

02_Rule_Based

2.1 [DEF] Rules

2.1.1 What is a rule

- An IF-THEN structure
- Relates given information to some actions.
- Relates IF part to THEN part.

2.1.2 Structure of a rule

- **Antecedent:** The IF part
 - Object
 - Operator: Identifies an object, assigns a value
 - Value: Symbolic / Numeric
- **Consequent:** The THEN part
 - Actions
- Example:

```
IF customer_age < 18
AND cash_withdrawal > 1000
THEN require(parent_signature)
```

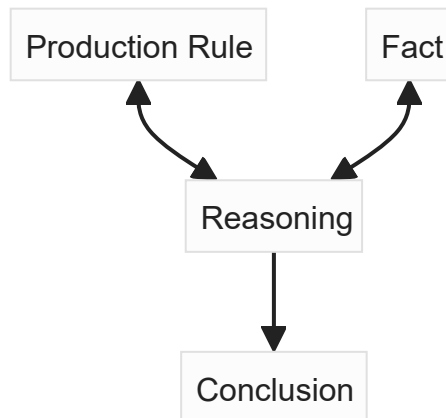
2.1.3 Usage of a rule

Rules can represent:

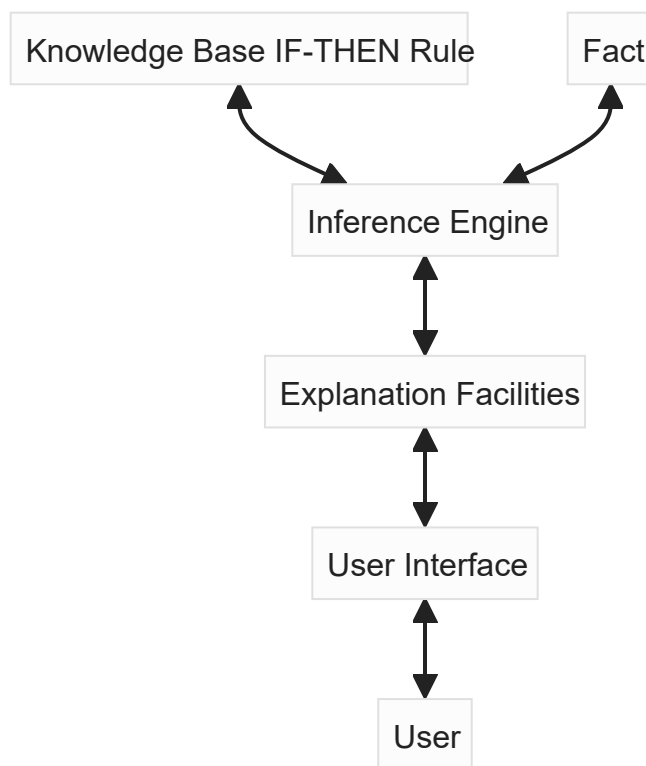
- Relations
- Recommendations
- Directives
- Strategies
- Heuristics

2.2 Rule-based Expert System

Production System Model



Rule-Based Expert System: Basic Structure



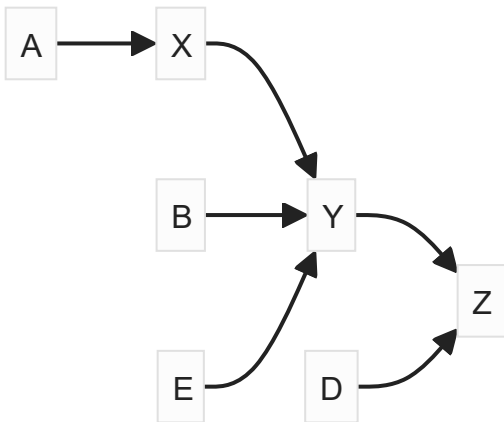
2.3 Forward & Backward Chaining

Example: A set of rules

Legend: If (A) then (B)



Graph of the rule set



Process:

