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UNIVERSITY INSTITUTE OF ENGINEERING

DEPARTMENT OF COMPUTER SCIENCE AND ENGG.

Bachelor of Engineering (Computer Science & Engineering)

Principles of Artificial Intelligence (20CST-258)

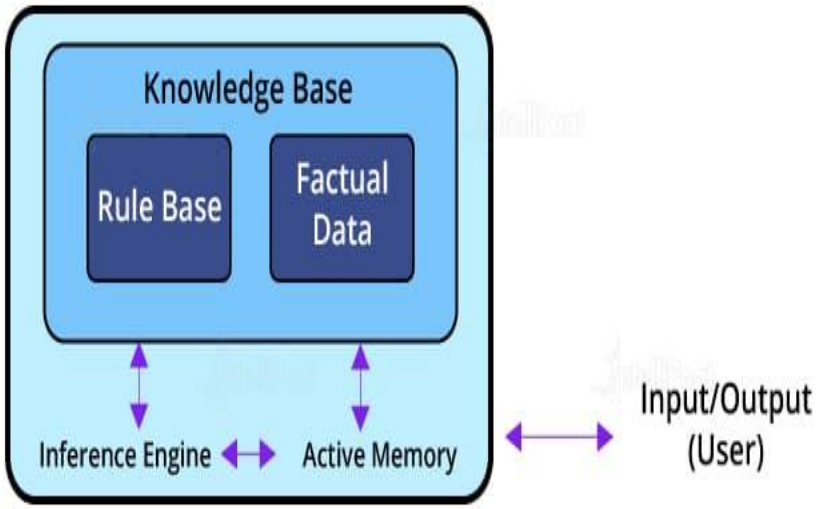
Production System

Outline

- Production System
- Components of Production System
- Features of Production System
- Classes of a Production System
- Production System Rules
- Use Case: Sorting a String in a Production System

Production system

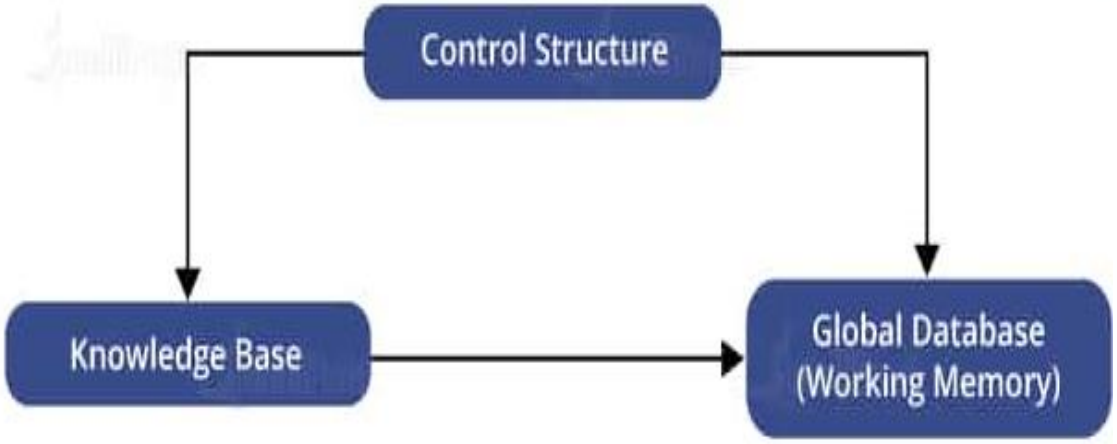
- Production system or production rule system :
  - A computer program typically used to provide some form of artificial intelligence:
    - consists primarily of a set of rules about behaviour.
    - includes the mechanism necessary to follow those rules as the system responds to states of the world.



Components of Production System

- The major components of Production System in Artificial Intelligence are:
  - **Global Database:** The global database is the central data structure used by the production system in Artificial Intelligence.
  - **Set of Production Rules:** The production rules operate on the global database. Each rule usually has a precondition that is either satisfied or not by the global database. If the precondition is satisfied, the rule is usually be applied. The application of the rule changes the database.
  - **Control System:** The control system then chooses which applicable rule should be applied and ceases computation when a termination condition on the database is satisfied. If multiple rules are to fire at the same time, the control system resolves the conflicts.

