Intelligent Control

Expert System (2b)

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Chapter Description

At the end of this topic , student should be able to:-

- Understand the concept of expert system.

Contents

2.4 Expert system characteristic

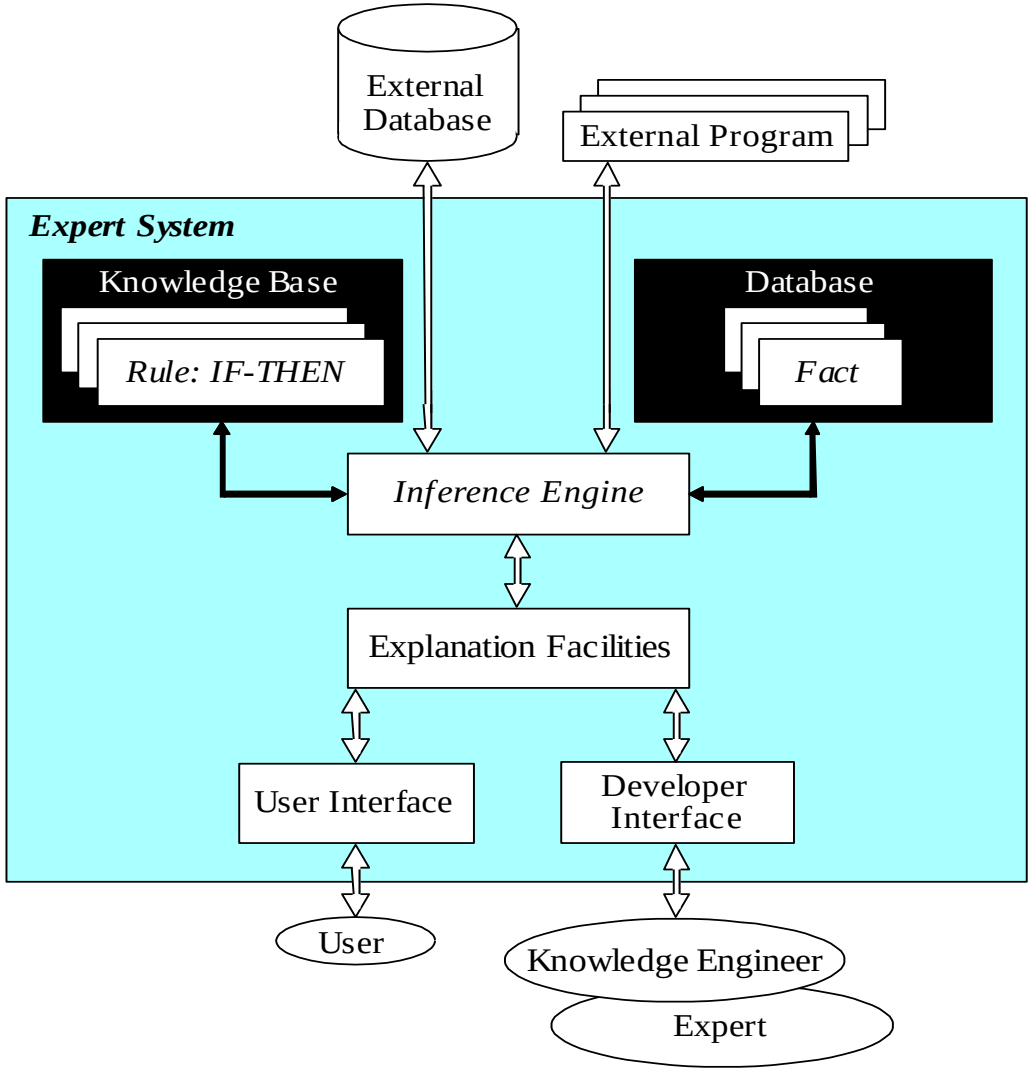
2.5 Forward and backward chaining

2.6 Conflict resolution

Expert system characteristic

2.4

Complete structure of a rule-based expert system



https://www.researchgate.net

Characteristics of an expert system

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To perform at a human expert level in a ***narrow, specialised domain***.

Has high-quality performance. The result must be correct.

Fast and reliable. E.g. Consider time for dying patient in ICU.

ES use **heuristics** as a guidance and reduce the searching area for a solution.

Able to explain its decision and review its own reasoning.

