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Expert System

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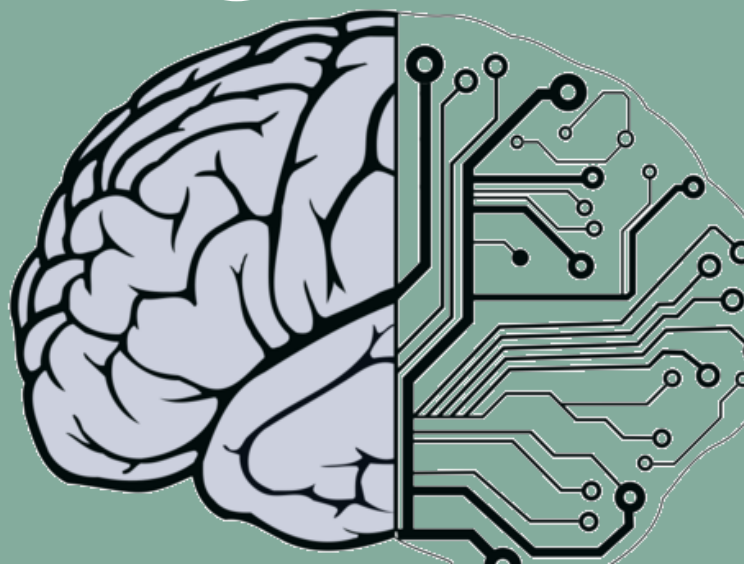
Expert System Architecture

~ Basic Concepts of Expert Systems

~ Basic Concepts of Expert Systems
~ Components of ES

~ Basic Concepts of Expert Systems
~ Components of ES
~ Who is involved?

Basic Concepts of Expert Systems



~ Expertise
~ Experts
~ Transferring Expertise
~ Inferencing Rules
~ Explanation Capability

Expertise

Expertise is the extensive, task-specific knowledge acquired from training, reading and experience

- Theories about the problem area
- Hard-and-fast rules and procedures
- Rules (heuristics)
- Global strategies
- Meta-knowledge (knowledge about knowledge)
- Facts

Enables experts to be better and faster than nonexperts

Expertise

~ Expertise is usually associated with a high degree of intelligence, but not always with the smartest person

~ Expertise is usually associated with a vast quantity of knowledge

~ Experts learn from past successes and mistakes

~ Expert knowledge is well-stored, organized and retrievable quickly from an expert