Components of Production System



Features of Production System

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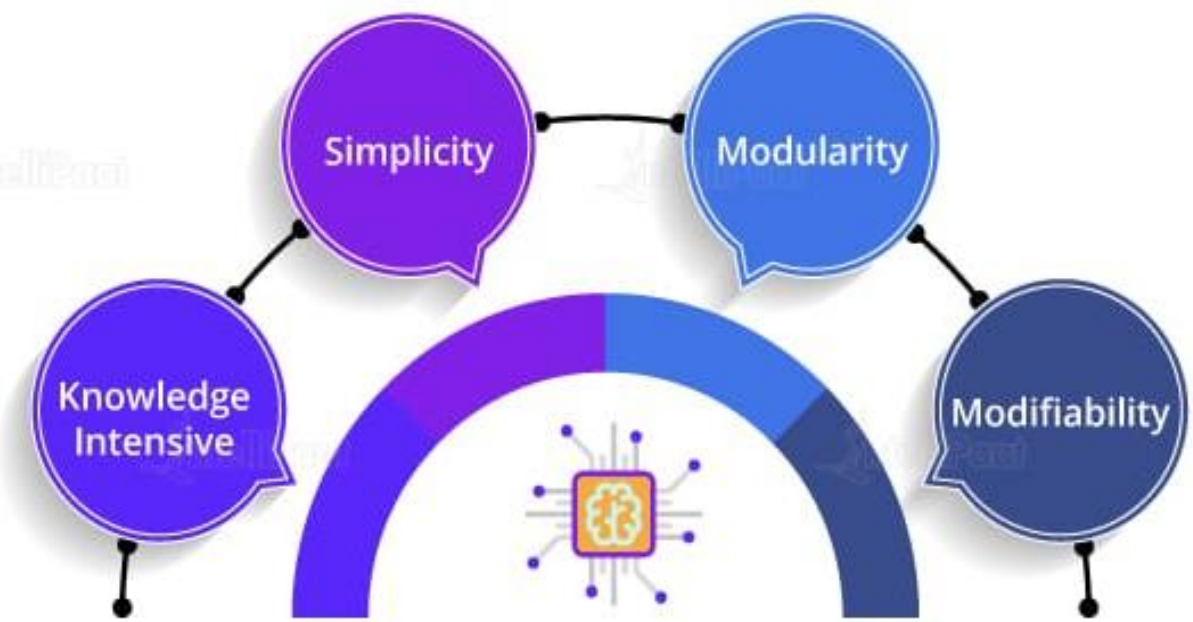

eatures of Production System in Artificial Intelligence

- The main features of the production system include:
  - **Simplicity:**
    - The structure of each sentence in a production system is unique and uniform as they use the “IF-THEN” structure.
    - This structure provides simplicity in knowledge representation.
    - This feature of the production system improves the readability of production rules.
  - **Modularity:**
    - This means the production rule code the knowledge available in discrete pieces.
    - Information can be treated as a collection of independent facts which may be added or deleted from the system with essentially no deleterious side effects.

Features of Production System

- The main features of the production system include:
  - **Modifiability:**
    - This means the facility for modifying rules.
    - It allows the development of production rules in a skeletal form first and then it is accurate to suit a specific application.
  - **Knowledge-intensive:**
    - The knowledge base of the production system stores pure knowledge.
    - Each production rule is normally written as an English sentence; the problem of semantics is solved by the very structure of the representation.

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Classes of a Production System

- There are four types of production systems that help in categorizing methodologies for solving different varieties of problems:
  - **Monotonic Production System:**
    - In this type of a production system, the rules can be applied simultaneously as the use of one rule does not prevent the involvement of another rule that is selected at the same time.
  - **Partially Commutative Production System**
    - This class helps create a production system that can give the results even by interchanging the states of rules.
    - If using a set of rules transforms State A into State B, then multiple combinations of those rules will be capable to convert State A into State B.

Classes of a Production System

- **Non-monotonic Production System**
  - This type of a production system increases efficiency in solving problems.
  - The implementation of these systems does not require backtracking to correct the previous incorrect moves.
  - The non-monotonic production systems are necessary from the implementation point of view to find an efficient solution.