ES utilize **symbolic reasoning** to solve problem. Symbols such as facts, concepts and rules are used

QUALIFYING CHARACTERISTICS OF EXPERT SYSTEMS

ES are suitable in a case where/when:

- No established theories.
- The information is blur, inexact or not clear.
- Incomplete system.
- The domain is very specific.

QUALIFYING CHARACTERISTICS OF EXPERT SYSTEMS … (Cont'd.)

ES are not suitable in a case where/when:

- The systems are calculative or deterministic in nature.
- There is a standard model or formula.
- So many human experts.
- Knowledge base is needed by end users.

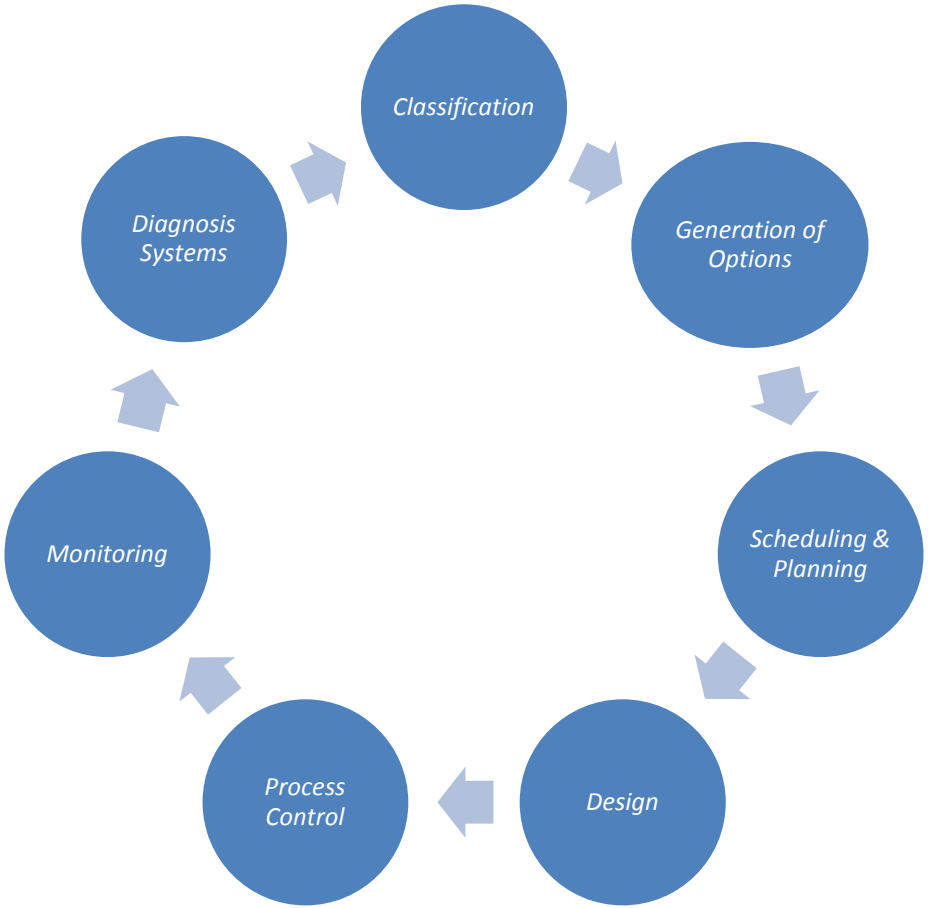
Comparison of expert systems with conventional systems and human experts

Human Experts	*Expert Systems*	*Conventional Programs*
Use knowledge in the form of rules of thumb or heuristics to solve problems in a narrow domain.	Process knowledge expressed in the form of rules and use symbolic reasoning to solve problems in a *narrow domain*.	Process data and use algorithms, a series of well-defined operations, to solve general numerical problems.
In a human brain, knowledge exists in a compiled form.	Provide a *clear separation of knowledge from its processing*.	Do not separate knowledge from the control structure to process this knowledge.
Capable of explaining a line of reasoning and providing the details.	*Trace the rules fired* during a problem-solving session and *explain how* a particular conclusion was reached and *why* specific data was needed.	Do not explain how a particular result was obtained and why input data was needed.

