

Knowledge Management

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IT 383
Knowledge Management

Lecture 7



The background features a series of vertical panels with rounded corners. The leftmost panel shows a person's hands typing on a laptop. The subsequent panels contain various white line-art icons on a semi-transparent background: a graduation cap, a play button, a target with an arrow, an open book, a magnifying glass, and a group of people. The main title is positioned to the right of these panels.

Knowledge Engineering Explanation and Justification

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Explanation and Justification



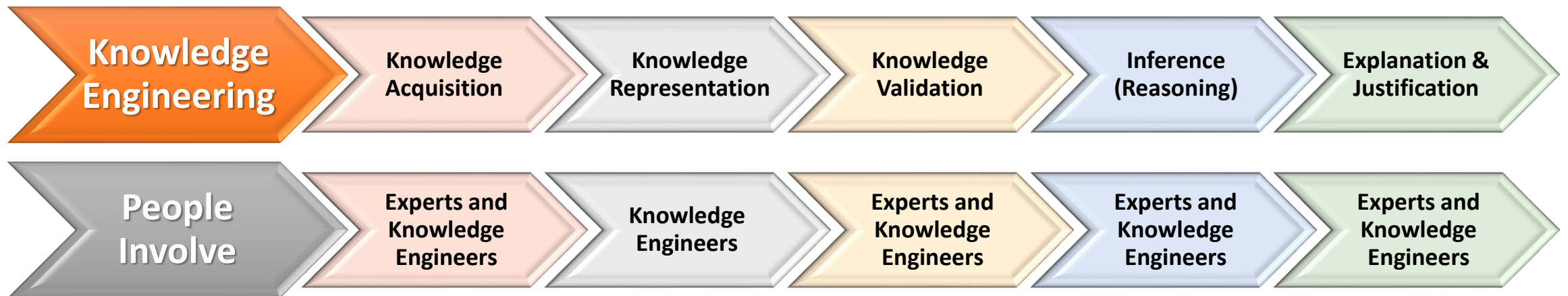
Justification in Knowledge Engineering (KE) is the process of providing structured reasoning for decisions made by a system. Unlike **explanation**, which focuses on "how" a decision was made, **justification** emphasizes "why" the decision is valid.