~ Experts have excellent recall

Experts

~ Degrees or levels of expertise

~ Nonexperts outnumber experts often by 100 to 1

Human Expert Behaviors

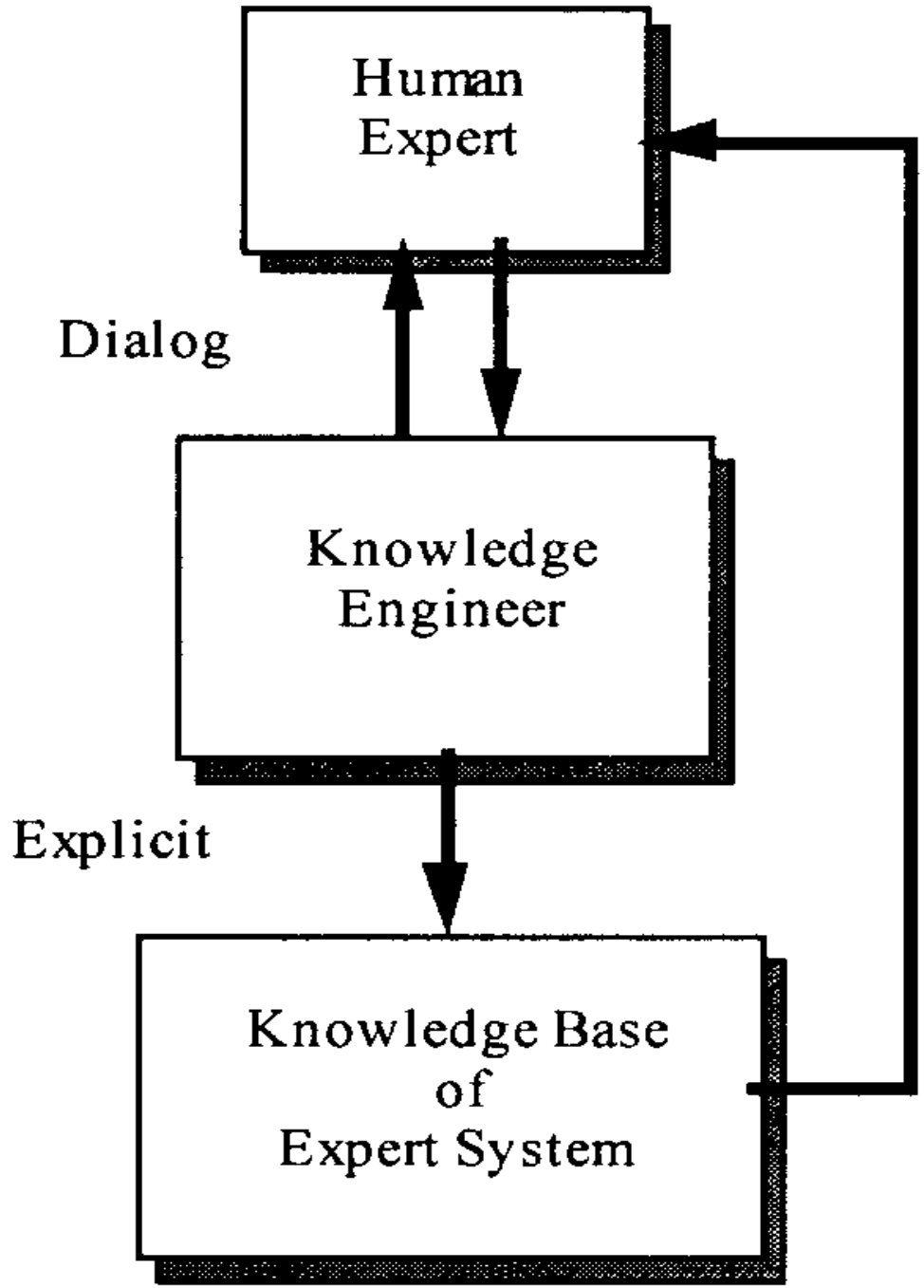
~ Recognizing and formulating the problem
~ Solving the problem quickly and properly
~ Explaining the solution
~ Learning from experience
~ Restructuring knowledge
~ Breaking rules
~ Determining relevance
~ Degrading gracefully (awareness of limitations)

Transferring Expertise

Two Knowledge Types

- ~ Facts
- ~ Procedures (Usually Rules)

Regarding the Problem Domain


Human
Expert
Dialog
Knowledge
Engineer
Explicit
Knowledge Base
of
Expert System

Inferencing

~ Reasoning (Thinking)

~ The computer is programmed so that it can make inferences

~ Performed by the Inference Engine

Rules

IF-THEN-ELSE

Explanation Capability

By the justifier, or explanation subsystem

Explanation Capability

An ES has to explain how the ES has arrived at a particular recommendation.

Explanation Capability

The explanation may appear in the following forms :

- Natural language displayed on screen.
- Verbal narrations in natural language.
- Listing of rule numbers displayed on the screen.

