CSE352 Q2 SOLUTIONS Fall 2019

CONCEPTUALIZATION DEFINITION Conceptualization is step one of formalization of knowledge in declarative form $\mathbf{C} = (\mathbf{U}, \ \mathbf{F}, \ \mathbf{P}, \mathbf{R})$, where $\mathbf{U}$ is a non empty finite set of objects called **universe** of discourse, $\mathbf{F}$ a finite set of functions defined on $\mathbf{U}$, $\mathbf{R}$ is a finite set of relations defined on $\mathbf{U}$.

QUESTION 1

Conceptualize the following situation

In a room there are 3 girls, 2 boys, and 2 cars one red and one blue.

The following properties must be true.

1. *Each girl likes exactly one boy.* **2.** *Some boys like some girls.*

3. *Two boys like a red car.* **4.** *One girl likes a blue car.*

Use as the the universe a set **U = { o1, o2, o3, o4, o5, o6, o7}**

Use as the relations: **R** = { GIRL, BOY, CAR, RCAR, BCAR, LIKE }

Use the **intended interpretation**

SOLUTION

These are MY definitions- you can have different sets of elements defining relations. relations

GIRL = $\{o1, o2, o3\}$, BOY = $\{o4, o5\}$, CAR= $\{o6, o7\}$, RCAR= $\{o6\}$, BCAR= $\{o7\}$

Observe that RCAR $\subseteq$ CAR and BCAR $\subseteq$ CAR

LIKE = LIKE1 $\cup$ LIKE2 $\cup$ LIKE3 $\cup$ LIKE 4, where

LIKE 1 makes *Each girl likes exactly one boy* TRUE and is defined as

LIKE 1 = $\{(o1, o4), \ (o2, o4), \ (o3, o5)\}$

LIKE 2 makes *Some boys like some girls* TRUE and is defined as

LIKE 2 = $\{(o4, o1)\}$

LIKE 3 makes *Two boys like a red car* TRUE and is defined as

LIKE 3 = $\{(o4, o6), \ (o5, o6)\}$

LIKE 4 makes *One girl likes a blue car* TRUE and is defined as

LIKE 4 = $\{(o2, o7)\}$

QUESTION 2

Here is a small set of RULES proposed for a simple rule-based system **S** for dealing with cars

R1 IF car is broken AND old AND income is small THEN repair it

R2 IF car is broken AND old AND do not repair AND income is medium THEN buy a used car

R3 IF car is broken AND is not old AND income is large THEN buy a new car

P1. WRITE the rules **R1, R2, R3** of the system **S** in **propositional convention 1**, i.e. as rules

$A_1 \cap A_2 \cap \cdots \cap A_n \Rightarrow C$ where $A_1, A_2, \ldots A_n, C$ are **atomic** formulas or **negations** of atomic formulas

Solution

ATOMIC FORMULAS are: A, B, C, D, E, F, G, H

A - represents " car is broken "

B - represents " car is old "

C - represents " income is small"

D - represents " repair car"

E - represents " income is medium "

F - represents "buy a used car "

G - represents "income is large "

H - represents "buy a new car "

Negations of ATOMIC FORMULAS are

$\neg B$ - represents " car is not old"

$\neg D$ - represents " do not repair"

RULES are

R1 $A \cap B \cap C \Rightarrow D$

R2 $A \cap B \cap \neg D \cap E \Rightarrow F$

R3 $A \cap \neg B \cap G \Rightarrow H$

P2. WRITE the rules **R1, R2, R3** in **propositional convention 2** as rules

$$A_1 \cap A_2 \cap \cdots \cap A_n \Rightarrow C \quad \text{where } A_1, A_2, \ldots A_n, C \text{ are } \textbf{atomic} \text{ formulas}$$

ATOMIC FORMULAS are: A, B, C, D, E, F, G, H, J, K

A - represents " car is broken "

B - represents " car is old "

C - represents " income is small"

D - represents " repair car"

E - represents " income is medium "

F - represents "buy a used car "

G - represents "income is large "

H - represents "buy a new car "

J - represents " car is NOT old "

K - represents " do not repair car"

RULES are

R1 $A \cap B \cap C \ \Rightarrow \ D$

R2 $A \cap B \cap K \cap E \Rightarrow F$

R3 $A \cap J \cap G \Rightarrow H$

QUESTION 3

WRITE the the system **S** rules:

R1 IF car is broken AND old AND income is small THEN repair it

R2 IF car is broken AND old AND do not repair AND income is medium THEN buy a used car

R3 IF car is broken AND is not old AND income is large THEN buy a new car

in the **PREDICATE convention** using predicates

attribute(x, value of attribute), attribute(object, value of attribute)

WRITE a database TABLE with an example of any **4 records** needed for solution in this case.