- **Commutative System**
  - Commutative systems are helpful where the order of an operation is not important.
  - Also, problems where the changes are reversible use commutative systems.
  - On the other hand, partially commutative production systems help in working on problems, where the changes are irreversible such as a chemical process.
  - When dealing with partially commutative systems, the order of processes is important to get the correct results.

Production System Rules

- Inference Rules
- It is a type of rule that consists of a logical form used for transformation.
- Production System rules can be classified as:
    - Deductive Inference Rules
    - Abductive Inference Rules

Deductive Inference Rules

- It consists of a logic that helps reasoning with the help of multiple statements to reach a conclusion.
- Example:
  - If it is given that 'A implies B,' then we can infer the conclusion as 'B.'

$$A: B \Rightarrow B$$

- Where,
  - A: The students are studying well.
  - B: If the students are studying well, then all the students will pass the exam.
- **Output:**
  - B: All the students will pass the exam.

Abductive Inference Rules

- This rule helps explain the conclusion in the simplest way by using the given observations.
- **Example:**
  - It is given that 'A implies B,' and there is a possibility to get the output as 'A.'

$$A: B \Rightarrow A$$

- Where,
  - A: All the students will pass the exam.
  - B: If the students are studying well, then all the students will pass the exam.
- **Output:**
  - The students are studying well.

Use Case: Sorting a String in a Production System

- The use of production rules with an example of sorting a string.
  - Initial String: ‘cbaca’
  - Final String: ‘aabcc’

- **The mechanism for sorting a string using the production system in AI:**

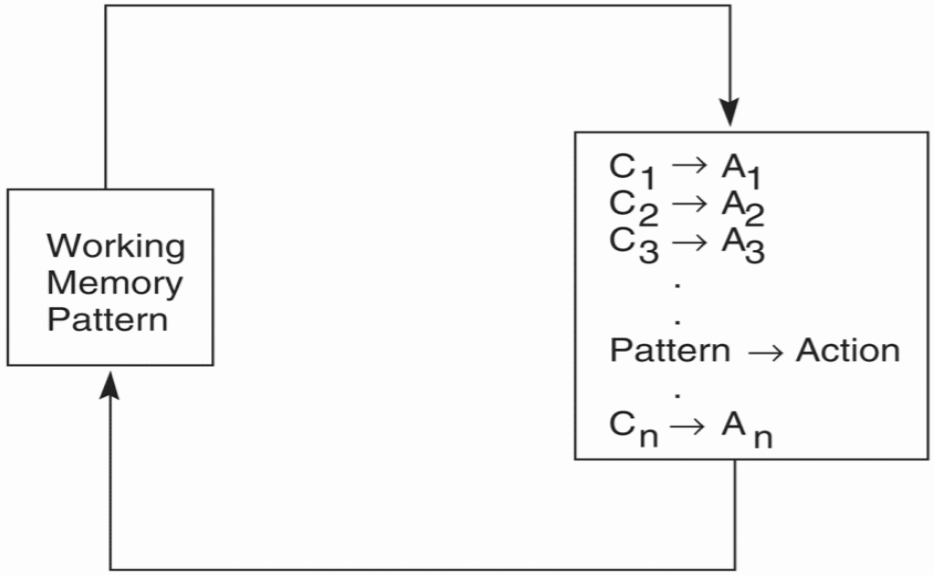
  – The production rules that we use for sorting will be enabled when it satisfies the condition by finding the sub-string in memory.

  – When a particular rule is selected, it replaces the matched string by the string present on the right-hand side of the production rule.

  – The loop of production rules will iterate until it finds the correct output.

Use Case: Sorting a String in a Production System

- A basic production rule that can be used in this case:
  - ba -> ab
  - ca -> ac
  - cb -> bc



Use Case: Sorting a String in a Production System

- The execution of the rules for converting the string.

Iteration #	Working memory	Conflict set	Rule fired
0	cbaca	1, 2, 3	1
1	cabca	2	2
2	acbca	2, 3	2
3	acbac	1, 3	1
4	acabc	2	2
5	aacbc	3	3
6	aabcc	Ø	Halt

- By using three production rules and seven iterations, we are able to convert the string ‘cbaca’ to ‘aabcc.’

THANK YOU