Short REVIEW

Cse352
AI Lecture Notes (5)
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PART ONE

- CONCEPTUALIZATION DEFINITION (NILSON)
- **Conceptualization** – step one of formalization of knowledge in declarative form

C = (**U**, **F**, **R**)

- **U** – Universe of discourse; it is a FINITE set of objects.
- **F** – Functional Basis Set; Set of functions (defined on **U**). Functions may be partial.
- **R** – Relational Basis Set; Set of relations defined on **U**.
- Remark: sets **U, R, F** are FINITE

Problem 1

- **Conceptualize** the following situation using **Nilsson's definition**
- *In a room there are 2 cats, 3 dogs, and 2 kind of FOOD– one for cats and one for dogs.*
- **The following properties must be true.**

1. *One cat likes all dogs.*

2. *One dog hates all cats.*

3. *Everybody (cats and dogs) like all FOOD.*

4. *One dog hates cat food.*

5. *All cats hate dog food.*

Problem 1- Notation

- **We use the following notation**
- **U** – Universe of discourse is the set

U ={ o1, o2, o3, o4, o5, o6, o7}

- **R** – Relational Basis Set; Set of relations

R = { CAT, DOG,FOOD, CFOOD, DFOOD, LIKE, HATE }

- **WE USE INTENDED Interpretation, i.e.**
- Relation **CAT** is defined intuitively by a property x is a cat
- Relation **DOG** is defined intuitively by a property x is a dog
- Relation **FOOD** is defined intuitively by a property x is food
- Relation **CFOOD** is defined intuitively by a property x is cat food
- Relation **DFOOD**is defined intuitively by a property x is dog food
- Relation **LIKE** is defined intuitively by a property x likes y
- Relation **LIKE** is defined intuitively by a property x likes y
- Relation **HATE** is defined intuitively by a property x hates y

Problem 1-Relations

Remark that the relations

CAT, DOG, FOOD, CFOOD, DFOOD

are *one argument relations* and

the relations

LIKE, HATE

are *two argument relation* and

all of them are defined on the Universe **U**

Solution: Relations Definition

- We define, for example the relation **CAT$\subseteq$ U** (one argument relation) as
- **CAT={ o1, o2}**
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- We define, for example the relation **DOG$\subseteq$ U**
- (one argument relation) as
- **DOG= { o3, o4,o5}**
- Observe that the sets **CAT** and **DOG** must be **disjoint-** as we use the **intended interpretation**

Solution: Relations Definition

- Observe that the sets **CAT**, **DOG** and **FOOD** must also be **disjoint-** as we use the **intended interpretation**
- We must define now the relation **FOOD** $\subseteq$ **U**
- (one argument relation) as
- **FOOD ={ o6, o7}**
- We define, for example the one argument relations
- **CFOOD** $\subseteq$ **FOOD** $\subseteq$ **U, DFOOD** $\subseteq$ **FOOD** $\subseteq$ **U,** as
- **CFOOD={ o7}, DFOOD={ o6}**
- Observe that the sets **CFOOD** and **DFOOD** must be **disjoint-** as we use the **intended interpretation**

DEFINITION of the relations **LIKE, HATE**

- Relations **LIKE, HATE** are defined intuitively by respective properties: *x likes y* and *x hates y*
- Both are 2 argument relation defined on **U**, i.e.
- **LIKE** $\subseteq$ **UxU** and **HATE** $\subseteq$ **UxU**

and must fulfill the following properties:

1. *One cat likes all dogs.*

2. *One dog hates all cats.*

3*.* *Everybody (cats and dogs) like all FOOD.*

4*.* *One dog hates cat food.*

5. *All cats hate dog food*

Definitions of the relations **LIKE, HATE**

- Observe that the relations **LIKE** and **HATE** in order to fulfill the conditions **1.-5.** must be defined differently on different subsets of **U**.
- We define first appropriate parts
- **LIKE1, LIKE2** of the relation **LIKE** that correspond to properties **1., 3.** and define **LIKE** as set union of all of them, i.e. we put
- $$\textbf{LIKE} = \textbf{LIKE1} \vee \textbf{LIKE2}$$

Definition of the relation **LIKE**

- **PROPERTIES**
- ***1.*** *One cat likes all dogs*
- We define **LIKE1** as follows

- **LIKE1 $\subseteq$ CAT x DOG $\subseteq$ UxU**
- **LIKE1 $\subseteq$ { o1, o2} x { o3, o4, o5} $\subseteq$ UxU**

- We put
- **LIKE1 ={(o2, o3), (o2, o4), (o2, o5)}**
- Observe that there are many ways of defining **LIKE1** – this is just my choice

Definition of the relation **LIKE**

- **PROPERTIES**
- *3. Everybody (cats and dogs) like all FOOD*

We define **LIKE2** as follows

- **LIKE2 $\subseteq$ (CAT $\bigvee$ DOG) x FOOD $\subseteq$ UxU**
- **LIKE1 $\subseteq$ { o1, o2, o3, o4, o5} x {o6, o7} $\subseteq$ UxU**
- We put
- **LIKE2 = { o1, o2, o3, o4, o5} x {o6, o7}**

LIKE = LIKE1 $\bigvee$ LIKE2

Definition of the relation **HATE**

- We define first appropriate parts
- **HATE1, HATE2, HATE3** of the relation **HATE** that correspond to properties **2., 4. , 5.** and define **HATE** as set union of all of them, i.e. we put
- **HATE= HATE1 $\vee$ HATE2 $\vee$ HATE3**

Definition of the relation **HATE**

- **PROPERTIES**
- ***2.*** *One dog hates all cats.*
- We define **HATE1** as follows

