It is useful to view the world as consisting of individuals (objects, things) and relations among individuals.

Often features are made from relations among individuals and functions of individuals.

Reasoning in terms of individuals and relationships can be simpler than reasoning in terms of features, if we can express general knowledge that covers all individuals.

Sometimes we may know some individual exists, but not which one.

Sometimes there are infinitely many individuals we 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).

in(kim,cs_building)
Features of Automated Reasoning

- Users can have meanings for symbols in their head.
- The computer doesn’t need to know these meanings to derive logical consequence.
- Users can interpret any answers according to their meaning.
Decision-theoretic Planning

- flat or modular or hierarchical
- explicit states or features or **individuals and relations**
- **static** or finite stage or indefinite stage or infinite stage
- **fully observable** or partially observable
- **deterministic** or stochastic dynamics
- **goals** or complex preferences
- **single agent** or multiple agents
- **knowledge is given** or knowledge is learned
- **perfect rationality** or bounded rationality
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.

⇒ Datalog
A variable starts with upper-case letter.
A constant starts with lower-case letter or is a sequence of digits (numeral).
A predicate symbol starts with lower-case letter.
A term is either a variable or a constant.
An 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.
A **definite clause** is either an atomic symbol (a fact) or of the form:

\[
\begin{array}{c}
a \\ \leftarrow \\ b_1 \land \cdots \land b_m
\end{array}
\]

\[
\text{head} \quad \text{body}
\]

where \( a \) and \( b_i \) are atomic symbols.

- **query** is of the form \(?b_1 \land \cdots \land b_m\).

- **knowledge base** is a set of definite clauses.
Example Knowledge Base

\[
\begin{align*}
\text{in}(\text{kim}, R) & \leftarrow \\
& \quad \text{teaches}(\text{kim}, \text{cs322}) \land \\
& \quad \text{in}(\text{cs322}, R). \\
\text{grandfather}(\text{william}, X) & \leftarrow \\
& \quad \text{father}(\text{william}, Y) \land \\
& \quad \text{parent}(Y, X). \\
\text{slithy}(\text{toves}) & \leftarrow \\
& \quad \text{mimsy} \land \text{borogroves} \land \\
& \quad \text{outgrabe}(\text{mome}, \text{Raths}).
\end{align*}
\]