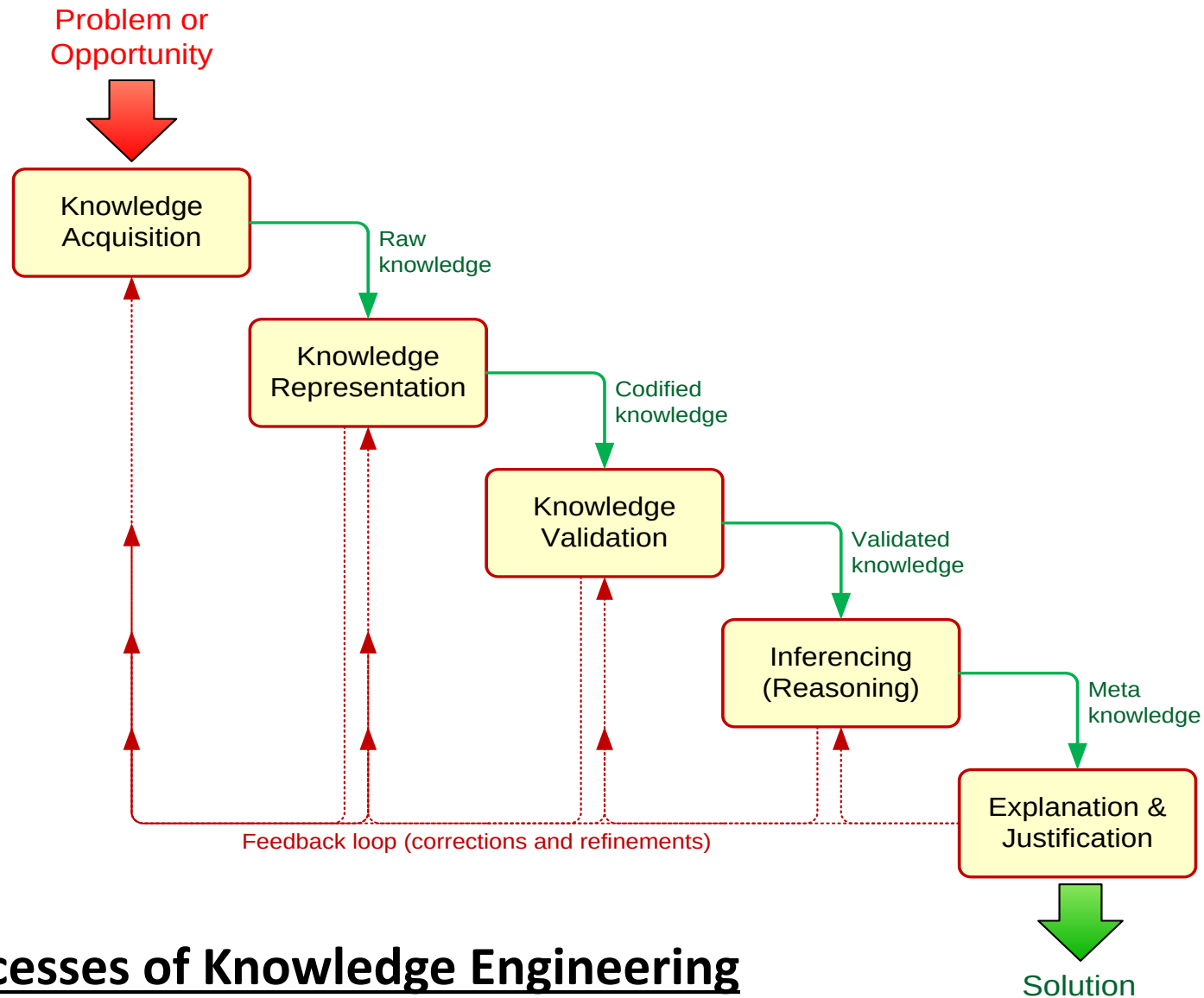
Lecture Objectives

- **Understanding Explanation and Justification**
- **Identify most common techniques in Explanation and Justification**
- **Understanding the importance and challenges of the most common techniques in Explanation and Justification**
- Understanding the Challenges of using AI in Explanation and Justification**

➤ **What is knowledge Engineering?**

A set of intensive activities involved in building, maintaining and using knowledge-based systems.

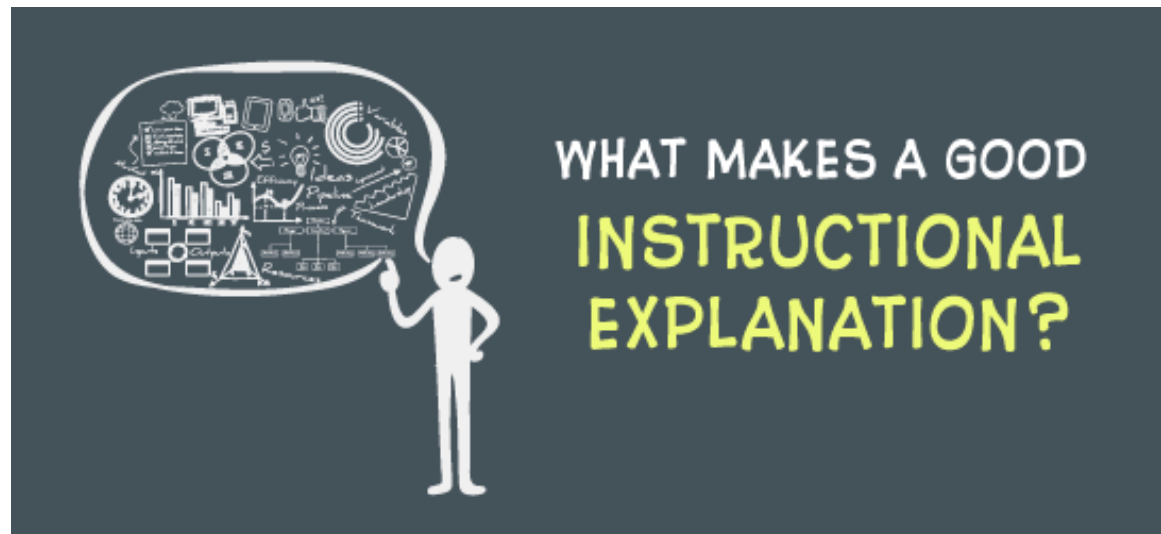




The Processes of Knowledge Engineering

➤ Explanation in Knowledge Engineering:

Explanation is the process of clarifying how a system arrived at a particular conclusion or decision. It helps users interpret and validate the reasoning of the system.



