Topic 2.3 Knowledge Representation and Reasoning using First Order [Predicate] Logic | Calculus (FOPL, FOL, FOPC)

a) FOL

- Founded on PL
- More expressive than PL
- Well studied, formalized and mathematically analyzed
- Subsumes or makes foundation of many other knowledge representation languages

b) FOL Syntax: [Rules describing structural units]

1-5. Sentence → AtomicSentence | ¬Sentence | (Sentence) |
Sentence Connective Sentence |
Quatifier Variable, Variable, … Sentence

6-7. AtomicSentence → Predicate (Term, Term, …) | Term = Term

8-10. Term → Constant | Variable | Function(Term, Term, …)

11-14. Connective → ∧ | ∨ | ⇒ | ⇔

15-16. Quantifier → ∀ | ∃ **17 … .** Variable → x | y | z | …

18 … . Predicate → Father | Subset | Greater | …

19 … . Constant → Karim | AUST | X1| …

20 … . Function → Sum | Log | MotherOf | …

- **Term** – object, Complex term – complicated object
- **Ground term** – a term without a variable

- **Examples**

- MotherOf (Rina) = Bina
  - syntactically correct FOL sentence

- $\forall x, y, z\ ((\text{Father}(x, y) \wedge \text{Father}(y, z)) \Rightarrow \text{Grandfather}(x, z))$
  - syntactically correct FOL sentence

** Analyze the two sentences above in '**Top-Down**' and '**Bottom-Up**' fashions.

c) Semantics of FOL

Rules :

- to **interpret** expressions (sentences), that is,
- to find **truth values** or **matches** by fixing **substitutions** or **binding lists** (lists of 'variable / term' pairs).

- Example from **Kinship Domain:**

TELL (KB, { Father(Karim, Rahim),
Father(Rahim, Selim),
Father(Rahim, Halim),
$\forall x, y, z$ ((Father(x, y) $\wedge$ Father(y, z)) $\Rightarrow$ Grandfather(x, z))
})

1. ASK (KB, Father(Rahim, Selim))
[Is Rahim the father of Selim?]
Returns: **True**

2. ASK (KB, $\exists x, y$ Grandfather(x, y))
[Who are grandfather of whom?]
Returns**:**
{x / Karim, y / Selim, y / Halim} - **substitution**