Comparison of expert systems with conventional systems and human experts (*Contd*)

Human Experts	*Expert Systems*	*Conventional Programs*
Use inexact reasoning and can deal with incomplete, uncertain and fuzzy information.	Permit *inexact reasoning* and can deal with incomplete, uncertain and fuzzy data.	Work only on problems where data is complete and exact.
Can make mistakes when information is incomplete or fuzzy.	*Can make mistakes* when data is incomplete or fuzzy.	Provide no solution at all, or a wrong one, when data is incomplete or fuzzy.
Enhance the quality of problem solving via years of learning and practical training. This process is slow, inefficient and expensive.	Enhance the quality of problem solving by adding new rules or adjusting old ones in the knowledge base. When new knowledge is acquired, *changes are easy* to accomplish.	Enhance the quality of problem solving by changing the program code, which affects both the knowledge and its processing, making changes difficult.

Expert System Application areas



Group Activity

- Given the following fields, select an area that your group is most expert with.
  - Industrial application/manufacturing
  - Robotics
  - Oil & gas
  - Troubleshooting in Electrical & Electronics
- Identify your problem domain and objectives
- Construct a flowchart to describe your system.
- The expert system must have at least 10 rules and 2 conclusion.

Forward and backward chaining

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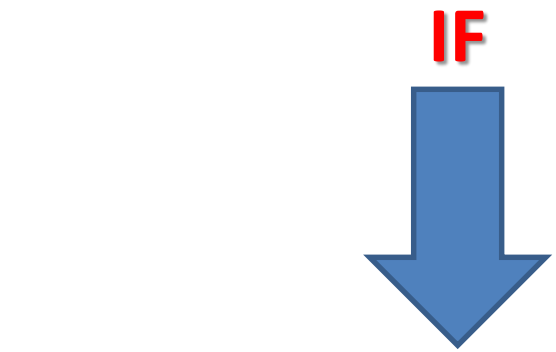
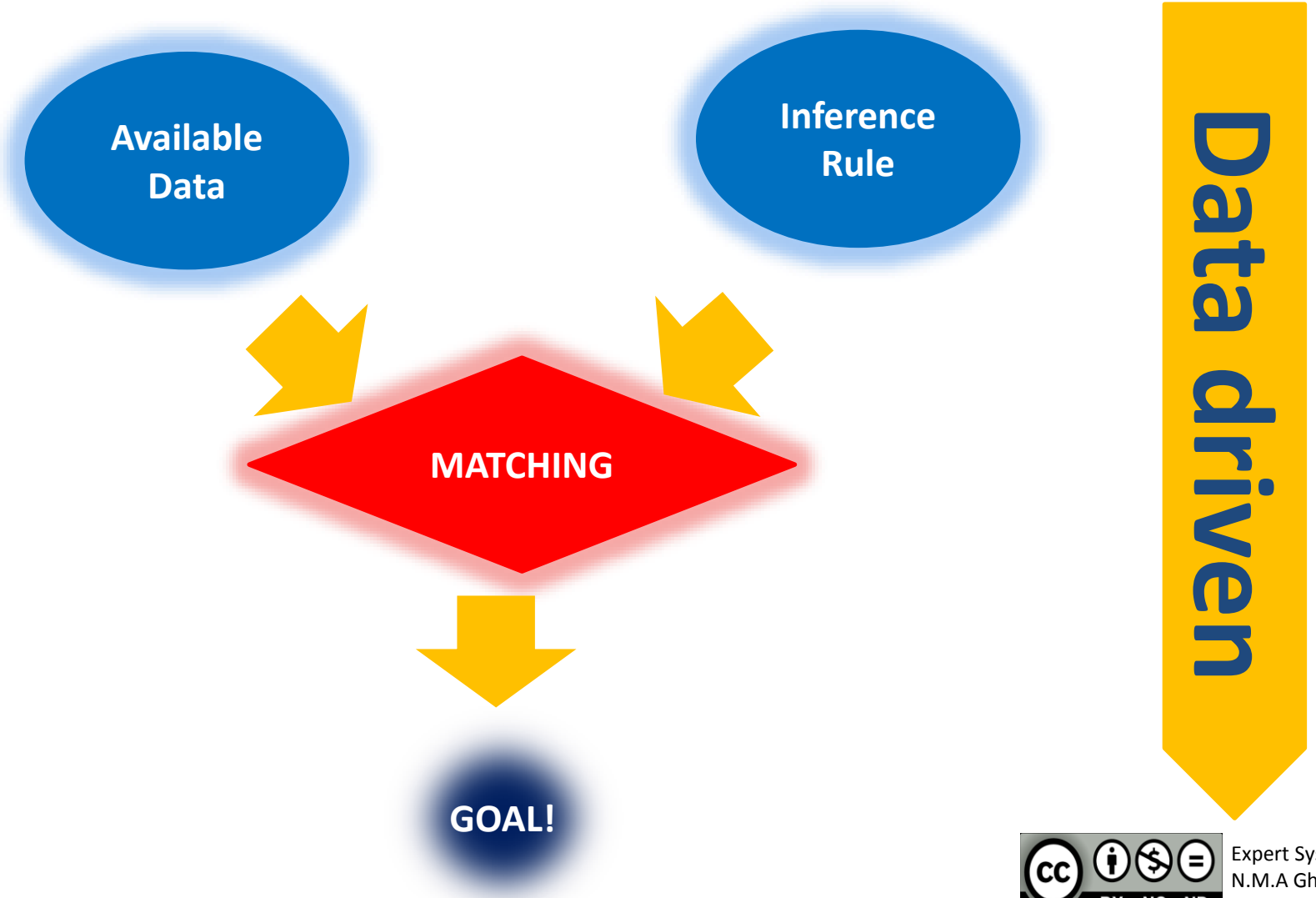
Forward chaining and backward chaining

