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).
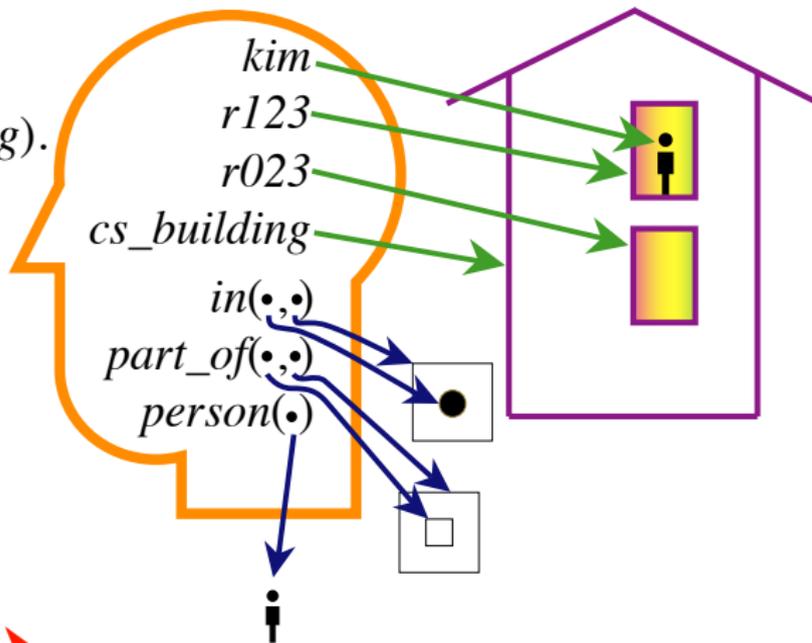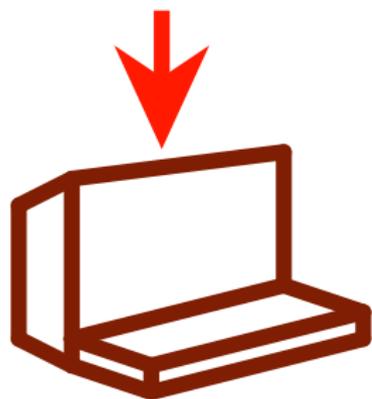
in(*kim*,*r123*).
part_of(*r123*,*cs_building*).
in(*X*,*Y*) ←
    part_of(*Z*,*Y*) ∧
    in(*X*,*Z*).

kim
r123
r023
cs_building
in(•,•)
part_of(•,•)
person(•)

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 consequence.
- 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.

$\implies$ 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:

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

  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

$$in(kim, R) \leftarrow$$
$$\quad teaches(kim, cs322) \wedge$$
$$\quad in(cs322, R).$$
$$grandfather(william, X) \leftarrow$$
$$\quad father(william, Y) \wedge$$
$$\quad parent(Y, X).$$
$$slithy(toves) \leftarrow$$
$$\quad mimsy \wedge borogroves \wedge$$
$$\quad outgrabe(mome, Raths).$$