An Experimental Comparison of Knowledge Representation Schemes

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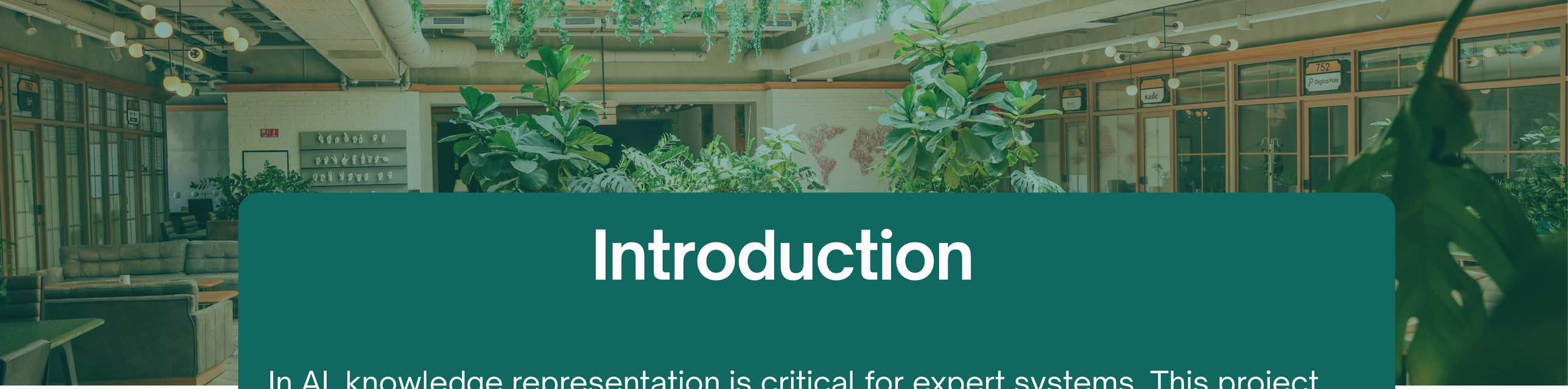


Introduction

In AI, knowledge representation is critical for expert systems. This project compares four techniques for solving risk management in large construction projects ,it refers to the way information, facts, rules, and heuristics are structured and encoded in a system.

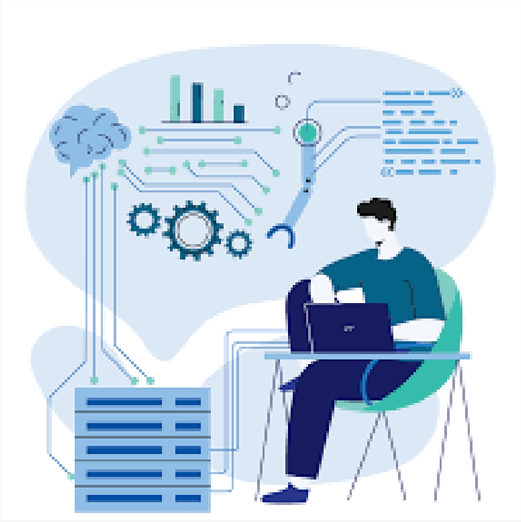
Problem Domain - Risk Management

- **Domain: Managing risks in large construction projects**
- **Risks refer to undesirable events causing:**
  - **Project delays**
  - **Budget overruns**
  - **Technical performance failures**

- **Risk causes are categorized into:**
- Management or operational errors
- Environmental factors
- Contractual defects

Overview of Knowledge Representation Schemes

1. Simple Production System
   - Basic if-then rules
   - Modular and easy to implement
2. Structured Production System
   - Extension of simple rules grouped by temporal order or phases
   - Adds structure to rule execution



3. Frame System
   1. Uses objects (frames) with attributes (slots)
   2. Supports inheritance and logical connections between concepts
4. Logic System
   1. Uses formal logic (Horn clauses)
   2. Suitable for theorem proving and formal inference

Components of the Expert Systems

Reasoning Types

. Forward Reasoning: Deduce risks from known causes

. Backward Reasoning: Validate possible risks by tracing causes

Knowledge Base	Inference Engine	Knowledge Maintenance	User Interface
Stores facts and rules	***Performs reasoning (forward and backward)***	***Allows editing and updating knowledge***	***Accepts input and presents output***

Forward Reasoning

- User inputs keywords
- System suggests related risk causes
- User selects relevant activities
- System applies rules and displays potential consequences

This method helps in proactive risk identification.

