CSCE 420: Artificial Intelligence

Homework 3

Due date: 5 November 2023 *Name: Huy Lai*

Problem 1. Proof by resolution. **Solution:**
Translate the following into first-order logic.

Every kid likes Snoopy	$\forall x(K(x) \rightarrow L(x, Snoopy))$
Everyone who likes Snoopy likes all beagles	$\forall x(L(x, Snoopy) \rightarrow (\forall y B(y) \rightarrow L(x, y)))$
Underdog is a beagle, and Underdog is a superhero	$B(Underdog) \wedge S(Underdog)$
Every superhero can fly or time travel	$\forall x(S(x) \rightarrow (F(x) \vee T(x)))$
No beagle can time travel	$\neg\exists x(B(x) \wedge T(x))$
Garfield does not like all things that can fly	$\neg\forall x(F(x) \rightarrow L(Garfield, x))$
Garfield is not a kid. (goal that will be negated latter)	$\neg K(Garfield)$

Convert the resulting formulas into a canonical form

1. $\forall x(K(x) \rightarrow L(x, Snoopy))$
   $\forall x(\neg K(x) \vee L(x, Snoopy))$
2. $\forall x(L(x, Snoopy) \rightarrow \forall y(B(y) \rightarrow L(x, y)))$
   $\forall x \forall y(L(x, Snoopy) \rightarrow (B(y) \rightarrow L(x, y)))$
   $\forall x \forall y(L(x, Snoopy) \rightarrow (\neg B(y) \vee L(x, y)))$
   $\forall x \forall y(\neg L(x, Snoopy) \vee (\neg B(y) \vee L(x, y)))$
   $\forall x \forall y(\neg L(x, Snoopy) \vee \neg B(y) \vee L(x, y))$
3. $B(Underdog) \wedge S(Underdog)$
   $B(Underdog)$
   $S(Underdog)$
4. $\forall x(S(x) \rightarrow (F(x) \vee T(x)))$
   $\forall x(\neg S(x) \vee (F(x) \vee T(x)))$
   $\forall x(\neg S(x) \vee F(x) \vee T(x))$
5. $\neg\exists x(B(x) \wedge T(x))$
   $\forall x \neg(B(x) \wedge T(x))$
   $\forall x(\neg B(x) \vee \neg T(x))$

6. $\neg\forall x(F(x) \rightarrow L(Garfield, x))$
   $\neg\forall x(\neg F(x) \vee L(Garfield, x))$
   $\exists x(F(x) \wedge \neg L(Garfield, x)$
   $F(\alpha) \wedge \neg L(Garfield, \alpha)$
   $F(\alpha)$
   $\neg L(Garfiled, \alpha)$

7. Negated goal: $K(Garfield)$

Resolving negated goal clause with $\neg K(x) \vee L(x, Snoopy)$
$\sigma = \{x/Garfield\}$
$L(Garfield, Snoopy)$

Resolving $L(Garfield, Snoopy)$ with $\forall x\forall y(\neg L(x, Snoopy) \vee \neg B(y) \vee L(x, y))$
$\sigma = \{x/Garfield\}$
$\neg B(y) \vee L(Garfield, y)$

Resolving $\neg B(y) \vee L(Garfield, y)$ with $B(Underdog)$
$\sigma = \{y/Underdog\}$
$L(Garfield, Underdog)$

Resolving $L(Garfield, Underdog)$ with $\neg L(Garfield, \alpha)$
$\sigma = \{\alpha/Underdog\}$
NULL Clause

The statement is proven $\square$

Problem 2. The resolution theorem prover.

Solution:
The resolution theorem prover is included in the submission folder.

Problem 3. Prolog

Solution:
The knowledge base is included in the submission folder as requested.
The queries are translated to prolog as follows:

```
grandparent(charles, X).
brother(william, X), spouse(X, Y).
uncle(X, charlotte).
aunt(X, archie).
nephew(X, harry).
stepmother(X, william).
sibling(X, Y).
cousin(X, Y), female(X).
niece(X, Y).
```

The results are included in `family_results.txt` as requested.