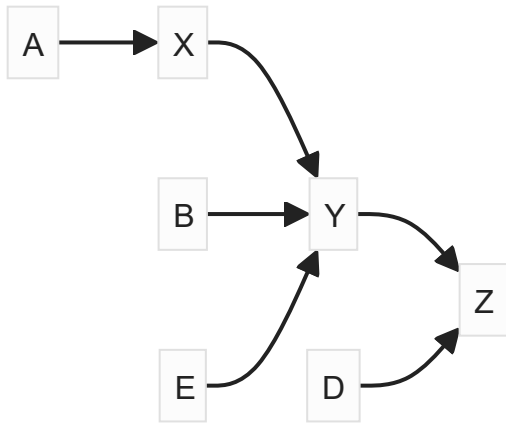
- Every cycle, don't use the fact derived in this cycle yet.
- Use BFS instead of DFS

Known	Rules Fired	Notes
A, B, E, D		
A, B, E, D, X, Y	A -> X, B->Y	Don't use X yet
A, B, E, D, X, Y, Z	D -> Z	

2.3.1 [DEF] Forward Chaining

- Data-Driven Reasoning
 - Given the rules, find the goal.
- Role:
 - Reasoning starts from the known data.
 - Proceeds forward with known data, execute rules to get new facts. *Any rule can be executed only once.*
 - Store new fact in the database.
 - Then use the new fact to do get other facts.

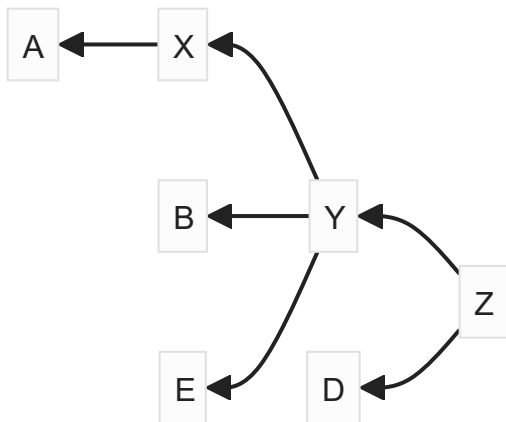
Graph of the rule set



2.3.2 [DEF] Backward Chaining

- Goal-Driven Reasoning
 - Given the goal, find the rules.
- Roles
 - An expert system has the goal
 - The inference engine attempts to **find the evidence** to prove it.

Graph of the rule set

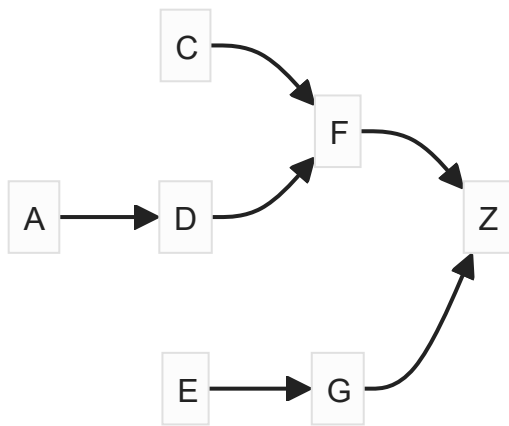


An Example process of Backward Chaining:

Facts:



Rules:



Backward-Chaining Stack Trace:

Given A, B, C, E.

Start.

```

    try F --> Z (Can't find F)
        try C & D --> Z (Can't find D)
            try C & A --> Z (Satisfied)
        try G --> Z (Can't find G)
            try E --> Z (Satisfied)
  
```

End.

2.4 Conflict Resolution

2.4.1 Methods

1. Highest-Priority
2. Most-Specific (Longest Matching Strategy)

Given:

A & B -> C

A -> !C

Choice:

A & B -> C

Reason:

A & B is more specific than A itself.

3. Most-recently Entered

2.4.2 Metaknowledge

- Knowledge about Knowledge
- About the use & control of domain knowledge in an expert sys.
- In rule-based expert systems: Metarules

2.5 Pros & Cons

2.5.1 Advantages

- **Natural Knowledge Representation**
- **Uniform Structure**
 - Each IF-THEN structure is an independent piece of knowledge.
- **Separation of knowledge & Processing**
- **Good for Incomplete & Uncertain Knowledge**

2.5.2 Disadvantages

- **Opaque Relations between Rules**
- **Ineffective search strategy**
- **Inability to learn**