Representing Knowledge using Rules

(Reference: Artificial Intelligence – Rich & Knight)

Predicate Logic (Limitations)

“It is very hot today.”

- ***How can relative degrees of heat be represented?***

“Blonde-haired people often have blue eyes.”

- **How can the amount of certainty be represented?**

“If there is no evidence to the contrary, assume that any adult you meet knows how to read.”

- **How can we represent that one fact should be inferred from the absence of another?**

**“I know John thinks Bill will win but I think he is

KR using Rules

- Provides the flexibility of combining procedural declarative and
- representation for using them in a unified form.
  - IF condition THEN action
  - IF premise THEN conclusion
  - IF proposition p1 and proposition p2 are true THEN proposition p3 is true

Examples of production rules :

IF

F

Advantage of Production Rules

- **they are modular,**
- **each rule define a small and independent piece of knowledge.**
- **new rules may be added and old ones deleted. rules are usually independent of other rules.**

Procedural vs Declarative Knowledge

- man(Marcus)
- man(Ceaser)
- person(Cleopatra)
- ∀x: man(x) → person(x)
- ∃y: person
- (y)

  Find y.

- Answers supported by Knowledge base:
  - Y=Marcus
  - Y=Ceaser
  - Y=Cleopatra
- Order of examining the assertions?

Role of Control Knowledge

- man(Marcus)
- man(Ceaser)
- ∀x: man(x) →
- person(x)

  person(Cleopatra)
- ∃y: person
- (y)

  Find y.

- Factors to be considered:
  - Order of examining the assertions
  - Search strategy?
    - BFS
    - DFS

Control Knowledge

- Which states are more preferable to others?
- Which rule to apply in a given situation?
- Order of pursuing sub-goals? Useful sequences of rules to apply

Logic Programming

- A programming language paradigm in which logical assertions are viewed as programs. Ex. PROLOG
- A Representation in Logic:
  - ∀x: { pet(x) ^ small(x) → apartmentpet(x) }
- A Representation in PROLOG:
  - apartmentpet(x) :- pet(x) , small(x)

Forward vs Backward Reasoning

Q. Find a value of X that satisfies the predicate apartmentpet(X).

- Two directions in which a search could proceed:
  - Forward, from the start states
  - Backward, from the goal states

Factors to be considered

- Are there more possible start states or goal states? (Move from smaller to larger)
- In which direction is the branching factor greater?

(Proceed in direction of lower branching factor) to a user?

- Will the program be asked to justify its reasoning process

(proceed in direction which correspond to user thinking)

What kind of event is going to trigger a problem-solving episode?

- Arrival of a new fact? (forward)
- A query to which a response is desired? (backward)

Comparison Chart

BASIS FOR COMPARISON	FORWARD REASONING	BACKWARD REASONING
Basic	Data-driven	Goal driven
Begins with	New Data	Uncertain conclusion
Objective is to find the	Conclusion that must follow	Facts to support the conclusions
Type of approach	Opportunistic	Conservative
Flow	Incipient to consequence	Consequence to incipient

Combining Forward & Backward reasoning

- Medical Diagnosis Program
- 9 out of 10 pre-conditions
- satisfied.

Conclusion?

From home to unfamiliar place (backward)

Matching

- Indexing
- Matching with Variables
- Complex and Approximate Matching

  Conflict resolution