Backward Reasoning

- User enters a hypothetical risk
- System asks a series of yes/no questions
- Based on answers, the system confirms or denies the risk.
- It also explains the reasoning chain (rules/frames used).
- This supports reactive decision-making .

Comparison based on :

- Implementation
- runtime efficiency
- knowledge structure.

Implementation Difficulty - Comparison

System	Implementation Effort	Notes
Simple Production	**Low**	Easy to write and manage rules ,used with simple project
Structured Production	**Medium**	**Requires grouping and temporal logic You have a lot of rules need to organized** group related knowledge together**, so the AI doesn't waste time searching**
Frame System	**High**	**Needs frame in knowledge hierarchy and slot definitions fast access to data**
Logic System	**Medium**	**Requires logical clause formation and resolution mechanisms** complex logical quieries

Runtime Performance - Comparison

System	Runtime Speed	Scalability
Simple Production	**Moderate**	**they get slower as you add more rules**
Structured Production	**Fast**	**Efficient for large systems** stay organized as they grow
Frame System	**Very Fast**	**Optimized using pointers and inheritance** stay organized as they grow
Logic System	**Low**	**solve problems step-by-step like a math proof, which takes time, get slower as you add more rules**

Project Objectives

- Identify and understand major risks in large construction projects.
- Analyze how different knowledge representation techniques can support risk management.
- Experimentally compare techniques based on implementation difficulty, performance, and scalability.
- Recommend the most effective knowledge representation method for real-world risk management applications.

Solutions Implemented

- Developed four expert systems to manage construction project risks, each using a distinct knowledge representation scheme:
  - Simple Production System
  - Structured Production System
  - Frame System
  - Logic System

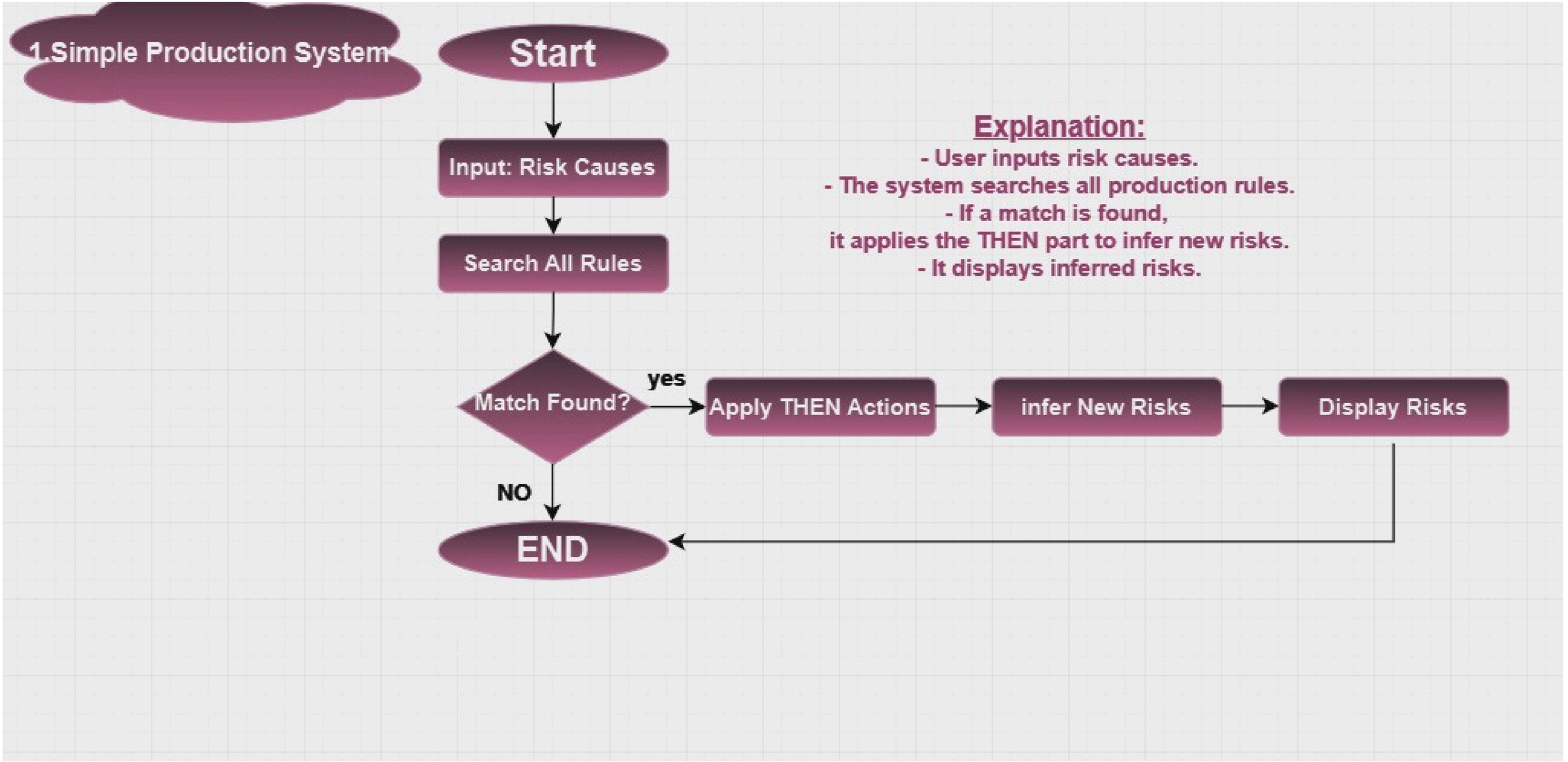
. Identify the size of knowledge to determine which system is better to be used .

