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PREDICATE LOGIC

Horn Clauses and Prolog Programming

Prolog Programming and Horn Clauses

- Prolog uses Horn Clauses as the basis for programming:
  - A Horn Clause is an implication with zero or more *antecedents* and one *implicand*:
    - All antecedents and the implicand are predicates.
  - i.e. a Horn Clause is of the form:
    - $p_1(T_{11},...,T_{1K1}) \wedge p_2(T_{21},...,T_{2K2}) \wedge ... \wedge p_m(T_{m1},...,T_{mKm}) \text{-->} q(T_{q1},...,T_{qKq})$
      - where each p_i is a predicate name and each T_{ij} is a term: i.e.
        - a constant
        - a variable or
        - a function term
- A single predicate $p(T_1,...,T_K)$ is a degenerate implication:
  - TRUE --> $p(T_1,...,T_K)$

Prolog Programming and Horn Clauses

- In Prolog, a typical Horn Clause of the form
  - $p_1(T_{11},...,T_{1K1}) \wedge p_2(T_{21},...,T_{2K2}) \wedge ... \wedge p_m(T_{m1},...,T_{mKm})$ --> $q(T_{q1}...,T_{qKq})$
- is represented as:
  - $q(T_{q1}...,T_{qKq})$:- $p_1(T_{11},...,T_{1K1})$, $p_2(T_{21},...,T_{2K2})$, ...,$p_m(T_{m1},...,T_{mKm})$.

    i.e.
    - the implicand is on the left most end,
    - the antecedents occur on the right of :- (read this as <--),
    - the commas separating the antecedents indicate conjunction, and
    - there is a period ending the clause.

Prolog Programming and Horn Clauses

- A Prolog program is a conjunction of Horn Clauses and the conjunction is implicit:
  - i.e. syntactically, a Prolog program is a list of Horn Clauses.
- A degenerate clause (with a single predicate) is referred to as a ***fact*** in Prolog: e.g.
  - nat(0).
- A typical Horn Clause is referred to as a ***rule*** in Prolog: e.g.
  - nat(s(X)) :- nat(X).
    - Note: A fact is a special form of a rule. End of Note.
- Argue that these two rules form a specification of *natural numbers* in Prolog.
- Exercise:
  - Specify the *addition* operation in Prolog.

Prolog Syntax

- Write a grammar for Prolog (i.e. Horn Clause formulas) syntax:
  - A Prolog program is a conjunction of Horn Clauses.
    - The conjunction is implicit: i.e.
      - a program is just a list of Horn Clauses.
    - Each Horn Clause is terminated by a period i.e. '.'
  - Horn-Clause syntax:
    - The ***implicand*** appears at the beginning of the clause,
    - followed by the implication symbol ":-",
    - which is followed by a comma-separated list of ***antecedents***
      - ***e.g.*** p(X) :- q(X,Y),r(Y,Z).