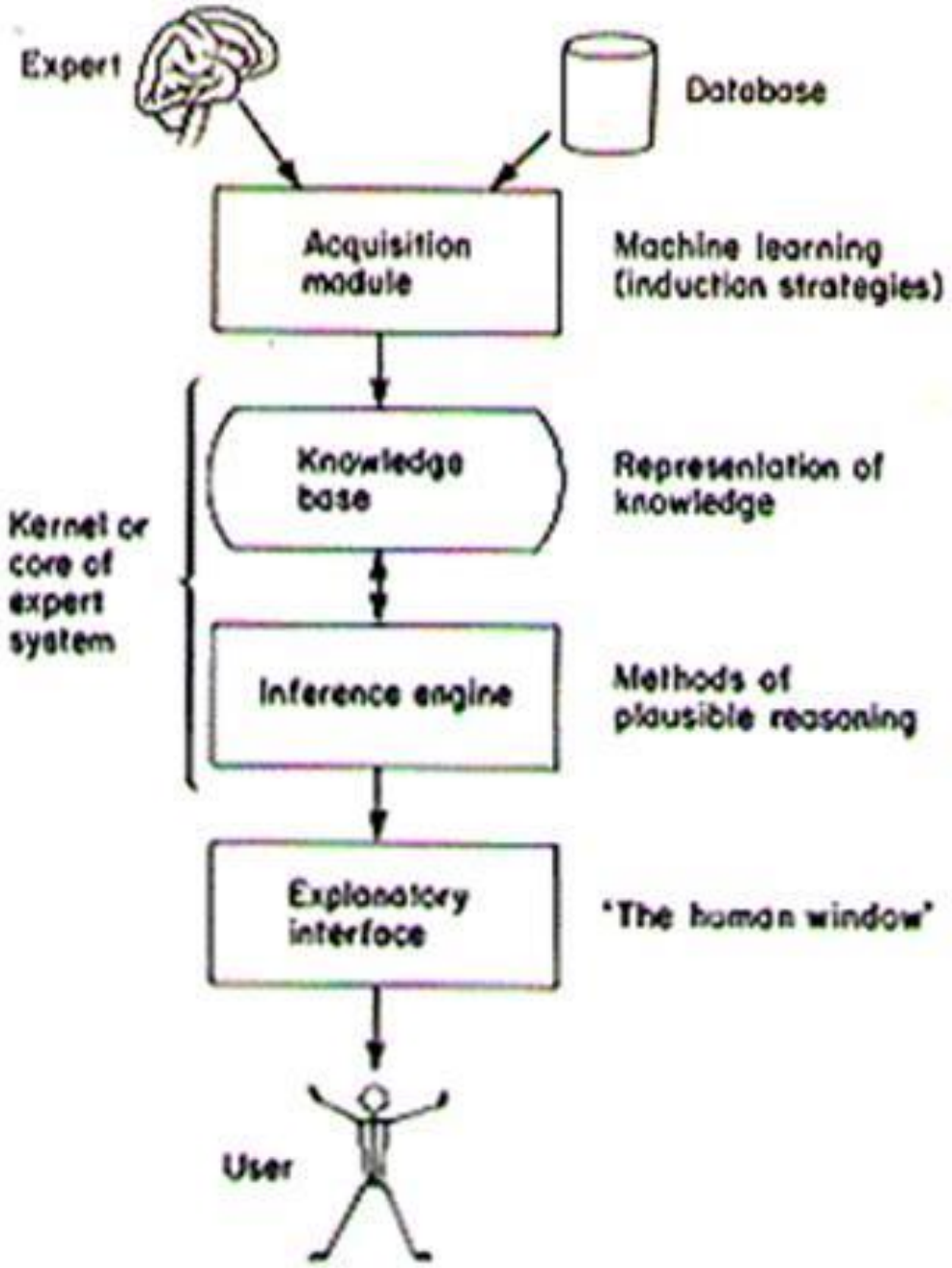
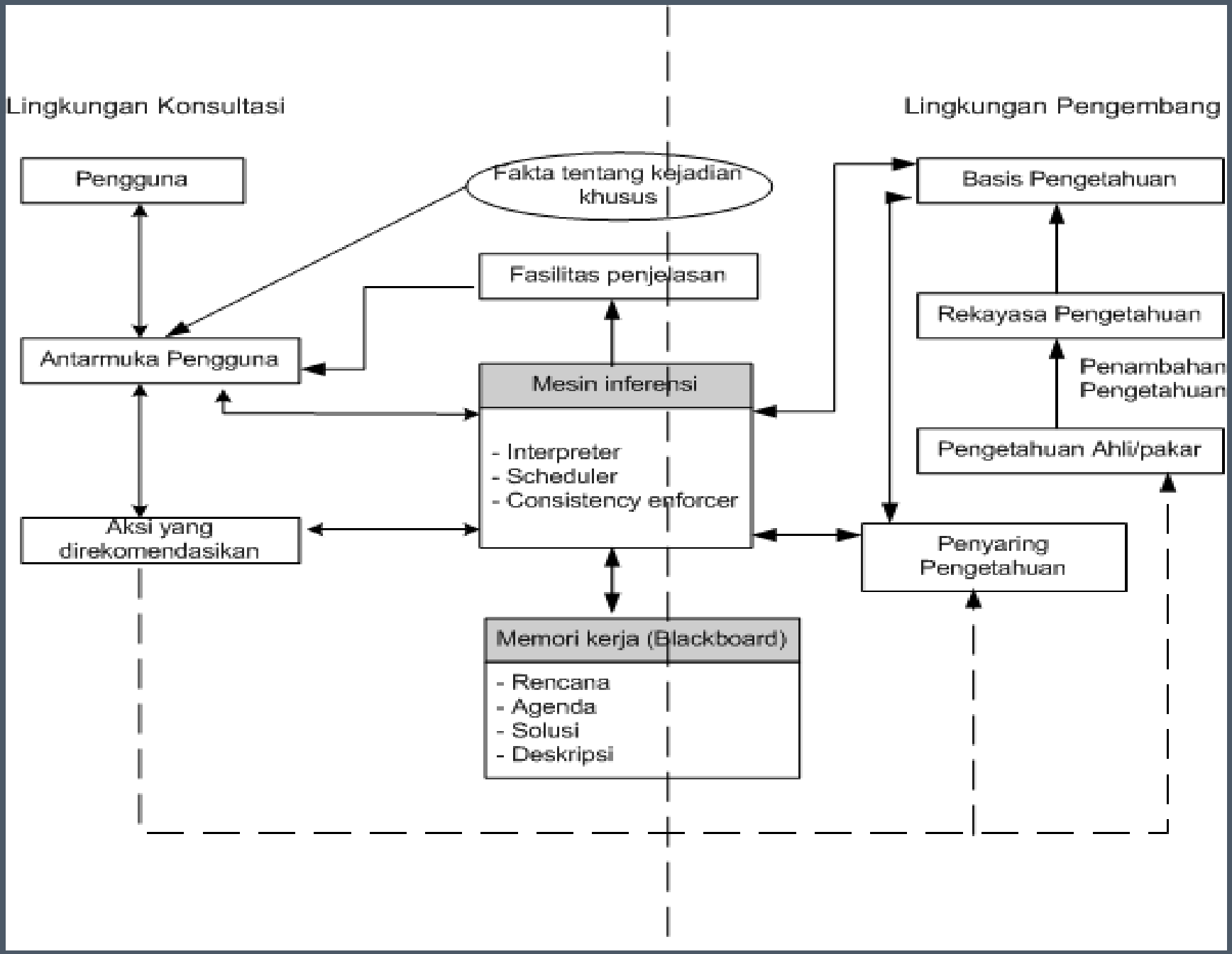