- Applied forward and backward reasoning techniques to identify and verify risks.

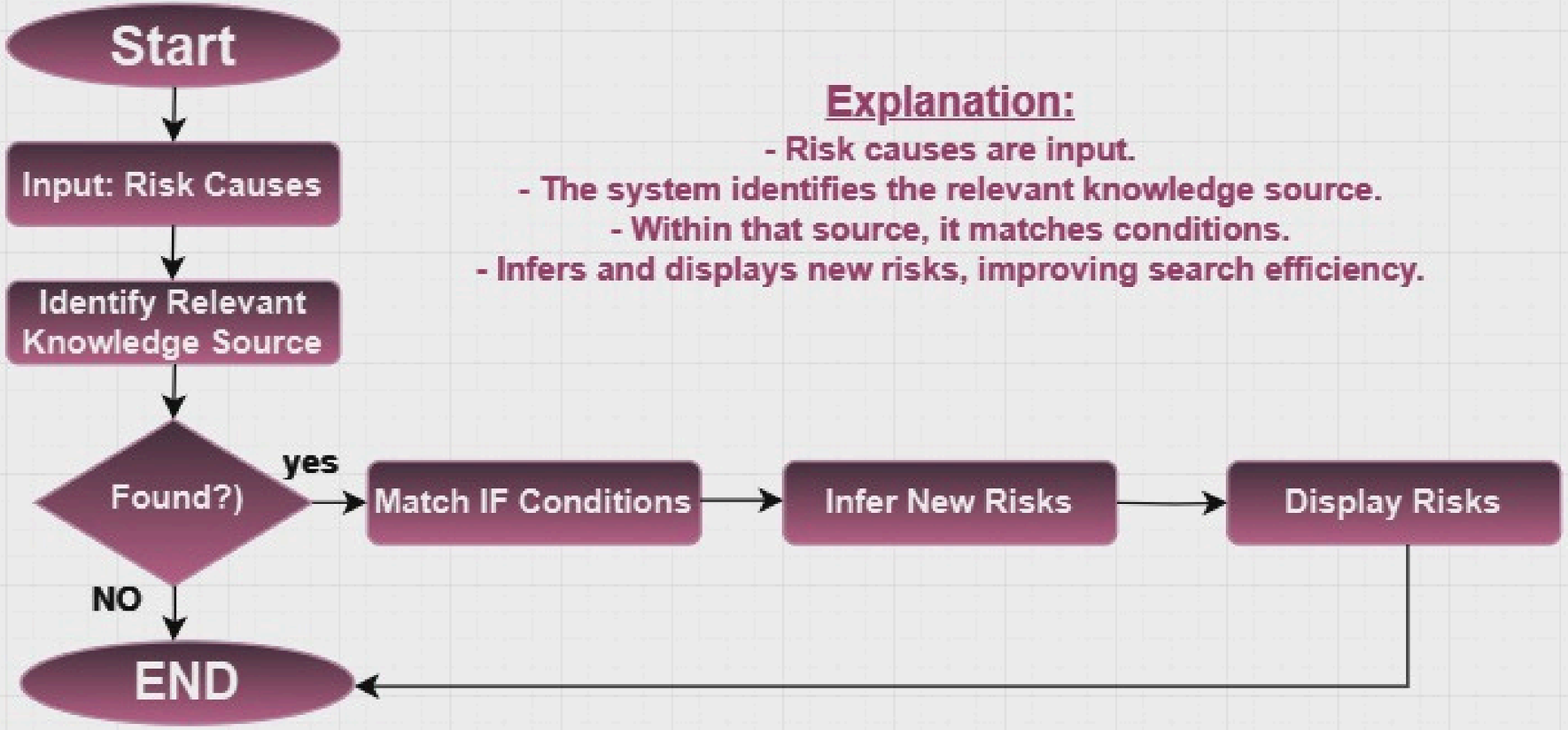
Key Findings

- Modular KR (Simple) is easier to implement but less efficient at runtime
- Structured KR (Structured, Frame) is more complex to build but highly efficient
- Logic systems are logically complete but slow
- Frame systems are fast and organized but hardest to design
- The choice depends on the domain complexity and performance needs

FlowCharts


1.Simple Production System
Start
Input: Risk Causes
