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Q1

Lexicon:

- car(X): Person x belongs to Carmichael Gym.
- runner(X): Person X is a runner.
- football(X): Person X is a football player.
- likes(X,Y): Person X likes Y.

English:

- John, Pitt, and Lisa are members of Carmichael gym.
- Each member of this gym is either runner, a football player, or both.
- None of the football players like rain and all the runners like sunny weather..
- Pitt hates whatever John likes, and likes whatever John hates..
- John likes rain and sunny weather.

Conclusion: There is a member of Carmichael gym that is a football player, but not a runner.

∀ ∃ ∧

FOPL:

1. car(john) ∧ car(pitt) ∧ car(lisa)
2. ∀M car(M) => (runner(M) v football(M))
3. ∀X ∀Y [football(X) => ~likes(X, rain)] ∧ [runner(Y) => likes(Y, sunny)]
4. ∀X [likes(john, X) => ~likes(pitt, X)] ∧ [~likes(john, X) => likes(pitt, X)]
5. likes(john, rain) ∧ likes(john, sunny)

Conclusion: ∃M car(M) ∧ football(M) ∧ ~runner(M)

CNF:

1. car(john)
2. car(pitt)
3. car(lisa)
4. ~car(X4) v runner(X4) v football(X4)
5. ~football(X5) v ~likes(X5, rain)
6. ~runner(X6) v likes(X6, sun)
7. ~likes(john, X7) v ~likes(pitt, X7)
8. likes(john, X8) v likes(pitt, X8)
9. likes(john, rain)
10. likes(john, sun)
11. ~car(X11) v ~football(X11) v runner(X11) — negated conclusion
12. ~football(pitt) v runner(pitt) — #11, #1, pitt/X11
13. ~car(pitt) v runner(pitt) — #12, #4, pitt/X4

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14. runner(pitt)	#13, #2
15. likes(pitt, sun)	#14, #6, pitt/X6
16. ~likes(john, sun)	#15, #7, sun/X7
17. []	#16, #10

Yes, “There is a member of Carmichael gym that is a football player, but not a runner” is derivable. In order to perform resolution, I had to use a different technique than 4-part heuristic as I was unable to solve using 4-part heuristic. This is evident in step 12, when I substituted pitt/X11 instead of john/X11 using step 2 instead of step 1.

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Q2

Pictures of graphs are below
Included PNG files of Q2 graphs for further clarity

- Plan graph: q2_plan_graph.PNG
- Solution path: q2_soln_path.PNG
- Mutex: q2_with_mutex.PNG

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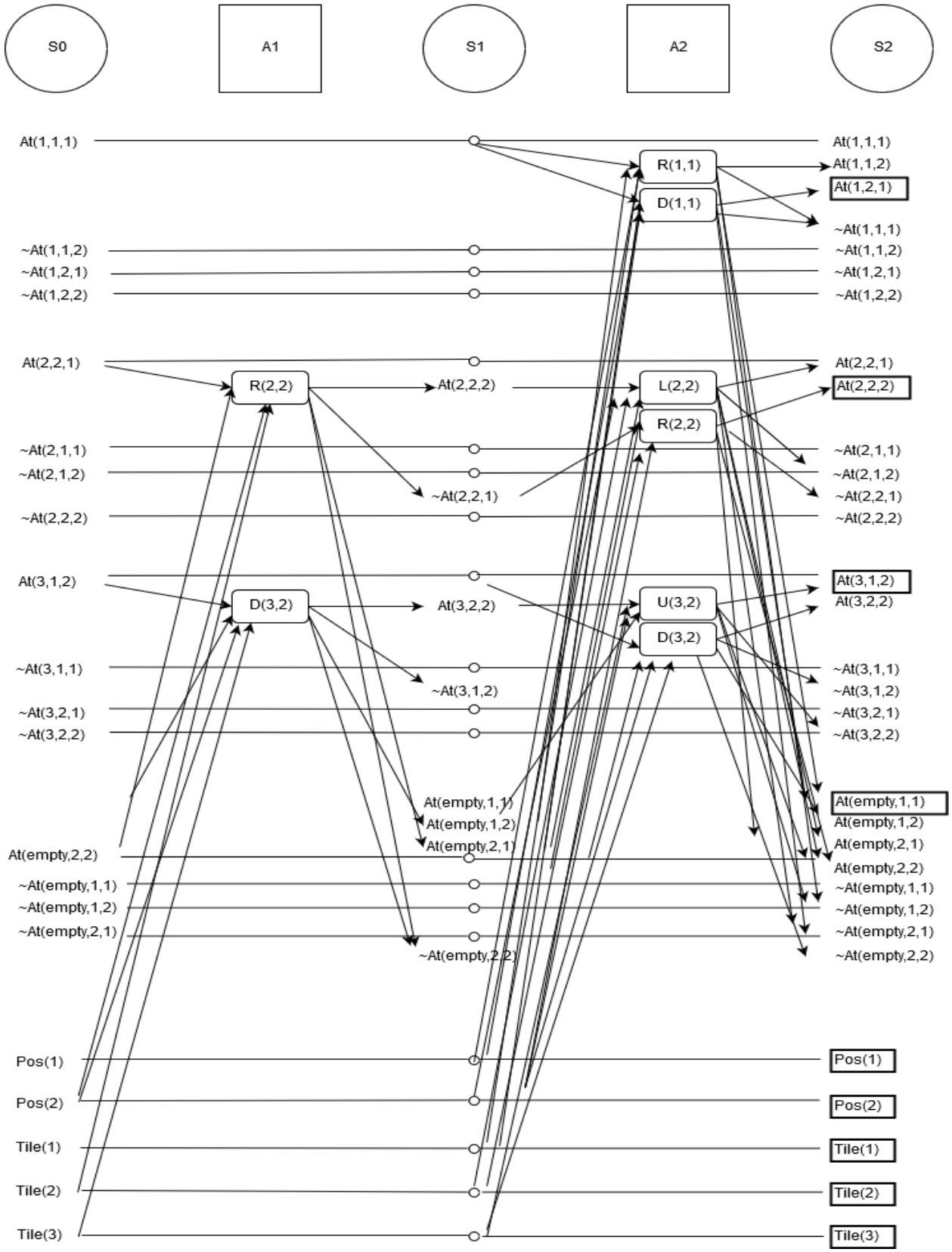
Q2 Plan Graph



