

A **semantics** specifies the meaning of sentences in the language.

An **interpretation** specifies:

- what objects (individuals) are in the world
- the correspondence between symbols in the computer and objects & relations in world
 - ▶ constants denote individuals
 - ▶ predicate symbols denote relations

An **interpretation** is a triple $I = \langle D, \phi, \pi \rangle$, where

- D , the **domain**, is a nonempty set. Elements of D are **individuals**.
- ϕ is a mapping that assigns to each constant an element of D . Constant c **denotes** individual $\phi(c)$.
- π is a mapping that assigns to each n -ary predicate symbol a relation: a function from D^n into $\{TRUE, FALSE\}$.

Example Interpretation

Constants: *phone, pencil, telephone.*

Predicate Symbol: *noisy* (unary), *left_of* (binary).

- $D = \{ \langle \text{✂} \rangle, \langle \text{☎} \rangle, \langle \text{✎} \rangle \}.$

- $\phi(\text{phone}) = \langle \text{☎} \rangle, \phi(\text{pencil}) = \langle \text{✎} \rangle, \phi(\text{telephone}) = \langle \text{☎} \rangle.$

- $\pi(\text{noisy}):$

$\langle \text{✂} \rangle$	FALSE	$\langle \text{☎} \rangle$	TRUE	$\langle \text{✎} \rangle$	FALSE
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$\pi(\text{left_of}):$

$\langle \text{✂}, \text{✂} \rangle$	FALSE	$\langle \text{✂}, \text{☎} \rangle$	TRUE	$\langle \text{✂}, \text{✎} \rangle$	TRUE
$\langle \text{☎}, \text{✂} \rangle$	FALSE	$\langle \text{☎}, \text{☎} \rangle$	FALSE	$\langle \text{☎}, \text{✎} \rangle$	TRUE
$\langle \text{✎}, \text{✂} \rangle$	FALSE	$\langle \text{✎}, \text{☎} \rangle$	FALSE	$\langle \text{✎}, \text{✎} \rangle$	FALSE

Important points to note

- The domain D can contain real objects. (e.g., a person, a room, a course). D can't necessarily be stored in a computer.
- $\pi(p)$ specifies whether the relation denoted by the n -ary predicate symbol p is true or false for each n -tuple of individuals.
- If predicate symbol p has no arguments, then $\pi(p)$ is either *TRUE* or *FALSE*.

Truth in an interpretation

A constant c **denotes in I** the individual $\phi(c)$.

Ground (variable-free) atom $p(t_1, \dots, t_n)$ is

- **true in interpretation I** if $\pi(p)(\langle\phi(t_1), \dots, \phi(t_n)\rangle) = \text{TRUE}$ in interpretation I and
- **false** otherwise.

Ground clause $h \leftarrow b_1 \wedge \dots \wedge b_m$ is **false in interpretation I** if h is false in I and each b_i is true in I , and is **true in interpretation I** otherwise.

Example Truths

In the interpretation given before, which of following are true?

noisy(phone)

noisy(telephone)

noisy(pencil)

left_of(phone, pencil)

left_of(phone, telephone)

noisy(phone) ← left_of(phone, telephone)

noisy(pencil) ← left_of(phone, telephone)

noisy(pencil) ← left_of(phone, pencil)

noisy(phone) ← noisy(telephone) ∧ noisy(pencil)

Example Truths

In the interpretation given before, which of following are true?

<i>noisy(phone)</i>	true
<i>noisy(telephone)</i>	true
<i>noisy(pencil)</i>	false
<i>left_of(phone, pencil)</i>	true
<i>left_of(phone, telephone)</i>	false
<i>noisy(phone) ← left_of(phone, telephone)</i>	true
<i>noisy(pencil) ← left_of(phone, telephone)</i>	true
<i>noisy(pencil) ← left_of(phone, pencil)</i>	false
<i>noisy(phone) ← noisy(telephone) ∧ noisy(pencil)</i>	true

Models and logical consequences (recall)

- A knowledge base, KB , is true in interpretation I if and only if every clause in KB is true in I .
- A **model** of a set of clauses is an interpretation in which all the clauses are true.
- If KB is a set of clauses and g is a conjunction of atoms, g is a **logical consequence** of KB , written $KB \models g$, if g is true in every model of KB .
- That is, $KB \models g$ if there is no interpretation in which KB is true and g is false.

User's view of Semantics

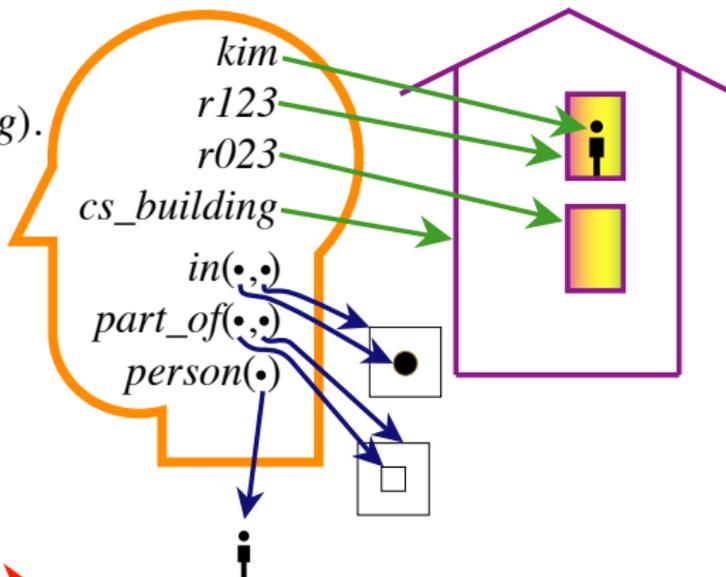
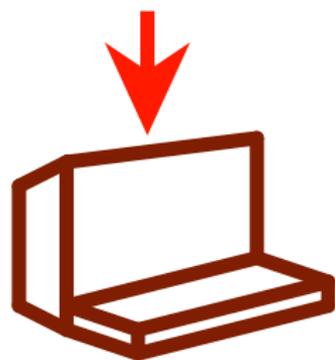
1. Choose a task domain: **intended interpretation.**
2. Associate constants with individuals you want to name.
3. For each relation you want to represent, associate a predicate symbol in the language.
4. Tell the system clauses that are true in the intended interpretation: **axiomatizing the domain.**
5. Ask questions about the intended interpretation.
6. If $KB \models g$, then g must be true in the intended interpretation.

Computer's view of semantics

- The computer doesn't have access to the intended interpretation.
- All it knows is the knowledge base.
- The computer can determine if a formula is a logical consequence of KB.
- If $KB \models g$ then g must be true in the intended interpretation.
- If $KB \not\models g$ then there is a model of KB in which g is false. This could be the intended interpretation.

Role of Semantics in an RRS

$in(kim, r123).$
 $part_of(r123, cs_building).$
 $in(X, Y) \leftarrow$
 $part_of(Z, Y) \wedge$
 $in(X, Z).$



$in(kim, cs_building)$