Using Rules

Chapter 6
Logic Programming

(Definite) logic program:

\[ A \leftarrow B_1, B_2, \ldots, B_m \]  \hspace{1cm} \text{program clause (Horn)}

head \hspace{1cm} \text{body}

\[ \leftarrow A_1, A_2, \ldots, A_n \]  \hspace{1cm} \text{goal clause}
Logic Programming

PROLOG (Alain Colmerauer 1972):

\[
\begin{align*}
\text{apartmentpet}(X) & :\ - \text{pet}(X), \text{small}(X) \\
\text{pet}(X) & :\ - \text{cat}(X) \\
\text{pet}(X) & :\ - \text{dog}(X) \\
\text{dog}(X) & :\ - \text{poodle}(X) \\
\text{small}(X) & :\ - \text{poodle}(X) \\
\text{poodle}(\text{fluffy}) & \\
\text{pet}(\text{mittens}) & \\
\end{align*}
\]

?- apartmentpet(X)
Forward vs. Backward Reasoning

- Forward: from the start states.
- Backward: from the goal states.
Forward vs. Backward Reasoning

• Forward rules: to encode knowledge about how to respond to certain input.

• Backward rules: to encode knowledge about how to achieve particular goals.
Forward vs. Backward Reasoning

Combining forward and backward reasoning

\[ \leftarrow A_1, \ldots, A_{k-1}, A_k, A_{k+1}, \ldots, A_n \]

achieved by forward reasoning

achieved by backward reasoning
Production Systems

Working memory:

\{A(1), A(2), B(2), B(3), B(4), C(5)\}

Rule memory:

\begin{align*}
A(x) \land B(x) \land C(y) & \Rightarrow \text{add } D(x) \\
A(x) \land B(y) \land D(x) & \Rightarrow \text{add } E(x) \\
A(x) \land B(x) \land E(x) & \Rightarrow \text{delete } A(x)
\end{align*}
Production Systems

RETE network (Forgy, 1982)
Production Systems

Conflict resolution:

Preferences based on rules:
- Specificity of rules
- Physical order of rules

Preferences based on objects:
- Importance of objects
- Position of objects

Preferences based on states:
- Evaluation of states
Pattern Matching

ELIZA (Weizenbaum, 1966):

Person: Men all are alike.
ELIZA: In what way?
Person: They're always bugging us about something or other.
ELIZA: Can you think of specific example?
Person: Well, my boyfriend made me come here.
ELIZA: Your boyfriend made you come here.
Person: He says I'm depressed much of the time.
ELIZA: I am sorry to hear you are depressed.
Person: It's true. I am unhappy.
ELIZA: Do you think coming here will help you not to be unhappy?
Pattern Matching

ELIZA (Weizenbaum, 1966):

Person: I need some help, that much seems certain.
ELIZA: What would it mean to you if you got some help?
Person: Perhaps I could learn to get along with my brother.
ELIZA: Tell me more about your family.

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Pattern Matching

ELIZA (Weizenbaum, 1966):

(X me Y) → (X you Y)
(I remember X) → (Why do you remember X just now?)
(My {family-member} is Y) → (Who else in your family is Y?)
(X {family-member} Y) → (Tell me more about your family)

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Person: My brother is mean to me.
ELIZA: Who else in your family is mean to you?
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