Artificial Intelligence - Homework #2

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Q2) - "If a city which John visits includes a Mexican restaurant, he always eats Taco here."

With FOL:

$$\forall x \exists y \; City(x) \land visit(John, x) \land MexicanRestaurant(y) \land include(x, y) \Rightarrow eatTaco(John, y).$$

In this FOL sentence, John is a constant and x,y are variables. City() and Mexican Restaurant() are predicates, visit(), include() and eatTaco() are functions.

- "Only one team from Turkey competed in the contest.

With FOL:

$$\exists x \forall y \; Team(x) \land from(x, Turkey) \land compete(x, contest) \land Team(y) \land from(y, Turkey) \land compete(y, contest) \Rightarrow x = y.$$

In this FOL sentence, x,y are variables. Turkey and contest are constants. Team() is predicate and from(), compete() are functions.

Q3)

a) Knowledge base: (before converting sentences into CNF)

1. $True(Ayse) \Leftrightarrow LivingRoom(Baris) \wedge \neg LivingRoom(Cem)$.

2. $True(Baris) \Leftrightarrow Garden(Baris) \wedge \neg LivingRoom(Baris)$.

3. $True(Cem) \Leftrightarrow \neg Garden(Ayse) \wedge \neg Garden(Baris)$.

4. $\forall x\ Guilty(x) \Leftrightarrow \neg True(x)$

5. $\forall x,y,z\ True(x) \wedge True(y) \wedge \neg True(z)$.

6. $\forall x\ Garden(x) \vee LivingRoom(x)$.

(For simplicity, I will use first letters of predicates, functions, constants and variables.)

1. $T(A) \Leftrightarrow L(B) \wedge \neg L(C)$.

$(T(A) \Rightarrow (L(B) \wedge \neg L(C))) \wedge ((L(B) \wedge \neg L(C)) \Rightarrow T(A))$

$(\neg T(A) \vee (L(B) \wedge \neg L(C))) \wedge (\neg(L(B) \wedge \neg L(C)) \vee T(A))$.

1. $(\neg T(A) \vee L(B)) \wedge (\neg T(A) \vee \neg L(C)) \wedge (\neg L(B) \vee T(A)) \wedge (L(C) \vee T(A))$

2. $T(B) \Leftrightarrow G(B) \wedge \neg L(B)$.

$(T(B) \Rightarrow (G(B) \wedge \neg L(B))) \wedge ((G(B) \wedge \neg L(B)) \Rightarrow T(B))$

$(\neg T(B) \vee (G(B) \wedge \neg L(B))) \wedge (\neg(G(B) \wedge \neg L(B)) \vee T(B))$

2. $(\neg T(B) \vee G(B)) \wedge (\neg T(B) \vee \neg L(B)) \wedge (\neg G(B) \vee T(B)). \wedge (L(B) \vee T(B))$

3. $T(C) \Leftrightarrow \neg G(A) \wedge \neg G(B)$

$(T(C) \Rightarrow (\neg G(A) \wedge \neg G(B))) \wedge ((\neg G(A) \wedge \neg G(B)) \Rightarrow T(C))$

$(\neg T(C) \vee (\neg G(A) \wedge \neg G(B))) \wedge (\neg(\neg G(A) \wedge \neg G(B)) \vee T(C))$

3. $(\neg T(C) \vee \neg G(A)) \wedge (\neg T(C) \vee \neg G(B)) \wedge (G(A) \vee T(C)) \wedge (G(B) \vee T(C))$

4. $Gu(x) \Leftrightarrow \neg T(x)$

$(Gu(x) \Rightarrow \neg T(x)) \wedge (\neg T(x) \Rightarrow Gu(x))$

$(\neg Gu(x) \vee \neg T(x)) \wedge (\neg(\neg T(x)) \vee Gu(x))$

4. $(\neg Gu(x) \vee \neg T(x)) \wedge (T(x) \vee Gu(x))$

5. $T(x) \wedge T(y) \wedge \neg T(z)$

6. $G(x) \vee L(x)$

a) (cont'd)

KB: (in CNF)

$(\neg T(A) \vee L(B)) \wedge (\neg T(A) \vee \neg L(C)) \wedge (\neg L(B) \vee T(A)) \wedge (L(C) \vee T(A)) \wedge$
$(\neg T(B) \vee G(B)) \wedge (\neg T(B) \vee \neg L(B)) \wedge (\neg G(B) \vee T(B)) \wedge (L(B) \vee T(B)) \wedge$
$(\neg T(C) \vee \neg G(A)) \wedge (\neg T(C) \vee \neg G(B)) \wedge (G(A) \vee T(C)) \wedge (G(B) \vee T(C)) \wedge$
$(\neg Gu(P_1) \vee \neg T(P_1)) \wedge (T(P_1) \vee Gu(P_1)) \wedge T(\theta_1) \wedge T(R_1) \wedge \neg T(S_1) \wedge$
$(G(X_1) \vee L(X_1))$

(Variables are changed with Skolem constants: P_1, θ_1, R_1, S_1, X_1)

b) To find who is guilty among from Ayşe (A), Barış (B) and Cem (C), I will apply resolution inference algorithm to knowledge base and the statement (α).