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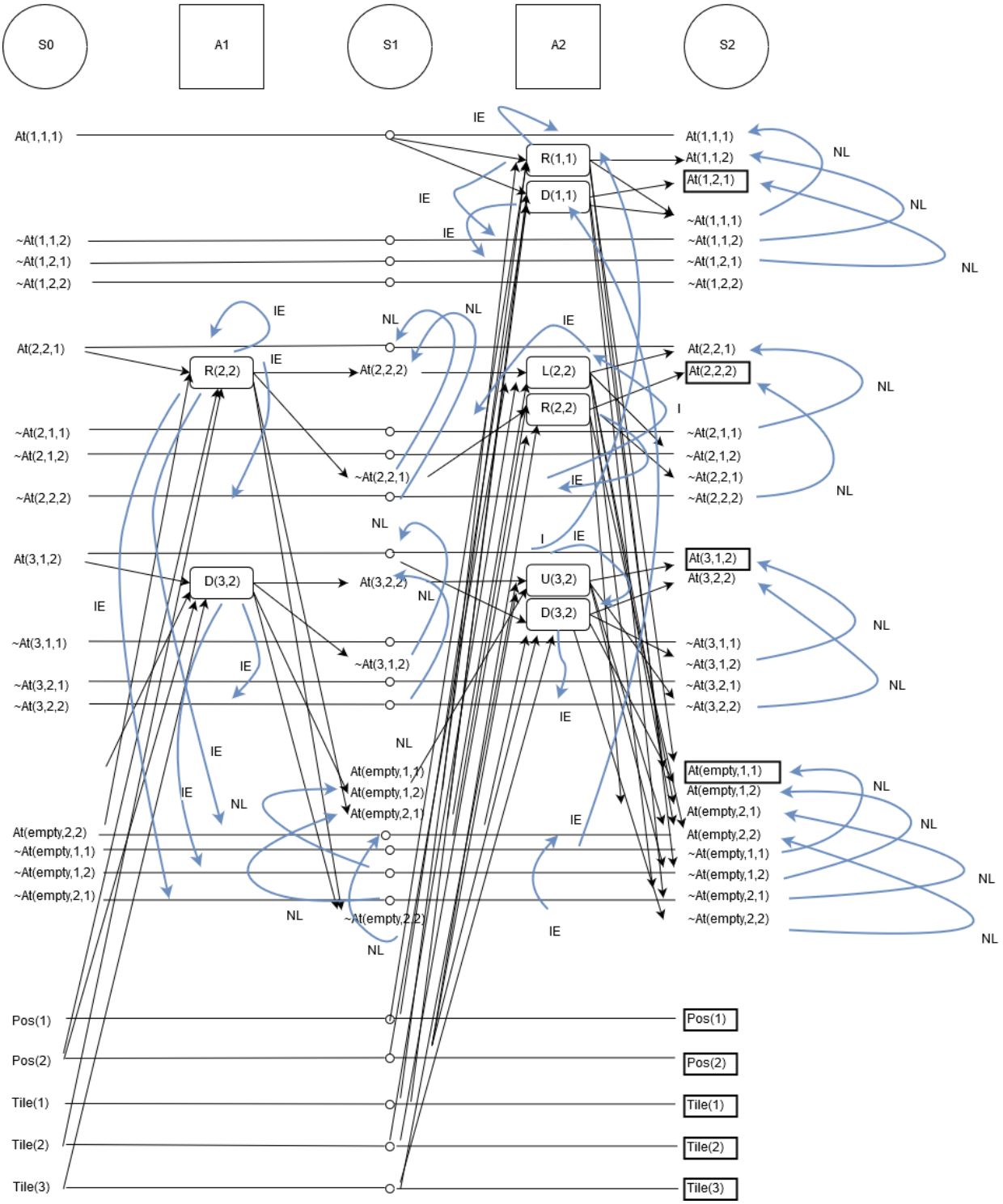
Q2 Plan Graph with Mutex



