Post and Markov Systems

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Production Systems

- Why rule-based systems are so useful for expert systems?
- Production systems were first used in symbolic logic by Post (1943)
- Post proved the important and amazing result that any system of mathematics or logic could be written as a certain type of production system.
- Computer languages are commonly defined using the Backus-Naur Form (BNF) of production rules.

Basic Idea

- The basic idea of Post was that any mathematical or logic system is simply a set of rules specifying how to change one string of symbols (antecedent) into another set of symbols (consequent).
- This idea is also valid with programs and expert systems where the initial string of symbols is the input data and the output string is some transformation of the input.

Example

- Input: “patient has fever”
  Output: “take an aspirin”
- The manipulations of the strings is based on syntax and not any semantics or understanding of what a fever, aspirin, and patient represent.
- A production rule for this example could be

  `Antecedent` $\rightarrow$ `Consequent`

  `Person has fever` $\rightarrow$ `take aspirin`

  where the arrow indicates the transformation of one string into another.

- Transform into IF THEN notation as

```
IF person has fever THEN take aspirin
```

- The production rule can also have multiple antecedents. For example:

```
person has fever AND
   fever is greater than 102 → see doctor
```

- A Post production system consists of a group of production rules, such as

  (1) car won't start $\rightarrow$ check battery

  (2) car won't start $\rightarrow$ check gas

  (3) check battery AND battery bad $\rightarrow$ replace battery

  (4) check gas AND no gas $\rightarrow$ fill gas tank

Lack of Control Strategy

- Although Post production rules were useful in laying part of the foundation of expert systems, they are not adequate for writing practical programs.
- The basic limitation of Post production rules for programming is lack of a **control strategy** to guide the application of the rules.
- A Post system permits the rules to be applied on the strings in any manner because there is no specification given on how the rules should be applied.

Markov Algorithm

- Markov (1954) specified a control structure for production systems.
- A **Markov algorithm** is an ordered group of productions which are applied in order of priority to an input string.
- If the highest priority rule is not applicable, then the next one is applied and so on.
- The algorithm terminates if either (1) the last production is not applicable to a string or (2) a production that ends with a period is applied.

Applying Production Rules

- A production system consisting of one rule:
  $AB \rightarrow HIJ$
  when applied to the input string GABKAB produces new string GHIJKAB
  and again GHIJKHIJ.
- The special character $\wedge$ represents the null string of no characters. For example
  $A \rightarrow \wedge$
  deletes all occurrences of the character A in a string.

- The Greek letters α,β, and so forth are used for special punctuation of strings.
- Example: Moves the first letter of an input string to the end.

  (1) αxy → yαx
  (2) α→ ∧.
  (3) ∧ → α
- Notice that the α symbol acts analogously to a temporary variable in a conventional programming language.
- The program then ends when rule 2 is applied since there is a period after rule 2.

Rule	Success or Failure	String
1	F	ABC
2	F	ABC
3	S	αABC
1	S	BαAC
1	S	BCαA
1	F	BCαA
2	S	BCA