Let α be statement that I want to prove. If KB stands for knowledge base, then $KB \Rightarrow \alpha$ would be true. $(KB \Rightarrow \alpha) \equiv \neg KB \vee \alpha$. If I use proof by contradiction, if $\neg KB \vee \alpha$ would be true, then $\neg(\neg KB \vee \alpha) \equiv KB \wedge \neg\alpha$ would be false. KB is true, so $\neg\alpha$ would be false. If I can prove that $\neg\alpha$ is false, then I would prove that my statement (α) is true.

My statements are Gu(A) (Ayşe is guilty), Gu(B) (Barış is guilty) and Gu(C) (Cem is guilty).

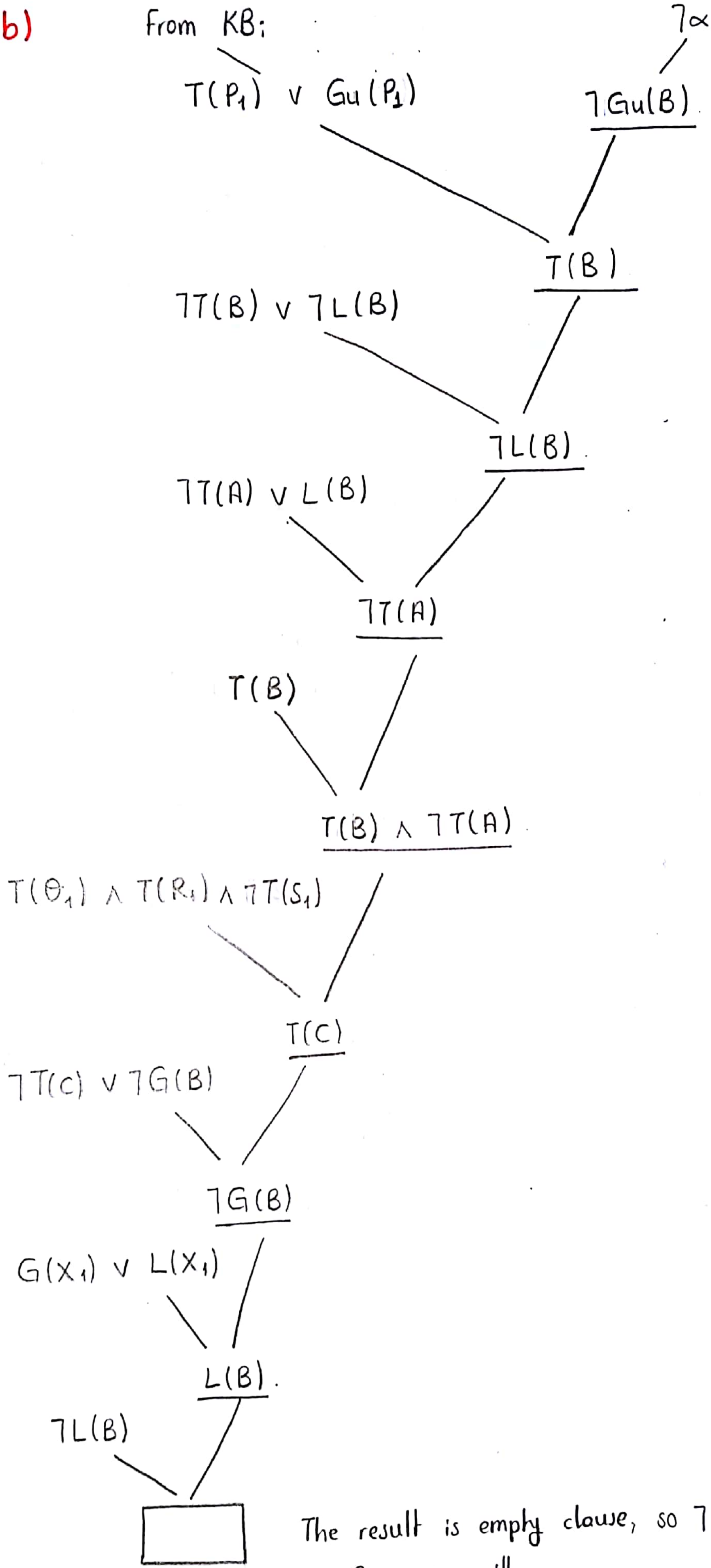
α : Gu(B) (Barış is guilty).

$\neg\alpha$: $\neg$Gu(B)

$KB \wedge \neg\alpha$.

(continue in the next page.)

b)



(P_1, Θ_1, R_1 and S_1 are skölem constants. They can be any person.)

(Clauses which are in left side are already in KB, clauses that are in the right side are added to KB in each step.)

The result is empty clause, so $\neg\alpha$ is false. α is true.

α: Boris is guilty.