➤ Types of Explanations

- 1- Trace-Based Explanations** – Show the step-by-step reasoning process used to reach a conclusion.
- 2- Model-Based Explanations** – Describe the internal structure or model of the system.
- 3- Example-Based Explanations** – Provide similar past cases to justify current decisions.
- 4- Contrastive Explanations** – Answer "Why A and not B?" to clarify alternative decisions.

Importance of Explanations

Increases trust in expert systems.

Helps users learn from the system.

Enhances debugging and error detection.

Improves human-AI collaboration.

Tools and Methods for Explanation in Knowledge Engineering

Explanation in Knowledge Engineering is crucial for improving transparency, trust, and usability of intelligent systems. There are key tools and methods used to provide explanations in knowledge-based systems (KBS) and AI models.

Tools and techniques for Explanation in Knowledge Engineering

Rule-Based Explanation

Rule-based explanation techniques are widely used in knowledge-based systems (KBS) to provide transparent and interpretable reasoning. These techniques use predefined rules (if-then statements) to explain decisions systematically.

Rule-based explanation techniques rely on explicit logic and knowledge representations to describe how a system reaches conclusions. These systems consist of rules, facts, and an inference engine that applies logical reasoning to derive results.

These techniques These use explicit rules to explain the reasoning process.

Basic Structure of Rule-Based Systems

Rules: Expressed as IF-THEN statements.

Facts: The knowledge base contains facts that the rules use.

Inference Engine: Uses forward or backward chaining to apply rules.

Example of a Rule-Based Explanation

Rules:

IF temperature > 100°F AND cough = "yes" THEN diagnosis = "fever"

Explanation:

"The system diagnosed a fever because the temperature exceeded 100°F and the patient reported a cough."

Tools and Methods:

Decision Trees – Show step-by-step decision paths.

Expert Systems (e.g., CLIPS, Drools, Prolog) – Use if-then rules to explain reasoning.

Logic Programming (e.g., Prolog, Datalog) – Provides structured explanations based on logical inference.

Rule-Based Explainable AI (XAI) Systems – Convert machine learning models into rule-based explanations.

Advantages of Rule-Based Explanation Techniques

Transparency – Every decision can be traced back to a rule.

Interpretability – Users can understand and modify rules easily.

Consistency – Ensures uniform decision-making.

Ease of Debugging – Errors can be identified by checking rule execution.

Challenges & Limitations of Rule-Based Explanation Techniques

Scalability Issues – Large rule bases become difficult to manage.

Lack of Flexibility – Fixed rules may not adapt well to new data.

Complexity in Rule Conflicts – Resolving contradictions in overlapping rules can be challenging.

➤ Justification in Knowledge Engineering:

Justification in Knowledge Engineering (KE) is the process of providing structured reasoning for decisions made by a system. Unlike explanation, which focuses on "how" a decision was made, justification emphasizes "why" the decision is valid.

Justification provides a deeper, more structured reasoning for a decision, often including the sources of knowledge used. While explanations focus on the "how," justifications focus on the "why" behind a decision.

➤ Types of Justification

1- Rule-Based Justification – Justifies decisions by referring to pre-defined rules in the system.

2- Case-Based Justification – Uses past cases or examples to support a decision.

3- Statistical Justification – Supports decisions using probability and data-driven reasoning.

4- Ethical and Legal Justification – Ensures compliance with ethical and legal standards.

Importance of Justification

Trust & Transparency – Users understand why a system makes certain decisions.

Regulatory Compliance – Ensures decisions align with legal frameworks (e.g., GDPR, AI Ethics).

Debugging & Improvement – Helps engineers refine rules and models.

Human-AI Collaboration – Enables humans to verify AI-generated recommendations.

Tools and techniques for Justification in Knowledge Engineering

Case-Based Reasoning (CBR) is a problem-solving approach in knowledge engineering where **past cases** (previous experiences) are used to solve new problems. Instead of relying on predefined rules like rule-based systems, CBR retrieves and adapts **similar past cases** to justify decisions.

Case-Based Reasoning (CBR)

CBR explains decisions by comparing them with past cases.