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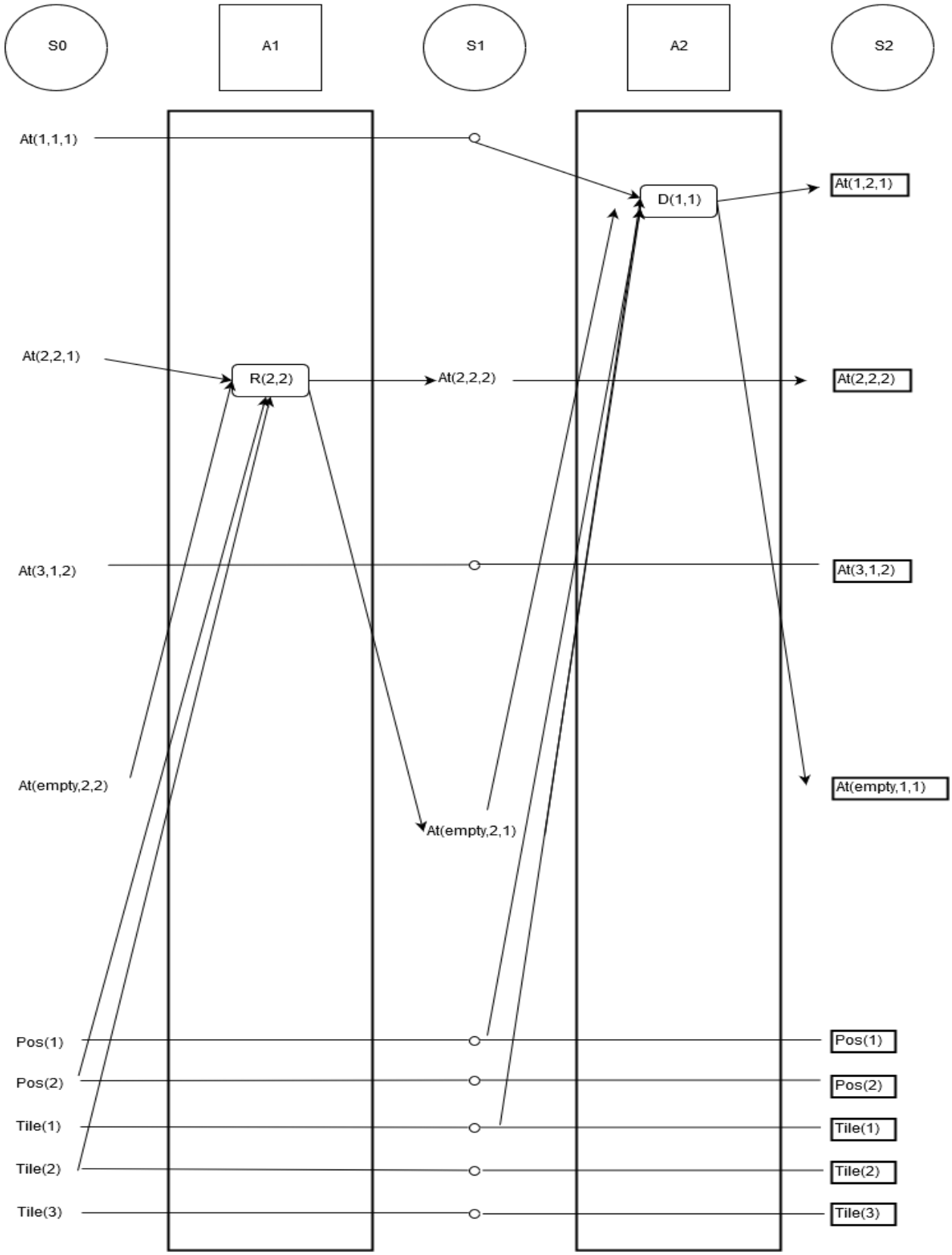
Q2 Solution Path