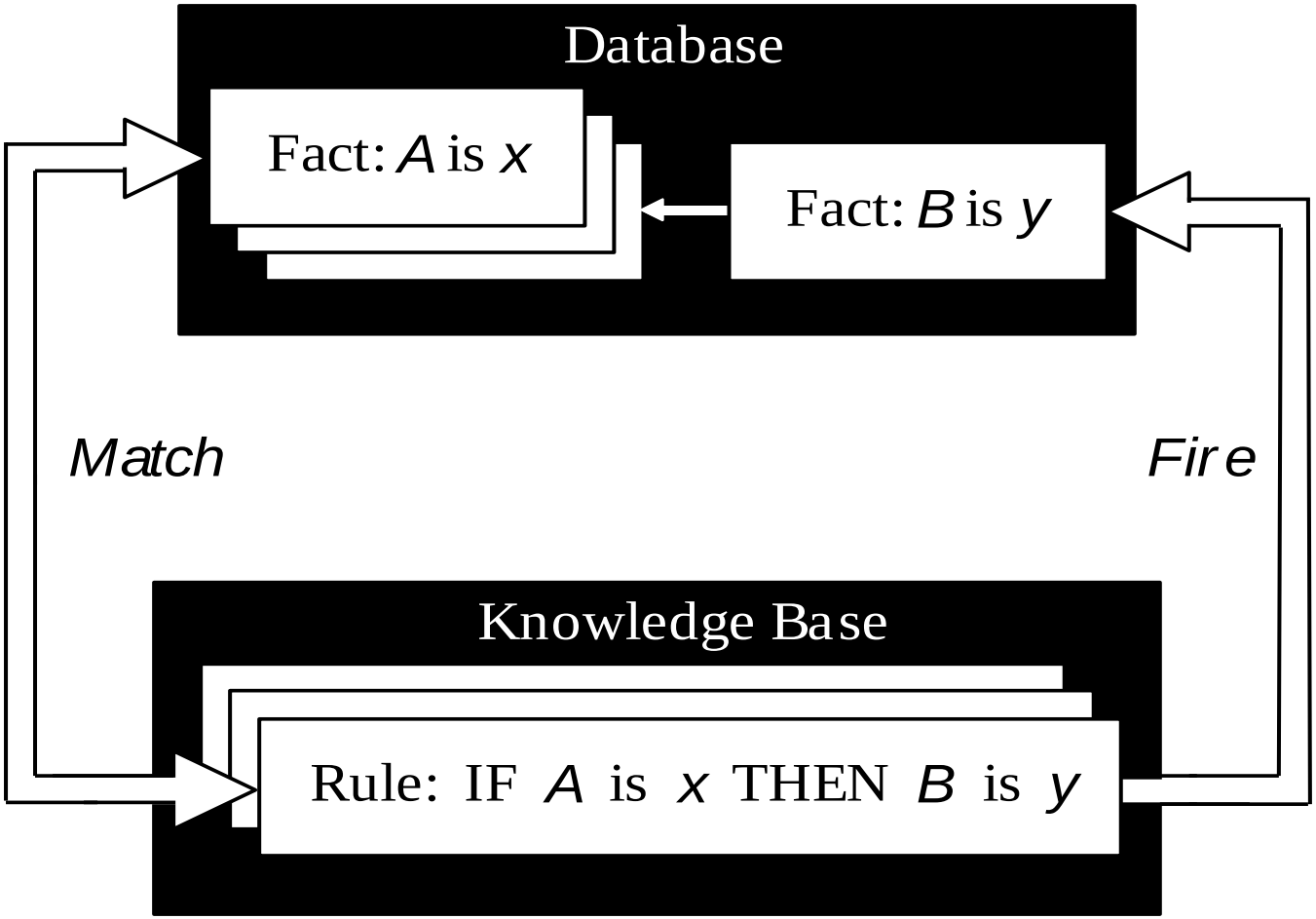


Inference chain

Forward Chaining



Inference engine cycles via a match-fire procedure



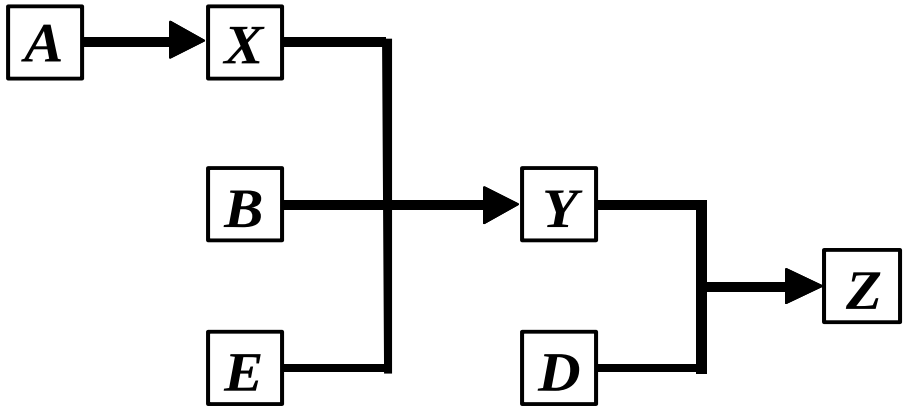
http://slideplayer.com

An example of an inference chain

Rule 1: IF *Y* is true
AND *D* is true
THEN *Z* is true

Rule 2: IF *X* is true
AND *B* is true
AND *E* is true
THEN *Y* is true

Rule 3: IF *A* is true
THEN *X* is true



Forward chaining

Data-driven reasoning.

Only the topmost rule is executed each time .

Starts from known data.

The rule adds new fact in the database when fired.