Example: A **medical diagnosis** system may diagnose a new patient by comparing their symptoms with past patient cases stored in a knowledge base.

Case-Based Reasoning follows a cycle of four main steps:

Step	Description	Example
Retrieve	Identify similar past cases relevant to the new problem.	A doctor retrieves past cases of patients with similar symptoms.
Reuse	Adapt solutions from the retrieved cases to solve the new problem.	The system suggests a treatment based on what worked in previous cases.
Revise	Evaluate and refine the proposed solution if needed.	The doctor adjusts the treatment plan based on new findings.
Retain	Store the new case for future reference and learning.	The patient's case is added to the database for future diagnoses.

The Structure of Case-Based Reasoning

Problem Description: Features of the current case (e.g., symptoms, patient history).

Solution: The decision or action taken in past cases.

Outcome: The result of the decision (e.g., success or failure).

An Example:

Case ID: 105

Symptoms: ["Fever", "Cough", "Shortness of Breath"]

Diagnosis: "Pneumonia"

Treatment: "Antibiotics"

Outcome: "Recovered in 7 days"

Tools and Methods:

myCBR – An open-source CBR tool for retrieving and explaining case-based decisions.

CAKE (Case-Based Knowledge Engineering) – A framework for case-based knowledge representation.

CBR-based Medical Decision Support Systems – Explain diagnoses by referencing similar past patient cases.

Advantages of Case-Based Reasoning Techniques

Handles Complex Knowledge – Learns from past cases instead of predefined rules.

Transparent & Justifiable – Justifies decisions with real-world examples.

Self-Learning – Improves over time as new cases are added.

Flexible – Works well in domains with incomplete knowledge.

Challenges & Limitations of Case-Based Reasoning Techniques

Requires a Good Case Base – Poor-quality cases lead to bad decisions.

Computational Complexity – Finding similar cases in large datasets can be slow.

Adaptation Difficulty – Not all past cases can be easily adapted to new problems.

Tools and techniques for Explanation and Justification in Knowledge Engineering

Artificial Intelligence (AI) plays a crucial role in **explanation and justification** within Knowledge Engineering, enabling AI systems to provide **transparent, interpretable, and trustworthy** reasoning for their decisions. These techniques are essential in applications like **expert systems, legal reasoning, financial decision-making, and healthcare diagnostics**.



Role of Artificial Intelligence (AI) in Explanation & Justification

Explanation: AI describes how a decision was reached.

justification: AI provides why a decision is correct, aligning with domain knowledge, logic, and ethical considerations.

Example: AI in Medical Diagnosis

Decision: "Diagnosis: Pneumonia"

Explanation: "The AI detected patterns of high fever, cough, and chest X-ray abnormalities associated with pneumonia."

Justification: "According to established medical guidelines and previous cases, these symptoms are strongly correlated with pneumonia."

Why AI-Based Explanation & Justification Important?

Ensures Fairness & Bias Detection

AI explanations help detect biased or unfair decisions.

Enhances Human-AI Collaboration

AI can provide justifications in expert decision support systems.

Helps professionals (doctors, lawyers, engineers) verify AI recommendations.

Why AI-Based Explanation & Justification Important?

Builds Trust & Transparency

Users are more likely to trust AI decisions if they understand them.

Improves Decision Accountability

Justification ensures AI decisions follow legal, ethical, and business rules.

Challenges in AI-Based Explanation & Justification

Black-Box Models – Deep learning models are difficult to interpret.

Bias & Fairness – AI may provide explanations that reflect biases in training data.

Scalability – Generating real-time justifications in large-scale systems.

User Understanding – Different users (experts vs. non-experts) need different explanations.

Explanation VS. Justification

Explanation VS. Justification

Feature	Explanation	Justification
Purpose	Clarifies how a decision was made	Provides reasons why a decision is valid Proves the validity of a decision
Focus	Process, reasoning and steps	Justifying the correctness of the decision Logical correctness & supporting evidence
Audience	Users needing clarity	Regulators, auditors, or decision-makers
Example	"The system chose X because of Y"	"X is the correct choice based on rules and evidence"

Summary

- **Understanding Explanation and Justification.**
- **Understanding the most common techniques in Explanation and Justification.**
- **Understanding the importance and challenges of the most common techniques in Explanation and Justification.**
- **Understanding the Challenges of using AI in Explanation and Justification**



Thank You