* Meaning Representations
  - FOPL
  - Examples

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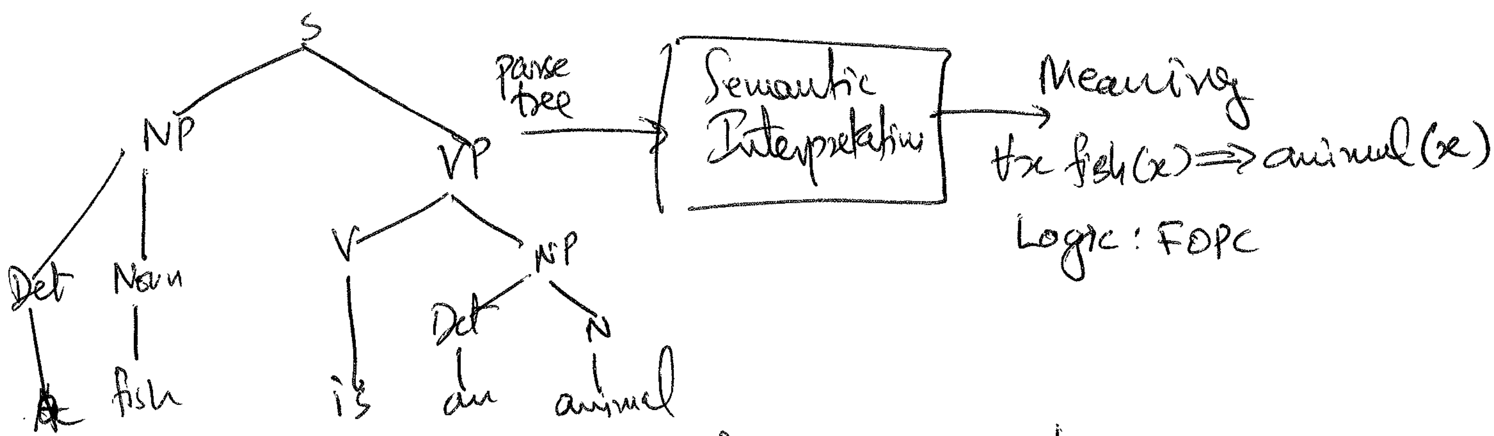


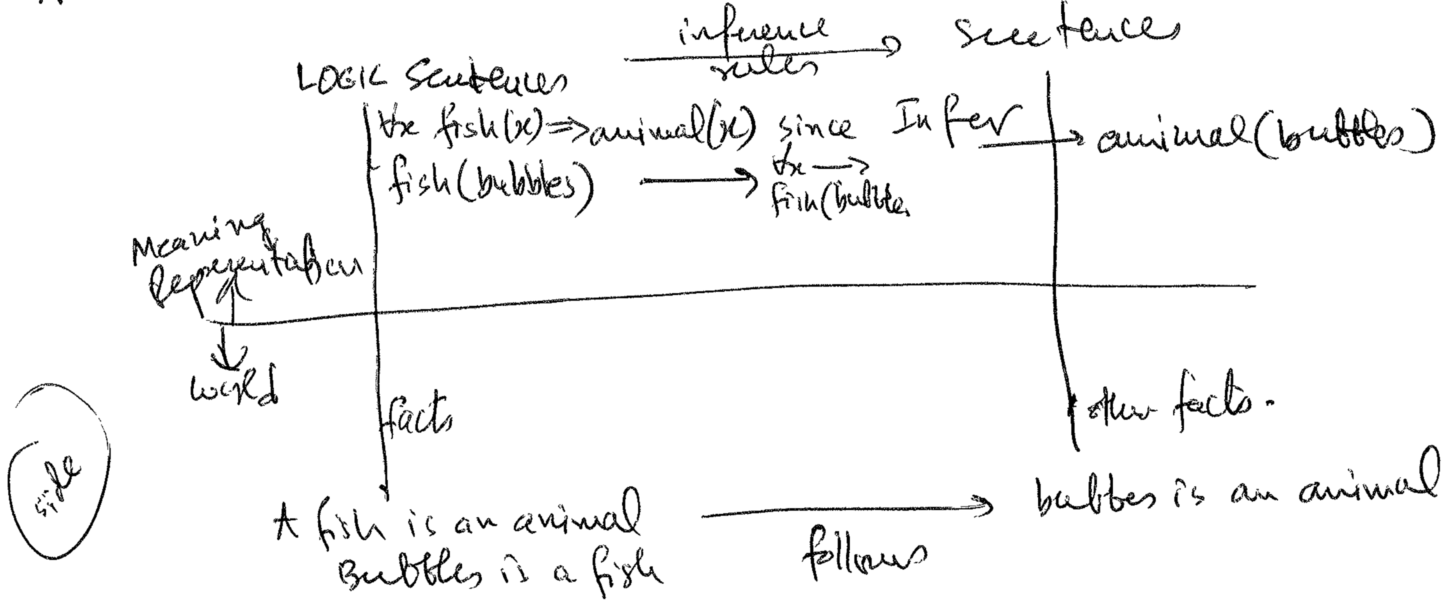


## Logic

1. Define a formal language to write sentences – Syntax
2. What do the sentences mean? Semantics
3. Rules of Inference – Proof Theory.