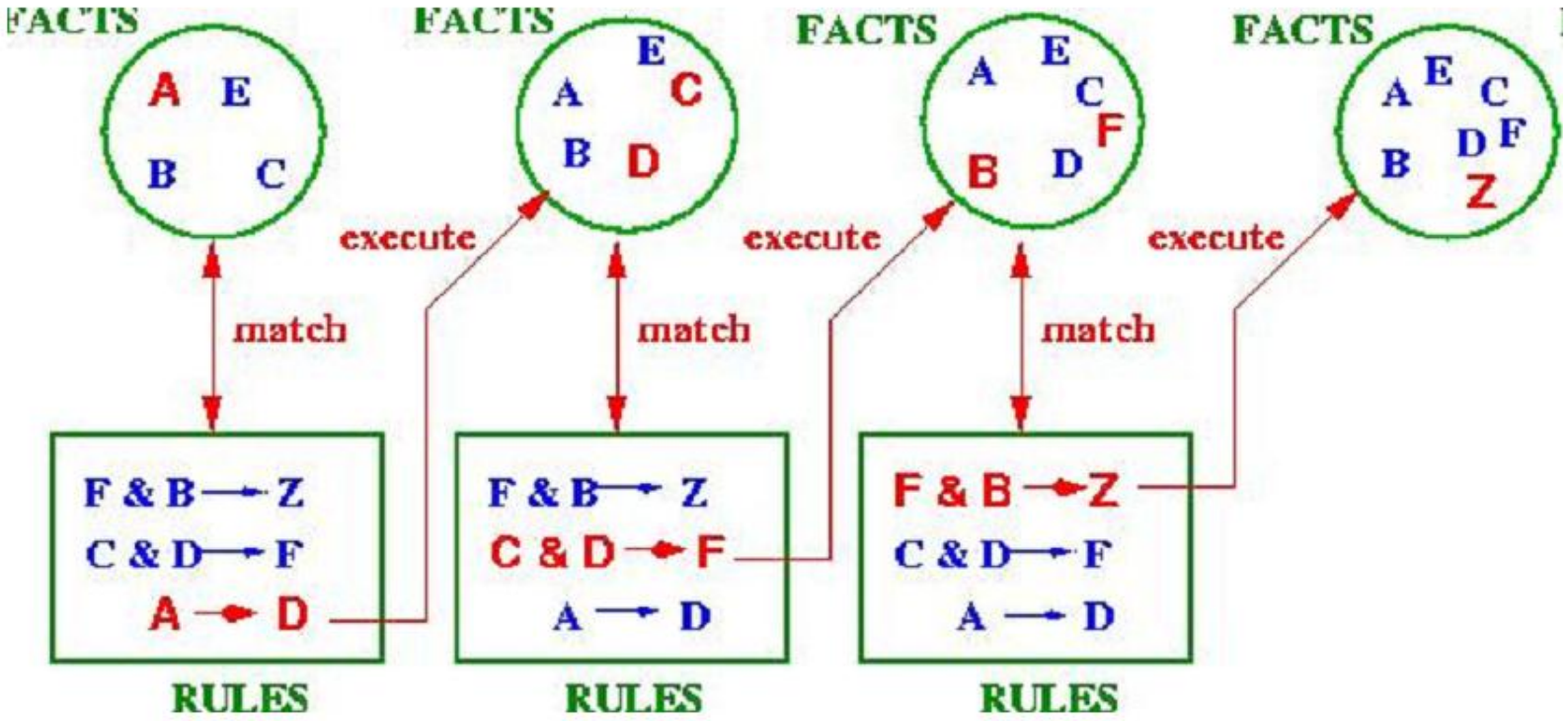
The match-fire cycle stops when no further rules.

The reasoning process forward.

Any rule can be executed only once.