- **HATE1 $\subseteq$ DOG x CAT $\subseteq$ UxU**
- **HATE1 $\subseteq$ { o3, o4, o5} x {o1, o2} $\subseteq$ UxU**

- We put, for example
- **HATE1 ={(o5, o1), (o5, o2)}**
- Observe that there are many ways of defining **HATE1** – this is just my choice

Definition of the relation **HATE**

- **PROPERTIES**
- ***4****. One dog hates cat food.*
- We define **HATE2** as follows

- **HATE2$\subseteq$ DOG x CFOOD$\subseteq$ UxU**
- **HATE2$\subseteq$ { o3, o4, o5} x {o7} $\subseteq$ UxU**

- We put, for examle
- **HATE2 ={ (o3, o7)}**
- Observe that there are many ways of defining **HATE2** – this is just my choice

Definition of the relation **HATE**

- **PROPERTIES**
- ***5.*** *All cats hate dog food*
- We define **HATE3** as follows
- **HATE3 $\subseteq$ CAT x DFOOD $\subseteq$ UxU**
- **HATE3 $\subseteq$ { o1, o2} x {o6} $\subseteq$ UxU**
- We put **HATE3 ={ (o1, o7), (o2, o7)}**

  and
- **HATE= HATE1 $\vee$ HATE2 $\vee$ HATE3**

- Observe that there is only one way of defining **HATE3**

PART 2: PREDICATE LOGIC CONCEPTUALIZATION

- Translations from Natural Language
- **Translate: "No house is red"**

- 1. Domain: $X \neq \phi$
- 2. Predicates: A(x) – x is a House B(x) – x is red
- 3. Functions: (none)
- 4. Connectives: ¬ - "**not**"
- 5. Quantifiers: $\exists_{A(x)}$ – "some houses" (restricted)
- 6. RESTRICTED FORMULA: $\neg \exists_{A(x)} B(x)$
- **7. LOGIC FORMULA:** $\neg \exists x \, (A(x) \wedge B(x))$

PREDICATE LOGIC CONCEPTUALIZATION

- Translations from Natural Language
- **BE CAREFUL!**
- **YOU MUST ALWAYS DO DIRECT TRANSLATION**
- **Never translate some logically EQUIVALENT FORM like in this case (via de Morgan Laws)**
- **“All houses are not red”**

PREDICATE LOGIC CONCEPTUALIZATION

- Translations from Natural Language
- **Translate: "All houses are not red"**

- 1. Domain: $X \neq \phi$
- 2. Predicates: A(x) – x is a house B(x) – x is red
- 3. Functions: (none)
- 4. Connectives: ¬ - "**not**"
- 5. Quantifiers: $\forall_{A(x)}$ – "**All** houses" **(restricted)**
- 6. RESTRICTED FORMULA: $\forall_{A(x)} \neg B(x)$
- **7. LOGIC FORMULA:** $\forall_x (A(x) \Rightarrow \neg B(x))$

Part 3: Rule Based Systems
Exercises

- Exercise 1
- Here are three simple **expert rules**
- **R1:** If your savings are small, then don't invest in stocks
- **R2:** If you have no children and large income, then invest in stocks
- **R3:** If you have children and small income, then invest in savings

Part 3: Exercise 1

- **Conceptualize** rules **R1, R2, R3**

in **Predicate Form** using predicates

attribute(x, value of attribute)

attribute(object, value of attribute)

WRITE a format of a database TABLE needed for your conceptualization

REMARK: In order to express the rules **Predicate Form** , we must first define appropriate ATTRIBUTES and their values

Part 3: Exercise 1

- **We have the following ATTRIBUTES:**

- **Savings**
  Values**: small, large**
- **Income**
  Values: **small, large**

- **InvestStocks**
  Values: **yes, no**

- **InvestSavings**
- Values: **yes, no**

- **Children**
  Values: **yes, no**

Exercise 1
Predicate Form Conceptualization

Data Table Example with 3 records

Records	Savings	Income	InvesrStocks	InvestSavings	Children
O_1	small	small	yes	yes	yes
O_2	large	small	no	no	no
O_3	small	large	yes	yes	no

Exercise 1: Rules in Predicate Form

- **RULES:**
- **R1:** Savings(x, small) → InvestStock (x, no)
- **R2:** Children(x, no) /\ Income(x, large)→ InvestStocks(x, yes)
- **R3:** Children(x, yes)) /\ Income(x, small)→ InvestSavings(x, yes)
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PART3:   Exercise 2

- Exercise 2
- **The initial database has the following FACTS**
- F1: Savings(John, small)
- F2: Children(John, no)
- F3: Income(John, large)
- **1.** Are these FACTS true in Exercise 1 Data Table for a record o = John?
- **2.** Design a Data Table 2 in which the above **FACTS** are true
- **3.** Can you deduce InvestStocks(John, yes) on the base of the Data Table 2

Part 3: Exercise 3

- Given rules from Exercise 1:
- **R1:** If your savings are small, then don't invest in stocks
- **R2:** If you have no children and large income, then invest in stocks
- **R3:** If you have children and small income, then invest in savings

Part 3: Exercise 3

- **Conceptualize** rules **R1, R2, R3**

In **Propositional Logic** in two ways:

1. Rules admit **only** atomic formulas; i.e. rules are built from propositional variables only – call the set of rules **PR1**
2. Rules admit atomic formulas and negation of atomic formulas – call obtained set of rules **PR2**

Part 3: Exercise 3

- Write initial databases B1 and B2

  of facts corresponding to the facts F1, F2, F3 from Exercise 2 for
- (1) propositional conceptualization 1.
- (2) propositional conceptualization 2.
- (3) use corresponding rules from sets

  PR1, PR2 to deduce all facts from

  B1 and B2, respectively

  Use Conflict Resolution from Busse Handout