* Meaning Representation
  - FOPC
  - Examples

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## FOPC

### Syntax

- constants
  refer to specific objects/individuals [nouns]
  e.g. Deepak, bubbles, dog, etc.
  [written starting with uppercase letter]

  Semantics
  - denote entities
    concrete
    abstract
    fictional

- functions
  - refer to objects without naming them

(1) e.g. locationOf(BrynMawrCollege)
  colorOf(—)
  distance(—, —)

  [written in lowercase]

  arity = # parameters

  also denote objects w/o name

- Terms
  - an object is a term
  - a function w/ arity n, followed by n terms is a term.

  e.g. Car54, distance(BMC, HC), etc.

- Relations
(2) - denote properties/relationships between objects
  [propositions] → ~~True/False~~
  e.g. Parent(x, y) : x is a parent of y
  Animal(x) : x is an animal
  Isa(x, y) : x is a y
  Saw(x, y) : x saw y
  etc.

  denote propositions (properties)

WFFS - Well-Formed Formulas
represent propositions T/F under an interpretation

e.g. Saw(Jack, dog)

Semantics

(3) · Atomic WFFS

Animal(~~Fish~~ Bubbles)

Isa(Deepak, Human)

T/F when the relation denoted by it holds for its arguments

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· Propositional WFFS

if $w_1$ and $w_2$ are WFFS, then so are

- $w_1$
- $\neg w_1$ negation
- $w_1 \wedge w_2$ conjunction
- $w_1 \vee w_2$ disjunction
- $w_1 \Rightarrow w_2$ implication

(4)

Semantics is defined by truth tables

· Variables

- A variable is a term -
denotes/can denote an object.
[lowercase letters]

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· Quantifier

· Universal $\forall$

if $w$ is a wff & $x$ is a variable then $(\forall x)w$ is a wff.

or $\forall x(w)$ or $\forall x[w]$ scope of $x$

(5)

e.g. $\forall x[P(x) \Rightarrow R(x)]$

$\forall x[Fish(x) \Rightarrow Animal(x)]$

$\forall x[Human(x) \Rightarrow Mortal(x)]$

$\forall x$ Vegetarian(x) ∧ Restaurant(x) ⇒ Serves(x, VegFood)

(6)

• Existential Quantifier: $\exists$

if $w$ is a wff & $x$ is a variable

$\exists x(w)$ or $\exists x\, w$ or $\exists x[w]$ is a wff.

e.g. $\exists x [P(x) \Rightarrow \exists y [R(x,y) \Rightarrow S(f(x))]]$

$\exists x$. Restaurant(x) ∧ Serves(x, MexicanFood) ∧ Near(locationOf(x), locationOf(BML))]

Semantics of $\forall$ and $\exists$

$\forall$ – wffs with $\forall$ must be true under all possible variable substitutions

$\exists$ – wffs with $\exists$ are true if one substitution of term for variable(s) results in wff being True.

[skip Inference Rules]

Examples:

Relations: $Near^2(x,y)$ : $x$ is near $y$
$Likes^2(x,y)$ : $x$ likes $y$
$Closed^1(x)$ : $x$ is closed.
$Serves(x,y)$ : $x$ serves $y$

1. BMC is near HC
$Near(BMC, HC)$

2. Deepak likes Xolo
$Likes(Deepak, Xolo)$

3. Xolo is closed.
$Closed(Xolo)$

4. Xolo serves Mexican food
$Serves(Xolo, MexicanFood)$

Granularity

or $\exists x\,[Food(x) \wedge Mexican(x) \wedge Serves(Xolo, x)]$

or $\exists x\,[Isa(x, Food) \wedge Isa(x, Mexican) \wedge Serves(Xolo, x)]$

5. Deepak eats a burrito.
$Eats(Deepak, Burrito52)$
$\exists x\,[Burrito(x) \wedge Eats(Deepak, x)]$
$\exists x\,[Isa(x, Burrito) \wedge Eats(Deepak, x)]$

6. Every person who eats a burrito is happy
$\forall x \forall y\,[Person(x) \wedge Burrito(y) \wedge Eats(x,y) \Rightarrow Happy(x)]$

Back to ⧺ + MLR. Next Algorithm. Good Break!