Expert
Database
Acquisition module
Machine learning (induction strategies)
Knowledge base
Represenlation of knowledge
Kernel or core of expert system
Inference engine
Methods of plausible reasoning
Explanatory interface
'The human window'
User

TABLE 12.1 Comparison of Conventional Systems and Expert Systems

Conventional Systems	Expert Systems
Information and its processing are usually combined in one sequential program	Knowledge base is clearly separated from the processing (inference) mechanism (i.e., knowledge rules separated from the control)
Program does not make mistakes (programmers do)	Program may make mistakes
Do not (usually) explain why input data are needed or how conclusions are drawn	Explanation is a part of most ES
Require *all* input data. May not function properly with missing data unless planned for	Do *not* require all initial facts. Typically can arrive at reasonable conclusions with missing facts
Changes in the program are tedious	Changes in the rules are easy to accomplish
The system operates only when it is completed	The system can operate with only a few rules (as the first prototype)
Execution is done on a step-by-step (algorithmic) basis	Execution is done by using heuristics and logic
Effective manipulation of large databases	Effective manipulation of large knowledge bases
Representation and use of data	Representation and use of knowledge
Efficiency is a major goal	Effectiveness is the major goal
Easily deal with quantitative data	Easily deal with qualitative data
Use numerical data representations	Use symbolic knowledge representations
Capture, magnify and distribute access to numeric data or to information	Capture, magnify and distribute access to judgment and knowledge

Components of Expert Systems


Lingkungan Konsultasi
Lingkungan Pengembang
Pengguna
Fakta tentang kejadian khusus
Basis Pengetahuan
Fasilitas penjelasan
Rekayasa Pengetahuan
Antarmuka Pengguna
Penambahan Pengetahuan
Mesin inferensi
- Interpreter
- Scheduler
- Consistency enforcer
Pengetahuan Ahli/pakar
Aksi yang direkomendasikan
Penyaring Pengetahuan
Memori kerja (Blackboard)
- Rencana
- Agenda
- Solusi
- Deskripsi