Solution

I use the intended interpretation names for ATTRIBUTES - you can use your own names

The ATTRIBUTES and their VALUES are:

CarBroken with values yes, no

CarBroken(x, yes) with values yes, no

Income with values small, medium, large

CarRepair with values yes, no

CarBuy with values new, used

Example of Data Table with 4 records is

Obj	CarBroken	CarOld	Income	CarRepair	CarBuy	CarRepair
0_1	yes	yes	small	no	new	
0_2	no	no	large	yes	used	
0_3	yes	yes	medium	no	new	
0_4	yes	no	small	no	used	

RULES ARE:

R1 $CarBroken(x, yes) \cap CarOld(x, yes) \cap Income(x, small) \ \Rightarrow CarRepair(x, yes)$

R2 $CarBroken(x, yes) \cap CarOld(x, yes) \cap CarRepair(x, no) \cap Income(x, medium) \Rightarrow CarBuy(x, used)$

R3 $CarBroken(x, yes) \cap CarOld(x, no) \cap Income(x, large) \Rightarrow CarBuy(x, new)$

QUESTION 4

P1 Given a set of clauses

$$\Delta = \{\{a, \neg b\},\ \ \{a, b, c\},\ \ \{\neg a, c\},\ \{\neg c, \neg b\}\}$$

Find all possible **complementary pairs** and all their possible **resolvents**

P2. Use Resolution Deduction to decide whether the set Δ of clauses is unsatisfiable or satisfiable.

$$\Delta = \{\{\ \neg a,\ b\ \},\quad \{\neg b\},\quad \{a,\ b\}\}$$

Solution

Consider Resolution Deduction as follows

1 $\Delta = \{\{\ \neg a,\ b\ \},\quad \{\neg b\},\quad \{a,\ b\}\}$

2 $\{b\}$ Resolution application on $\{\ \neg a,\ b\ \},\ \{a,\ b\}$

3 $\{\}$ Resolution application on $\{b\},\ \{\neg b\}$

Δ is UNSATISFIABLE

P3. Use the **Deletion Strategies** "PURE LITERAL", "TAUTOLOGY" where applicable to decide whether the set Δ is unsatisfiable or satisfiable.

$$\Delta = \{\{\ \neg a,\ a,\ b,\ \neg c\},\quad \{a,\ \neg b,\ c\},\quad \{\neg a,\ \neg c\}\}$$

Solution

1 Transform Δ into Δ' by deleting TAUTOLOGY $\{\ \neg a,\ a,\ b,\ \neg c\}$

2 $\Delta' = \{\ \{a,\ \neg b,\ c\},\quad \{\neg a,\ \neg c\}\}$

The literal $\neg b$ is PURE

3 Transform Δ' into Δ'' by deleting the pure literal clause $\{a,\ \neg b,\ c\}$

$\Delta'' = \{\{\neg a,\ \neg c\}\}$ STOP

Δ is SATISFIABLE by the Completeness of TAUTOLOGY and PURE LITERAL Deletion Strategies

QUESTION 5

FIND the **SET of CLAUSES** that you need to **decide** whether the ARGUMENT

$$((A_1 \cap A_2) \Rightarrow B)$$

is **valid/not valid**, where

$A_1 :\quad (((a \Rightarrow \neg b) \Rightarrow (b \Rightarrow \neg a)) \cup ((a \Rightarrow \neg c) \cup b))$

$A_2 :\quad ((a \Rightarrow b) \Rightarrow a)$

$B :\quad (\neg(a \Rightarrow (\neg b \cap c)) \Rightarrow (a \cap (b \cap \neg c)))$

Solution RESOLUTION HOMEWORK