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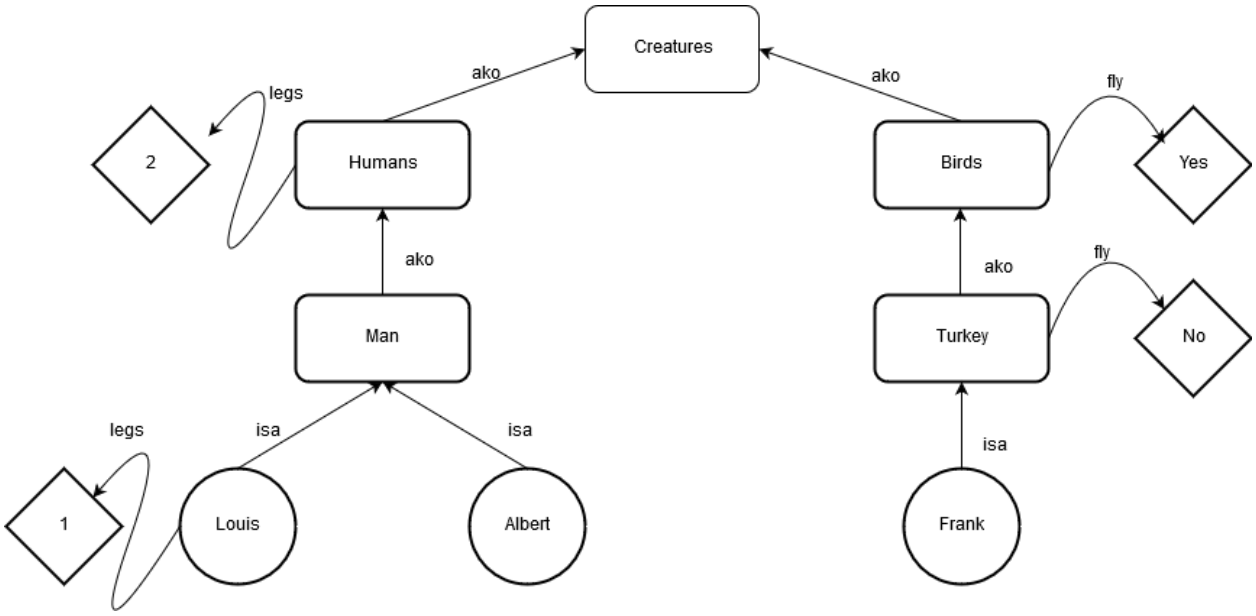
Q3

3.1 and 3.3. Taxonomy Graph



3.2 and 3.4: consult readme and included Prolog file for query answers, Prolog facts and rules

3.2 Inferences for Relations

1. Loius is a man, Louis is a human, Louis is a creature:

```
?- rel(louis, Rel, Group).
Rel = isa,
Group = man ;
Rel = isa,
Group = humans ;
Rel = isa,
Group = creatures ;
```

2. Albert is a man, Albert is a human, and Albert is a creature.

```
?- rel(albert, Rel, Group).
Rel = isa,
Group = man ;
Rel = isa,
Group = humans ;
Rel = isa,
Group = creatures ;
```

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3. Frank is a turkey, Frank is a bird, and Frank is a creature.

```
?- rel(frank, Rel, Group).
Rel = isa,
Group = turkey ;
Rel = isa,
Group = birds ;
Rel = isa,
Group = creatures ;
```

3.4 Inferences for Properties
Louis has one leg

```
?- hasProp(louis, Property, Value).
Property = legs,
Value = one ;
```

Albert has two legs

```
?- hasProp(albert, Property, Value).
Property = legs,
Value = two ;
```

Frank cannot fly

```
?- hasProp(frank, Property, Value).
Property = fly,
Value = no ;
```