All ES Components

~ Knowledge Acquisition Subsystem

~ Knowledge Base

~ Inference Engine

~ User

~ User Interface

~ Blackboard (Workplace)

~ Explanation Subsystem (Justifier)

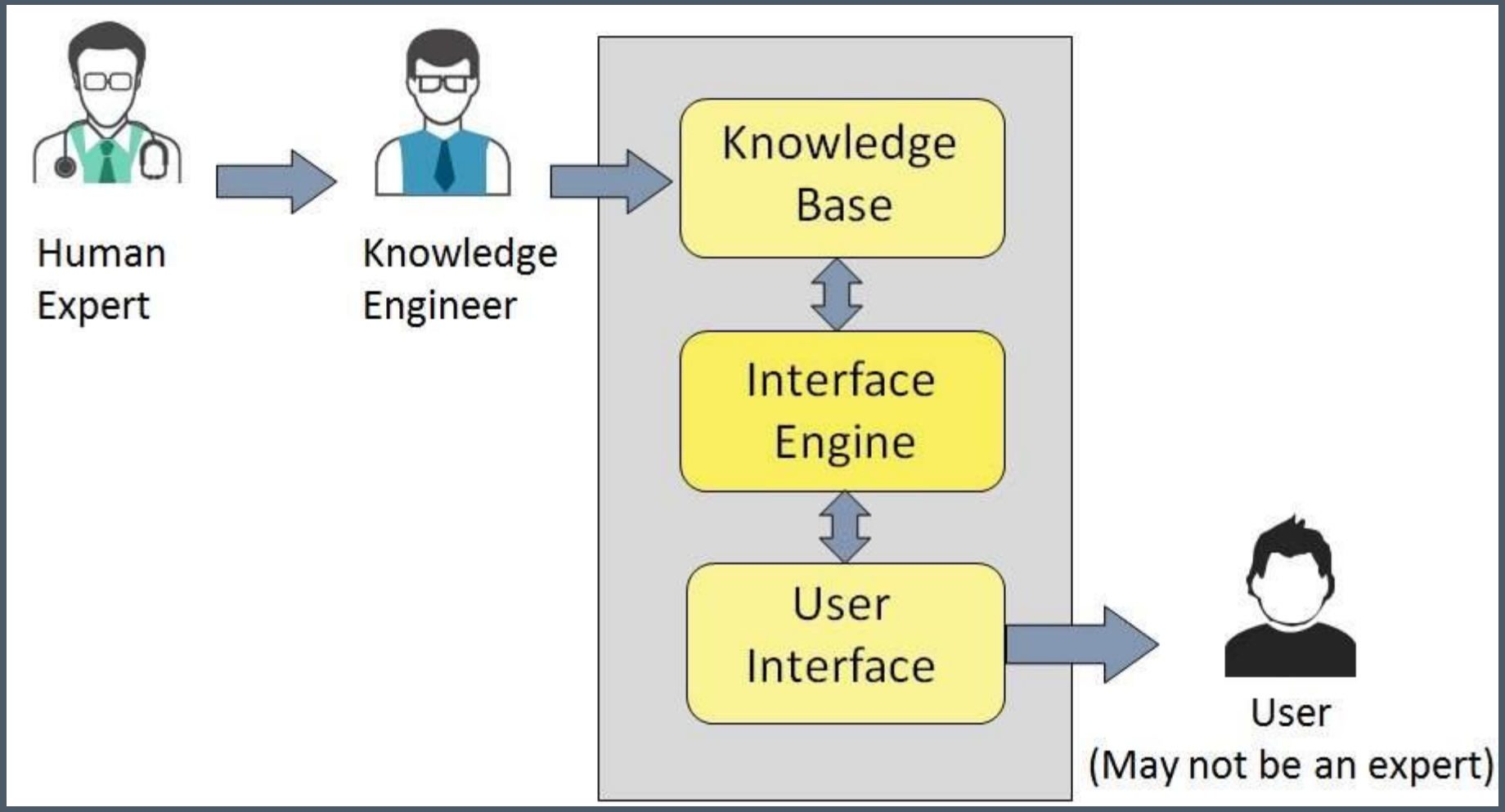
Knowledge Refining System

Three Major ES Components

~ Knowledge Base

~ Inference Engine

~ User Interface


Human Expert
Knowledge Engineer
Knowledge Base
Interface Engine
User Interface
User
(May not be an expert)