Search All Rules
Match Found?
yes
Apply THEN Actions
infer New Risks
Display Risks
NO
END
Explanation:
- User inputs risk causes.
- The system searches all production rules.
- If a match is found,
it applies the THEN part to infer new risks.
- It displays inferred risks.

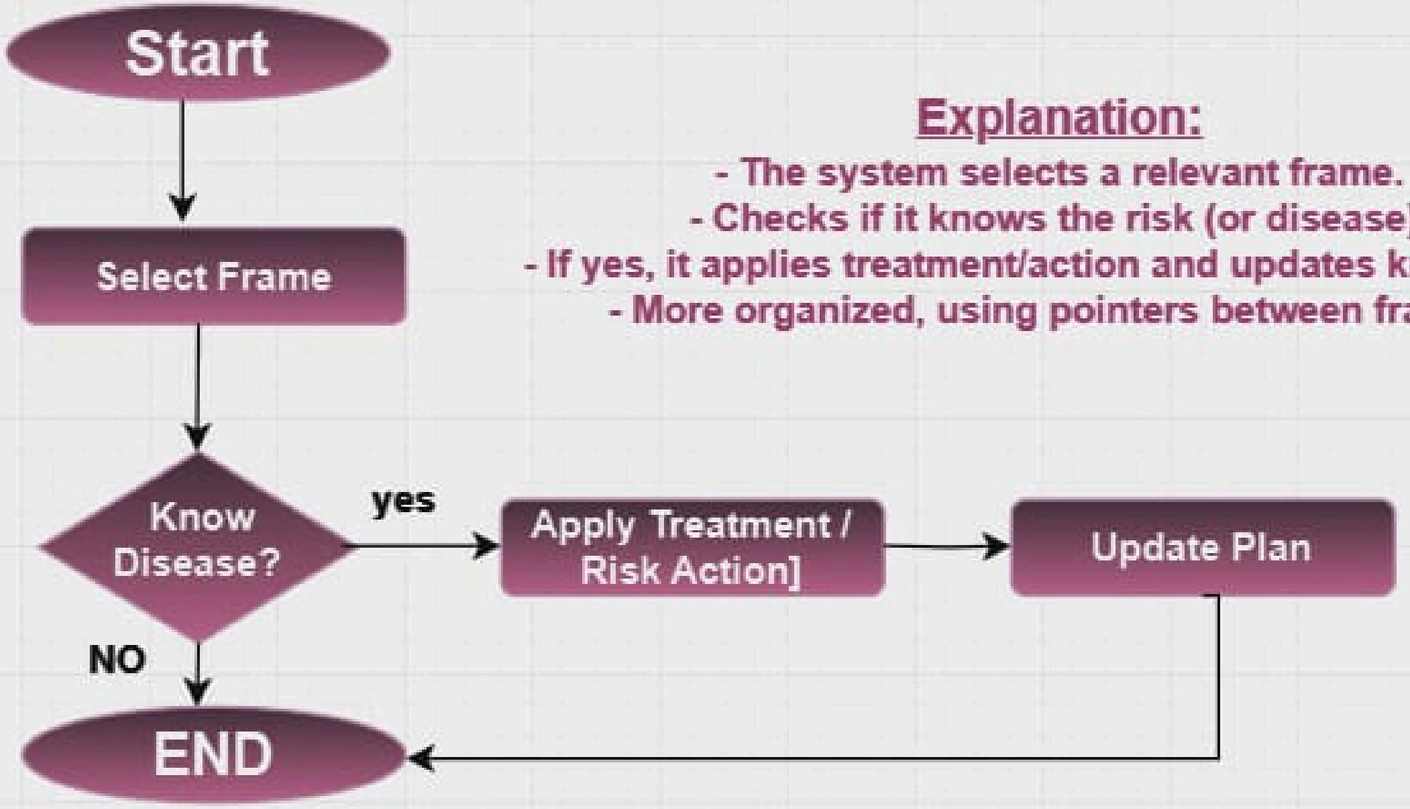
2.Structured Production System



Explanation:

- Risk causes are input.
- The system identifies the relevant knowledge source.
- Within that source, it matches conditions.
- Infers and displays new risks, improving search efficiency.