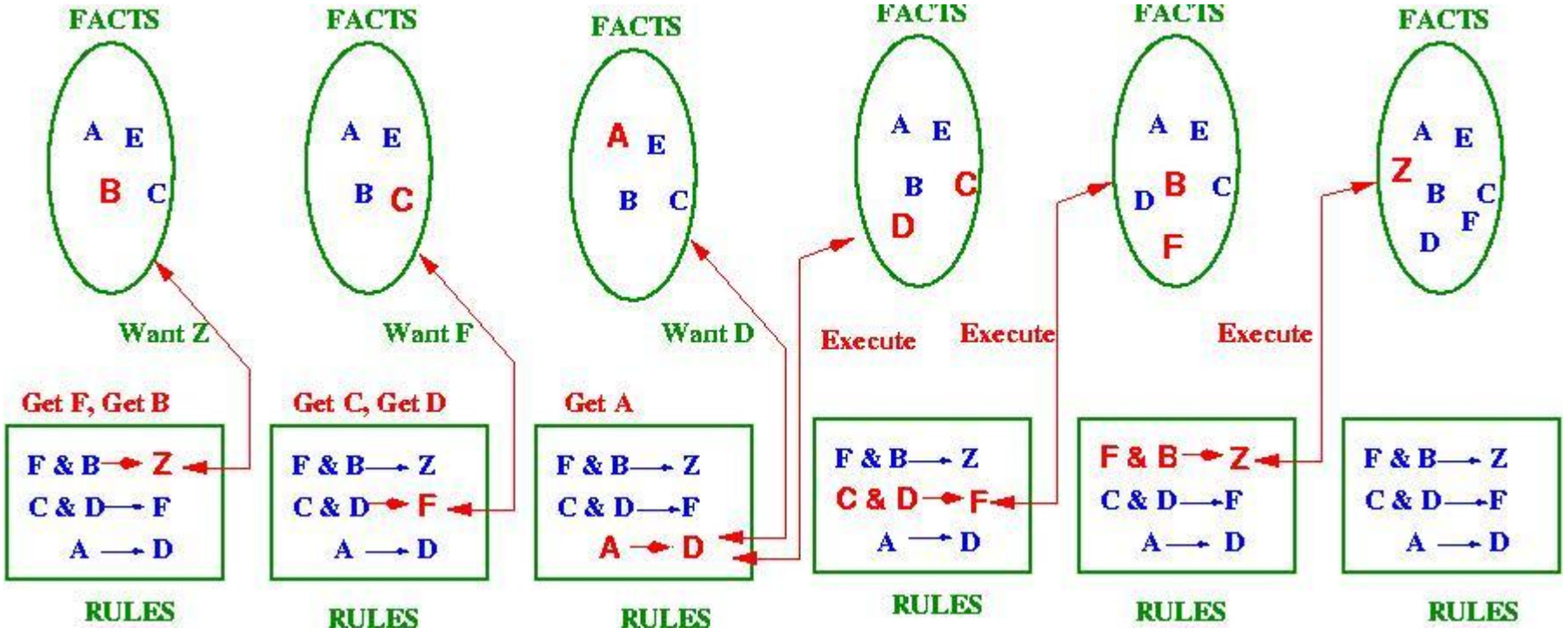
Forward chaining

Goal state: Z
Termination condition: stop if Z is derived or no further rule can be applied



Source: Kerber (2004), http://www.cs.bham.ac.uk/~mmk/Teaching/AI/l2.html

Backward chaining



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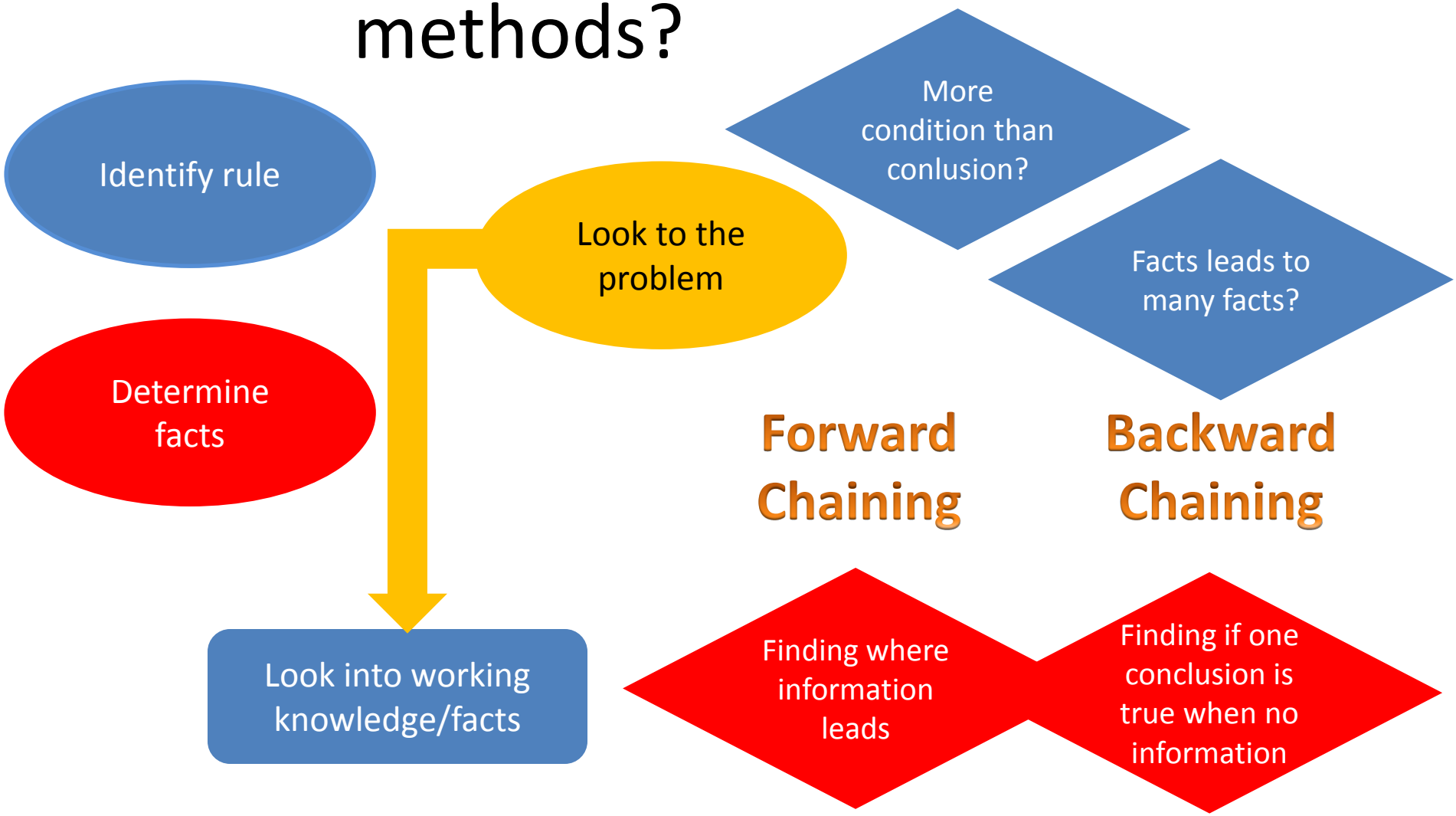
So how to choose between methods?



