Objects and Relations

- Often features are made from relationships between objects and functions of objects.
- It is useful to view the world as consisting of objects and relationships amongst the objects.
- Reasoning in terms of objects and relationships can be simpler than reasoning in terms of features, as you can express general knowledge that covers all individuals.
- Sometimes you may know some individual exists, but not which one.
- Sometimes there are infinitely many objects you want to refer to (e.g., set of all integers, or the set of all stacks of blocks).

Role of Semantics in Automated Reasoning

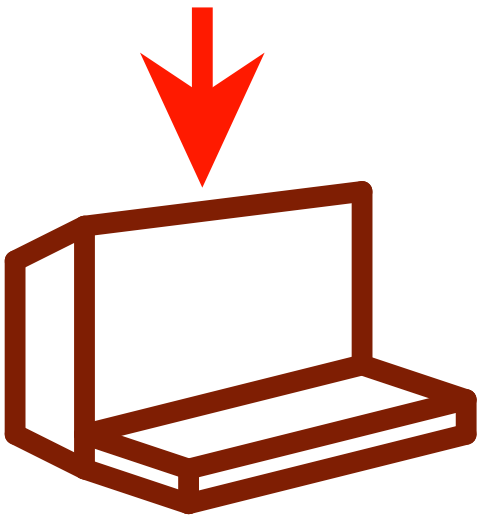
$in(kim,r123).$

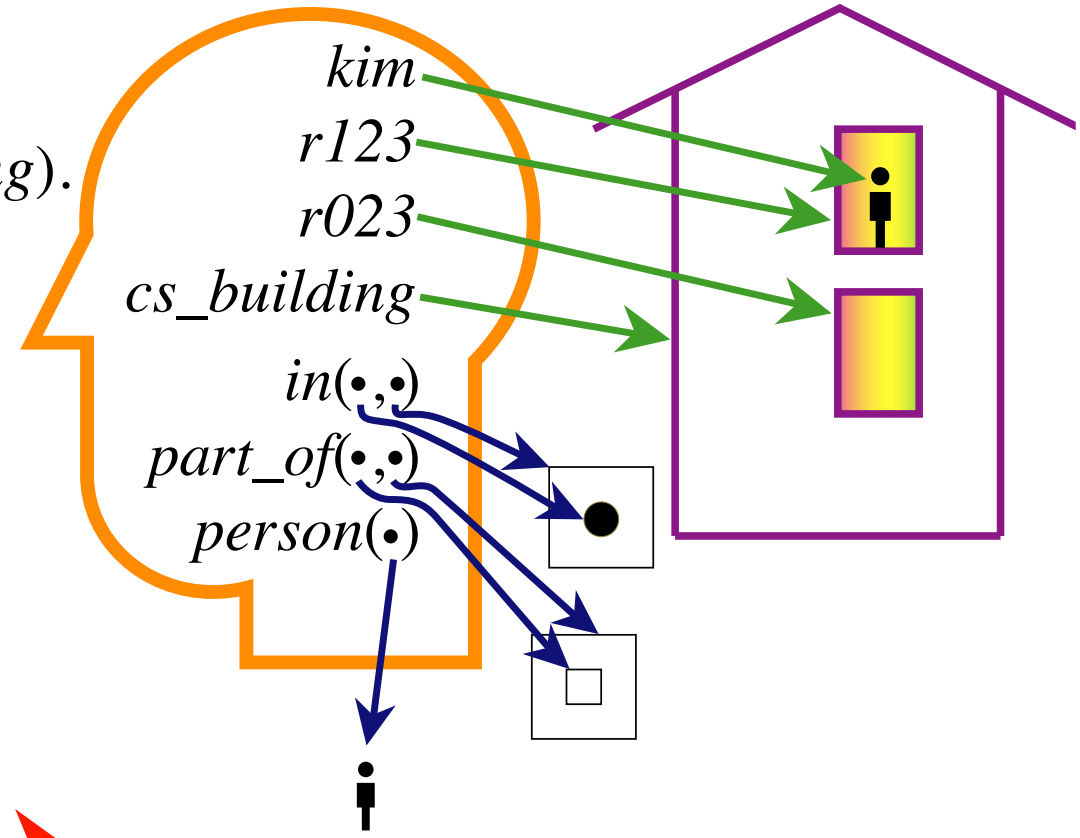
$part\_of(r123,cs\_building).$

$in(X,Y) \leftarrow$

$part\_of(Z,Y) \wedge$

$in(X,Z).$





$in(kim,cs\_building)$

Features of Automated Reasoning

- The user can have meanings for symbols in their head.
- The computer doesn't need to know these meanings to derive logical consequents.
- The user can interpret any answers according to their meaning.

Representational Assumptions of Datalog

- An agent's knowledge can be usefully described in terms of *individuals* and *relations* among individuals.
- An agent's knowledge base consists of *definite* and *positive* statements.
- The environment is *static*.
- There are only a finite number of individuals of interest in the domain. Each individual can be given a unique name.

$\Longrightarrow$ Datalog

Syntax of Datalog

- variable starts with upper-case letter.
- constant starts with lower-case letter or is a sequence of digits (numeral).
- predicate symbol starts with lower-case letter.
- term is either a variable or a constant.
- atomic symbol (atom) is of the form p or $p(t_1, \ldots, t_n)$ where p is a predicate symbol and t_i are terms.

Syntax of Datalog (cont)

- definite clause is either an atomic symbol (a fact) or of the form:

$$\underbrace{a}_{\text{head}} \leftarrow \underbrace{b_1 \wedge \cdots \wedge b_m}_{\text{body}}$$

  where a and b_i are atomic symbols.
- query is of the form $?b_1 \wedge \cdots \wedge b_m$.
- knowledge base is a set of definite clauses.

Example Knowledge Base

$$
\begin{aligned}
&in(kim, R) \leftarrow \\
&\qquad teaches(kim, cs322) \wedge \\
&\qquad in(cs322, R). \\
&grandfather(william, X) \leftarrow \\
&\qquad father(william, Y) \wedge \\
&\qquad parent(Y, X). \\
&slithy(toves) \leftarrow \\
&\qquad mimsy \wedge borogroves \wedge \\
&\qquad outgrabe(mome, Raths).
\end{aligned}
$$