# Department of Computer Science

# University of Karachi

Assignment 1 (10th July 2020)

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**BSCS-III Year EVE Artificial Intelligence**

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## Q1 Represent the following in FOL statements

**Answer.**

**a) Water is a liquid between 0 and 100 degrees.**

(W ⊂ Water) ⇒ (Degrees (0) < Temp (w) < Degrees (100)) ^Liquid (w)

**b) Water boils at 100 degrees.**

(W ⊂ Water) ^ Boiling (w) ⇒ Temp (w) ≥ Degrees (100)

**c) The water in John's bottle is frozen.**

(W ⊂ Water) ^ InJohnsBottle(w) ⇒ Temp(w) < Degrees(0)

**d) Perrier is a kind of water.**

Perrier ⊂ Water

**e) John has Perrier in his water bottle.**

(Perrier ⊂ Water) ^ InJohnsBottle (Perrier)

**f) All liquids have a freezing point.**

(W ⊂ Liquid) ⇒ HasFreezingPoint (w)

## Q2 Explain what is wrong with the following purpose definition of the set membership predicate ∈.

Answer.

These axioms are sufficient to prove set membership when x is in fact a member of a given set; they have nothing to say about cases where x is not a member. For example, it is not possible to prove that x is not a member of the empty set.

Another way view the problem is to look at some of the unintended models allowed by the axioms. Consider a model with domain elements, A, {A}, and {}, where we interpret the ∈ relation as

I(∈) = { < A, {A} >, < A, {} > }

This model satisfies the axioms but is clearly not what we intend as A is considered to be an element of the empty set.

## Q3 Write axioms describing the predicates: GrandChild, GreatGrandparent, Brother, Sister, Daughter, Son, Aunt, Uncle, BrotherInLaw, SisterInLaw and FirstCousin. Find out the proper definition.

Answers.

These predicates are all relational and they should be read as relation(a,b) ⇒ a is a relation of b.

**GrandChild(a,b)** ⇒ parent(b,x) ∧ parent(x,a)

**GreatGrandparent(a,b)** ⇒ parent(a,x) ∧ GrandChild(b,x)

The Sibling relationship is added to make the expression of some future relationships simpler. In this situation, Sibling encompasses full, half and step siblings.

**Sibling(a,b)** ⇒ parent(x,a) ∧ parent(x,b) ∧ not_equal(a,b)

**Sibling(a,b)** ⇒ Sibling(b,a)

**Brother(a,b)** ⇒ Sibling(a,b) ∧ gender(a,'male')

**Sister(a,b)** ⇒ Sibling(a,b) ∧ gender(a,'female')

**Son(a,b)** ⇒ parent(b,a) ∧ gender(a,'male')

**Daughter(a,b)** ⇒ parent(b,a) ∧ gender(a,'female')

**Uncle(a,b)** ⇒ parent(x,b) ∧ Sibling(x,a) ∧ gender(a,'male')

**Aunt(a,b)** ⇒ parent(x,b) ∧ Sibling(x,a) ∧ gender(a,'female') married is a primitive relation, meaning it is not defined in terms of any other relations. It is necessary however to note that it is reflexive.

**married(a,b)** ⇒ married(b,a)

BrotherInLaw(a,b) ⇒ married(b,x) ∧ Sibling(a,x) ∧ gender(a,'male')

SisterInLaw(a,b) ⇒ married(b,x) ∧ Sibling(a,x) ∧ gender(a,'female')

FirstCousin(a,b) ⇒ parent(x,a) ∧ parent(y,b) ∧ Sibling(x,y)

## Write down the basic fact depicted in family tree .

Suitable reasoning system would be Prolog. Family-tree. Prolog represents the above relations and predicates.

## Express the proper definition of a mth cousin removed n times in first-order logic.

Children of siblings are first cousins

Children of first cousins are second cousins

Children of mth cousins are (m + 1)th cousins

Removedness is a function of generations, if two cousins are from different generations, they are removed that once for each generation.

The first step is to express the mth cousin. This definition, for the sake of brevity expresses siblings as 0th cousins.

Cousin(a,b,m) ⇒ (greater(m,0) ∧ parent(x,a) ∧ parent(y,b) ∧ Cousin(x,y,m1)) ∨ (equal(m,0) ∧ Sibling(a,b)) Cousin(a,b,m) ⇒ Cousin(b,a,m)

Next, a different predicate is added which is distinguished by the number of arguments. A n is added to represent "removed n times."

Cousin(a,b,m,n) ⇒ (greater(n,0) ∧ (parent(x,a) ∧ Cousin(x,b,m,n-1)) ∨ (parent(x,b) ∧ Cousin(x,a,m,n-1))) ∨ (equal(n,0) ∧ Cousin(a,b,m)) Cousin(a,b,m,n) ⇒ Cousin(b,a,m,n)

## **Write the basic facts of the following family tree using a suitable reasoning system:**

Using the same system, Tell it the sentences and Ask it who are Elizabeth's grandchildren, Diana's brothers-in-law, and Zara's great-grandparents. Using prolog and family-tree.prolog ,the following results are derived:

grandchild(A,'Elizabeth'). (Elizabeth's grandchildren)

**A = 'Beatrice'**

**A = 'Eugene'**

**A = 'Peter'**

**A = 'Zara'**

**A = 'William'**

**A = 'Harry'**

**brotherInLaw(A,'Diana'). (Diana's brothers-in-law)**

**A = 'Andrew' To Do: There's a loop for some reason and it returns 'Andrew' over and over. Specifically it doesn't get to:**

**A = 'Edward'**

**greatGrandparent(A,'Zara'). (Zara's great-grandparents)**

**A = 'George'**

**A = 'Mum'**