Knowledge Acquisition Subsystem

~ Knowledge acquisition is the accumulation, transfer and transformation of problem-solving expertise from experts and/or documented knowledge sources to a computer program for constructing or expanding the knowledge base

~ Requires a knowledge engineer

Knowledge Base

The knowledge base contains domain-specific and high-quality knowledge necessary for understanding, formulating, and solving problems

Knowledge Base

Knowledge is required to exhibit intelligence.
The success of any ES majorly depends upon the collection of highly accurate and precise knowledge.

Knowledge Base

Two Basic Knowledge Base Elements

~ Facts, It is the information widely accepted by the Knowledge Engineers and scholars in the task domain.

~ Special heuristics, or rules that direct the use of knowledge. It is about practice, accurate judgement, one's ability of evaluation, and guessing

Inference Engine

~ The brain of the ES
~ The control structure or the rule interpreter
~ Provides a methodology for reasoning

Inference Engine

Use of efficient procedures and rules by the Interface Engine is essential in deducting a correct, flawless solution.

Inference Engine

In case of knowledge-based ES, the Interface Engine acquires and manipulates the knowledge from the knowledge base to arrive at a particular solution.

Inference Engine

In case of rule based ES, it –

- Applies rules repeatedly to the facts, which are obtained from earlier rule application.
- Adds new knowledge into the knowledge base if required.
- Resolves rules conflict when multiple rules are applicable to a particular case.

Inference Engine

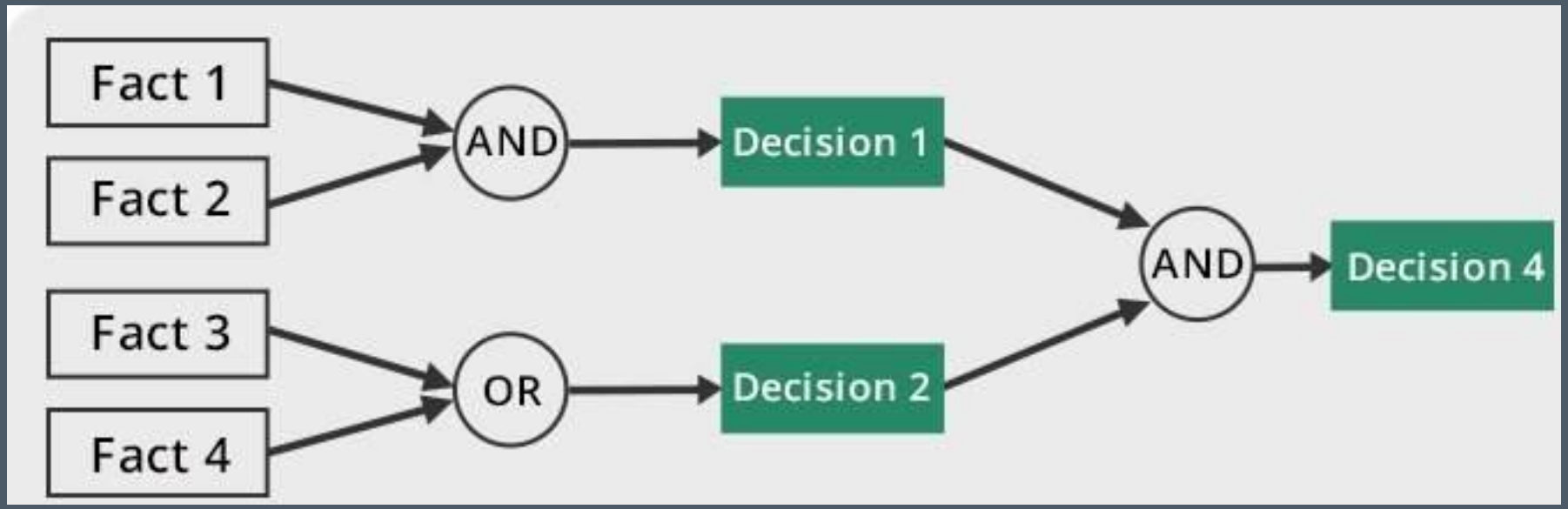
To recommend a solution, the interface engine uses the following strategies –

Forward Chaining
Backward Chaining

Forward Chaining

It is a strategy of an expert system to answer the question, "What can happen next?"

