CS 161

HW5

Xiaopei Zhang

004309991

1.

(a). The original propositional logic sentence can be converted to:

The truth table is:

|  |  |  |
| --- | --- | --- |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

From the truth table, we find out that this propositional logic sentence is neither valid nor unsatisfiable.

(b). The original propositional logic sentence can be converted to:

The truth table is:

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

From the truth table, we find out that this propositional logic sentence is neither valid nor unsatisfiable.

(c). The original propositional logic sentence can be converted to:

The truth table is:

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

From the truth table, we find out that this propositional logic sentence is valid.

2.

Variables defined for this question:

, , , and

Their semantics are:

(a). The knowledge base is:

* (I).
* (II).
* (III).
* (IV).

(b). With the help of logic equivalences, we can convert each entry in the knowledge base to a clause or a conjunction.

* (I).
* (II).
* (III).
* (IV).

The CNF version of the knowledge base is:

(c). Let’s give index to each clause appeared in our knowledge base:

* (1).
* (2).
* (3).
* (4).
* (5).
* (6).

To prove the statements mentioned in the question, I use “proof by refutation”:

:

We need to add another entry in the knowledge base, forming , which is

* (7).

Actually, is satisfiable if we assign as the following:

, , , and .

Therefore, the original knowledge base does not entail

:

We need to add another entry in the knowledge base, forming , which is

* (7).

Resolution on (6), (7):

* (8).

Resolution on (4), (8):

* (9).

Resolution on (1), (9):

* (10).

Resolution on (5), (8):

* (11).

Resolution on (3), (11):

* (12).

Resolution on (10), (12):

* (13).

Since we generate an empty clause, we conclude that is inconsistent, which means the original knowledge base entails

:

We need to add another entry in the knowledge base, forming , which is

* (7).

Resolution on (4), (7):

* (8).

Resolution on (1), (8):

* (9).

Resolution on (5), (7):

* (10).

Resolution on (3), (10):

* (11).

Resolution on (9), (11):

* (12).

Since we generate an empty clause, we conclude that is inconsistent, which means the original knowledge base entails

3.

(a).

Algorithm:

:

:

:

(b). Unification fails

Algorithm:

:

:

:

:

(c).

Algorithm:

:

:

:

(d). Unification fails

Algorithms:

:

:

4.

(a). The knowledge base in first-order logic is:

* (1).
* (2).
* (3).
* (4).
* (5).
* (6).
* (7).

(b). The clausal form translated into is:

* (1).
* (2).
* (3).
* (4).
* (5).
* (6a).
* (6b).
* (7).

(c). To prove , I use “proof by refutation”:

We need to add another entry in the knowledge base, forming , which is

* (8).

Resolution on (1), (8):

* (9).

Resolution on (4), (9):

* (10).

Resolution on (6a), (10):

* (11).

Resolution on (5), (11):

* (12).

Resolution on (6b), (12):

* (13).

Since we generate an empty clause, we conclude that is inconsistent, which means the original knowledge base entails

(d). To show , I use “proof by refutation”:

We need to add another entry in the knowledge base, forming , which is

Its clausal form is:

* (8).

Resolution on (7), (8):

* (9).

Resolution on (6a), (9):

* (10).

After this step, the rest of derivation is the same as part (c) after the second step. Therefore, we generate an empty clause at the end, which means is inconsistent with the substitution . That is, the original knowledge base entails

(e). The replacing axioms are as follows:

The first statement can be translated into a clausal form as follows:

In this expression, is a Skolem function of .

Then, the new knowledge base is:

* (1).
* (2).
* (3).
* (4).
* (5).
* (6a).
* (6b).
* (6c).
* (7).

To show , I use “proof by refutation”:

We need to add another entry in the knowledge base, forming , which is

Its clausal form is:

* (8).

Resolution on (7), (8):

* (9).

Resolution on (6a), (9):

* (10).

Resolution on (6b), (10):

* (11).

Resolution on (6c), (11):

* (12).

Resolution on (4), (12):

* (13).

Resolution on (5), (13):

* (14).

Resolution on (6c), (14):

* (15).

Resolution on (6a), (15):

* (16).

Resolution on (6b), (16):

* (17).

Resolution on (6c), (17):

* (18).

In (10), means what Bill eats. Hence, we know that is inconsistent with the substitution . That is, the original knowledge base entails