present}) = 0.01$

Mathematical calculations are applied to find the value of A test which is as given below

$$P(\text{virus} = \text{present} / \text{Test } A) = \frac{\left[\frac{P(\text{test } A = + / \text{virus} = \text{present})}{P(\text{virus} = \text{present})}\right]}{\left[\begin{array}{c} P \text{ test } A = + / \text{virus} = \text{present}) \\ P = (\text{virus} = \text{present}) \\ P(\text{Test } A = + / \text{virus} = \text{absent}) \\ P(\text{virus} = \text{absent}) \end{array}\right]}$$

$$\text{Test } A = \frac{(0.95)(0.01)}{(0.95)(0.01) + (0.1)(0.99)} = \frac{0.0095}{0.0095 + 0.099}$$

$$= \frac{0.0095}{0.1085} = \underline{\underline{0.088}}$$

Mathematical calculations for B ⟹

$$P(\text{virus} = \text{present} / \text{test } B = +) = \frac{\left[\begin{array}{c} P(\text{test } B = + / \text{virus} = \text{present}) \\ P(\text{virus} = \text{present} \end{array}\right]}{\left[\begin{array}{c} P(\text{test } B = + / \text{virus} = \text{present}) \\ P(\text{virus} = \text{present}) \\ P(\text{test } B = + / \text{virus} = \text{absent}) \\ P(\text{virus} = \text{absent}) \end{array}\right]}$$

$$\text{Tes } B = \frac{(0.9)(0.01)}{(0.9)(0.1) + (0.05)(0.99)} = \frac{0.009}{0.0585} = \underline{\underline{0.15}}$$

The value of obtained from B test is higher. Thus, it can be ~~side~~ said that result of B test is more reliable.