CSE352 Q1 SOLUTIONS Fall 2018

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

R1 IF savings are not adequate THEN invest in savings

R2 IF savings are adequate AND income is adequate THEN invest in stocks

R3 IF there is a partner AND partner has a job THEN income is adequate

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

A - represents "savings are adequate"

B - represents " invest in savings "

C - represents " income is adequate"

D - represents " invest in stocks"

E - represents " there is a partner"

F - represents "partner has a job "

NEGATIONS of ATOMIC FORMULAS are

$\neg A$ - represents "savings are NOT adequate"

RULES are

R1 $\neg A \Rightarrow B$

R2 $A \cap C \Rightarrow B$

R3 $E \cap F \Rightarrow C$

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

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

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

A - represents "savings are not adequate"

B - represents " invest in savings "

C - represents " savings are adequate "

D - represents " income is adequate"

E - represents " invest in stocks"

F - represents " there is a partner"

G - represents "partner has a job "

RULES are

R1 $A \Rightarrow B$

R2 $C \cap D \Rightarrow E$

R3 $F \cap G \Rightarrow D$

QUESTION 3

WRITE the the system **S** rules:

R1 IF savings are not adequate THEN invest in savings

R2 IF savings are adequate AND income is adequate THEN invest in stocks

R3 IF there is a partner AND partner has a job THEN income is adequate

in the **PREDICATE convention** using predicates

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

WRITE a database TABLE with few records 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:

SavingsAdequate with values yes, no

InvestSaving with values yes, no

IncomeAdequate with values yes, no

InvestStocks with values yes, no

Partner with values yes, no

PartnerJob with values yes, no

The Data Table with 4 records is

Obj	SavingsAdequate	InvestSavings	IncomeAdequate	InvestStocks	Partner	PartnerJob
0_1	yes	no	yes	yes	no	yes
0_2	no	no	no	no	yes	no
0_3	yes	yes	yes	yes	no	yes
0_4	yes	no	no	yes	no	yes

RULES ARE:

R1 $SavingsAdequate(x, no) \Rightarrow InvestSaving(x, yes)$

R2 $SavingsAdequate(x, yes) \cap IncomeAdequate(x, yes) \Rightarrow InvestStocks(x, yes)$

R3 $Partner(x, yes) \cap PartnerJob(x, yes) \Rightarrow IncomeAdequate(x, yes)$

QUESTION 4

Use Resolution do decide whether the set Δ of clauses is unsatisfiable or satisfiable.

Use the **Deletion Strategies** "PURE LITERAL", "TAUTOLOGY" where applicable.

P1.

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

Solution

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

P2.

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

Solution

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

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

3 $\{\neg b,\ c\}$ Resolution application with resolvent a - STOP

Δ is SATISFIABLE by the Completeness of TAUTOLOGY Deletion Strategy