Conflict Resolution

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Conflict resolution

Rule 1

- IF the lamp switch is turned ON
- THEN the bulb is bright.

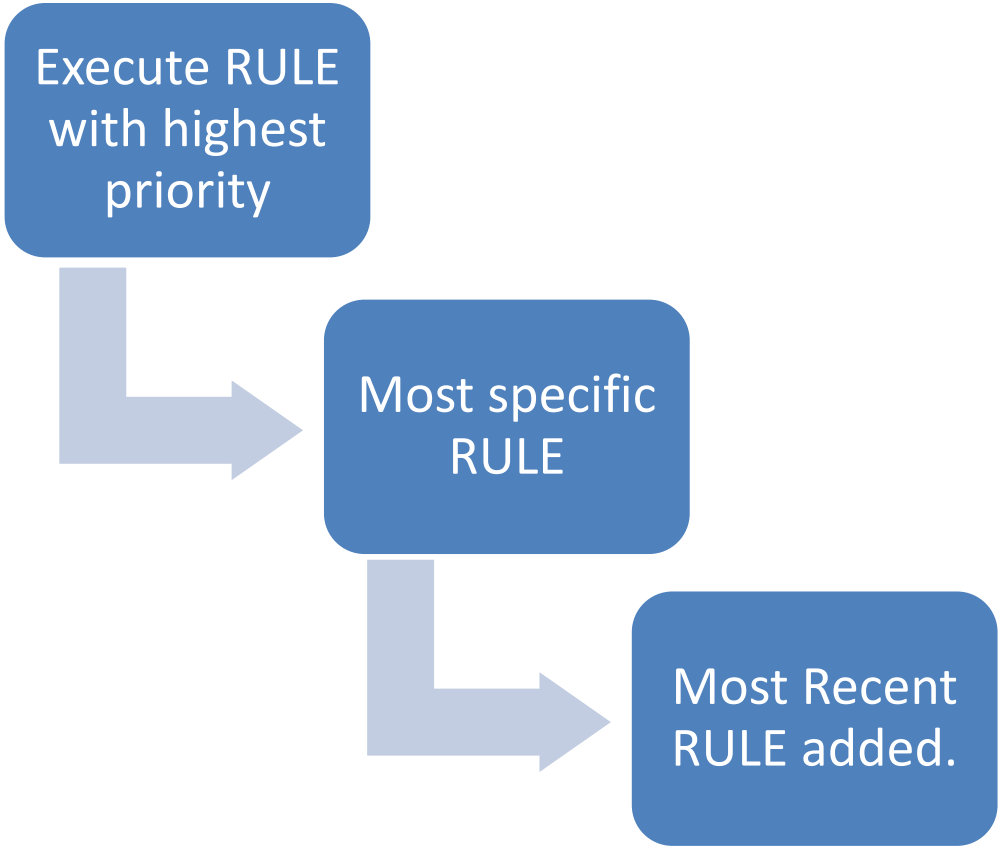
Rule 2

- IF the lamp switch is turned OF
- THEN the bulb is dark.

Rule 3

- IF the lamp switch is turned OF
- THEN the bulb is bright.

Methods used for conflict resolution



Advantages/Disadvantages of rule-based expert systems

-Natural knowledge representation.

-Uniform structure.

-Separation of knowledge from its processing.

- Dealing with incomplete and uncertain knowledge.

-No transparent relation between RULE.

-Ineffective search strategy.

-Inability to learn.

-Not able to learn from experience.

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