Birzeit University

Department of Electrical and Computer Engineering

Faculty of Engineering and Technology

ENCS 3340: Artiticial Intelligence, HW#2 – Logic Instructor: Dr Adnan Yahya Due Date: 21/4/2021

Q1:

a- Use a truth table (Enumeration) to prove modus tollens is sound for proposition logic:

$$\frac{P \rightarrow Q, \quad \neg Q}{\neg P}$$

b- Prove the goal R for propositional logic using Resolution/Refutation.

1. P v Q,
2. P v R,
3. ¬P v R,
4. R v S,
5. R v ¬Q,
6. ¬S v ¬Q

c- Show that the above knowledge base is the clausal form of
   a. (P →Q) →Q,
   b. (P →P) →R,
   c. (R →S) →¬(S →Q)

Q2: Represent the following English sentences in first-order logic:

a. All swans are white.
b. There is a black swan.
c. All bowlers drink soda.
d. Some dogs have fleas.
e. There is somebody who loves everyone.
f. Everybody is loved by someone.
g. There is a barber in Ramallah who shaves all men in Ramallah who do not shave themselves.
h. Politicians can fool some of the people all of the time, and all of the people some of the time, but they can't fool
all of the people all of the time.

Q3: Find the Most General Unifier (MGU), if one exists for the pairs:

1. f(g(x,y), c) and f(g(f(d,x),z),c)
2. h(c,d,g(x,y)) and h(z,d,g(g(a,y),z))
3. P(f(a), g(X)) and P(Y,Y)
4. P(a,X,h(g(Z))) and P(Z,h(Y),h(Y))
5. P(X,X) and P(Y,f(Y))
6. P(a, f(x, a)) and P(a, f(g(y), y))

Q4: Assume KB consists of the following rules:

R1: Soda(x) ^ Chips(y) → Cheaper(x, y)
R2: Chips(x) ^ Cereals(y) → Cheaper(x, y)
R3: Cheaper(x, y) ^ Cheaper(y, z) → Cheaper(x, z)

And the facts:

F1: Soda(Sprite)
F2: Chips(Ruffles)
F3: Cereals(Cheerios)
F4: Cereals(MiniWheats)

a. Assume that all facts F1-F4 are known at the beginning of the inference process. Illustrate the process of forward chaining by listing all newly inferred facts. Assume that both rules and facts are matched and tried in the order of their appearance.

b. Show how to prove Cheaper(Sprite, Cheerios) using backward chaining and the KB given in part

Q5: Prove each of the **Goals:** grandmother(abe, carl) and grandmother(abe, mary) (each separately) by refutation resolution from the following clause set. Is the clause set Horn?

1- grandparent(X, Y) □ ¬parent(X, Z) □ ¬ parent(Z, Y). 2- parent(X, Y) □ ¬father(X, Y).
3- parent(X, Y) □ ¬mother(X, Y).
4- father(abe, bev).
5- mother(bev, carl).
6- mother(bev, mary).