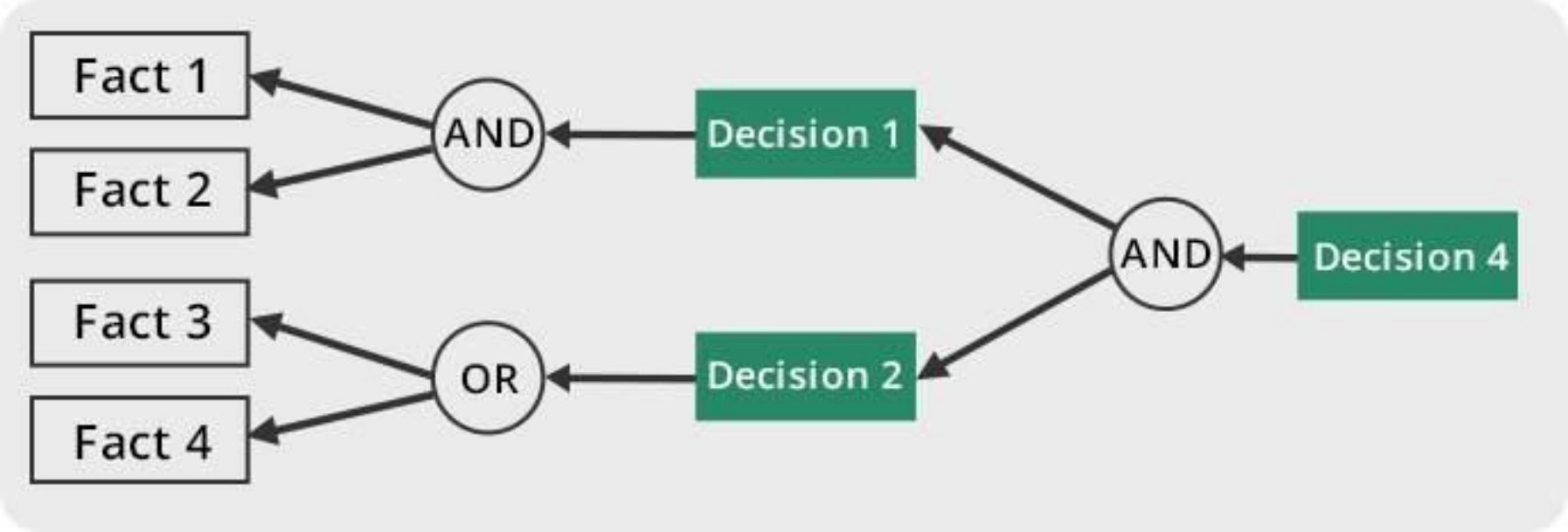
Forward Chaining



Backward Chaining

With this strategy, an expert system finds out the answer to the question, "Why this happened?"

Backward Chaining



User Interface

User interface provides interaction between user of the ES and the ES itself.

User Interface

Language processor for friendly, problem-oriented communication NLP, or menus and graphics

User Interface

The explanation may appear in the following forms :

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User Interface

The user interface makes it easy to trace the credibility of the deductions.

Explanation Subsystem (Justifier)