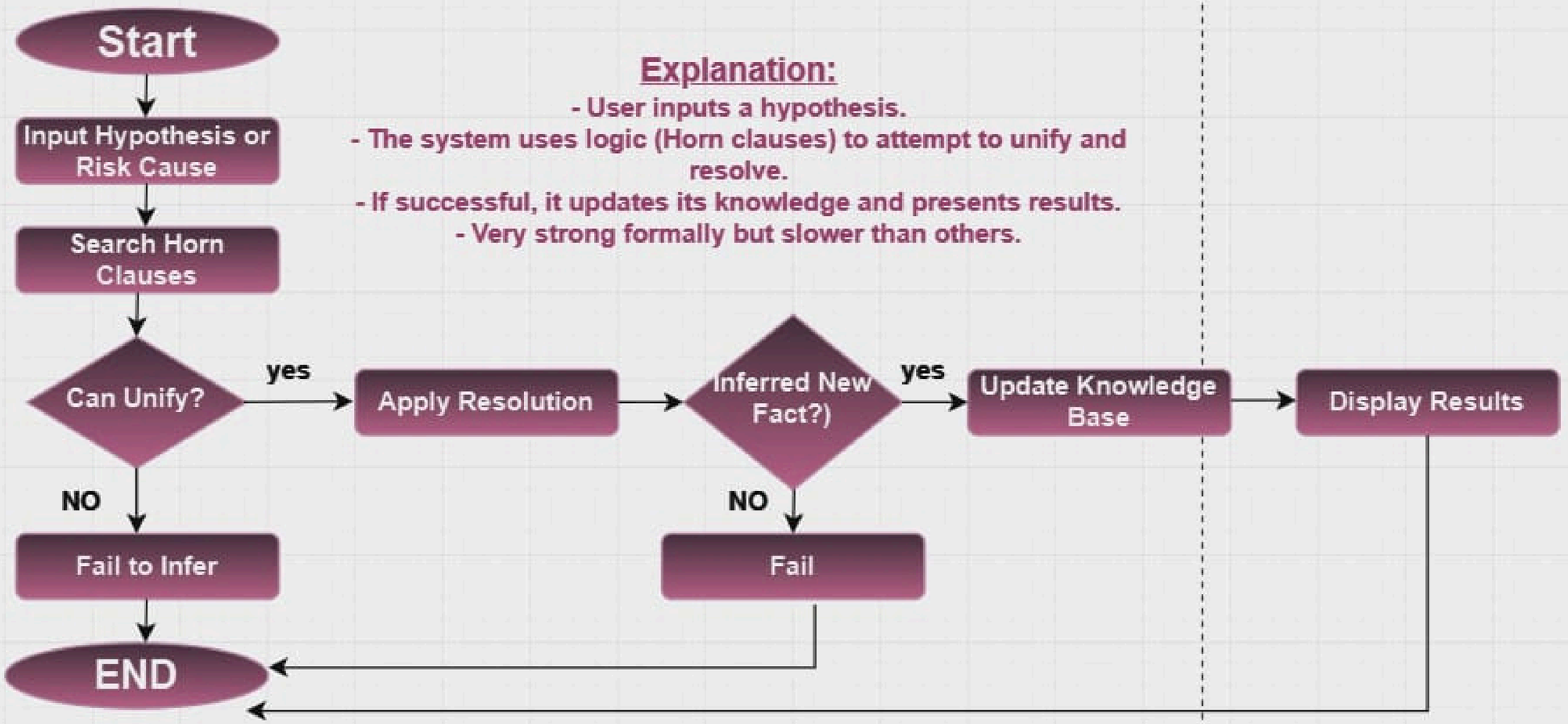
3.Frame System



Explanation:

- The system selects a relevant frame.
- Checks if it knows the risk (or disease).
- If yes, it applies treatment/action and updates knowledge.
- More organized, using pointers between frames.

4.Logic System



Explanation:

- User inputs a hypothesis.
- The system uses logic (Horn clauses) to attempt to unify and resolve.
- If successful, it updates its knowledge and presents results.
- Very strong formally but slower than others.

THANK YOU