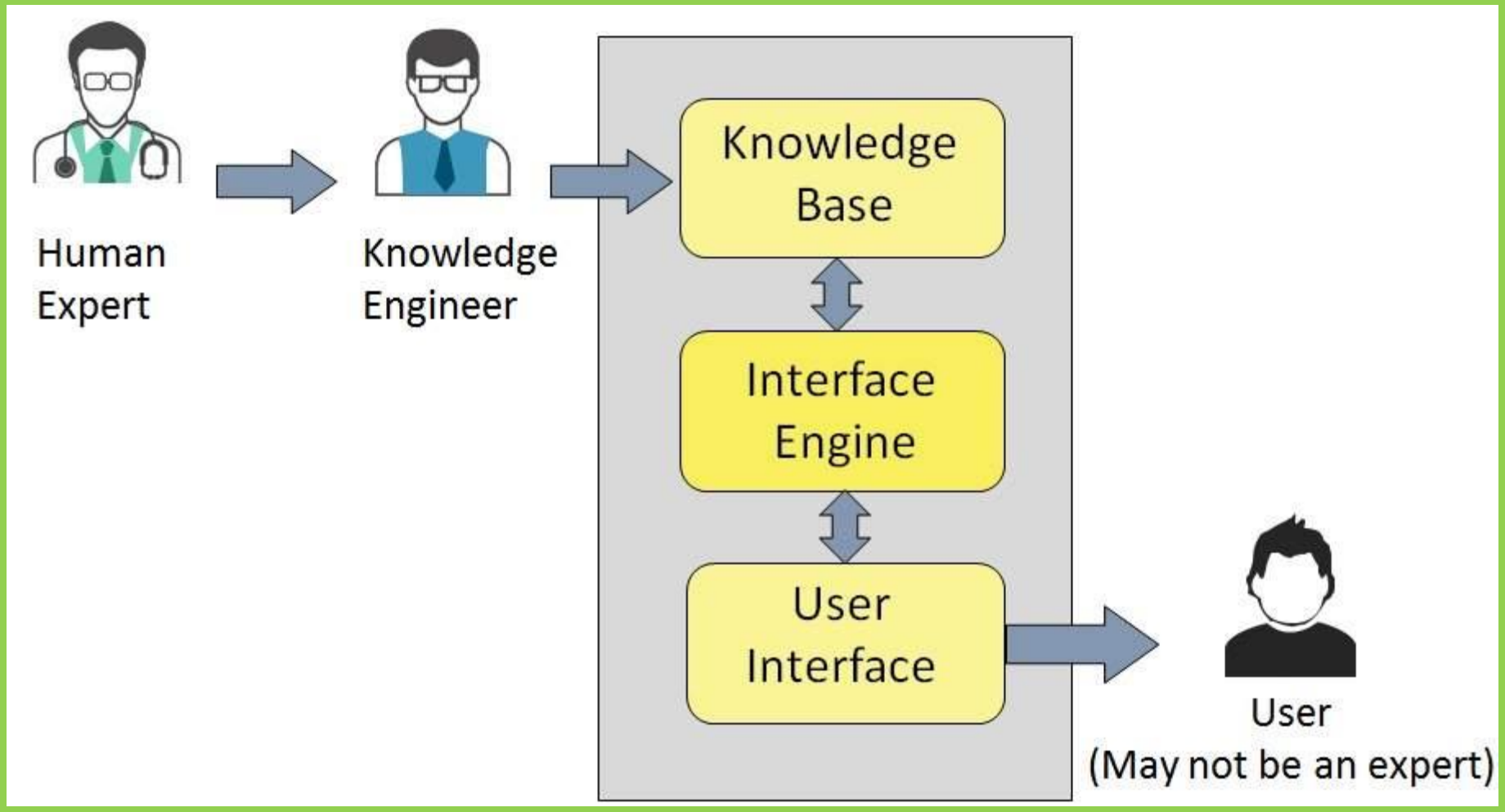
Traces responsibility and explains the ES behavior by interactively answering questions

- Why?
- How?
- What?
- (Where? When? Who?)

Knowledge Refining System

- Learning for improving performance

Who is involved?


Human Expert
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~ Knowledge Engineer
~ The Expert
~ The Builder
~ The User

The Expert

~ Has the special knowledge, judgment, experience and methods to give advice and solve problems
~ Provides knowledge about task performance

Knowledge Engineer

A knowledge engineer is a computer scientist who knows how to design and implement programs that incorporate artificial intelligence techniques.

Knowledge Engineer

Helps the expert(s) structure the problem area by interpreting and integrating human answers to questions, drawing analogies, posing counterexamples, and bringing to light conceptual difficulties

Usually also the System Builder

The User

Possible Classes of Users

A non-expert client seeking direct advice - the ES acts as a *Consultant* or *Advisor*

A student who wants to learn - an *Instructor*

An ES builder improving or increasing the knowledge base - a *Partner*

An expert - a *Colleague* or *Assistant*

The User

The Expert and the Knowledge Engineer Should Anticipate Users' Needs and Limitations When Designing ES

Other Participants

~ System Builder
~ Tool Builder
~ Vendors
~ Support Staff
~ Network Expert