

Knowledge Representation and Reasoning

Unit 5: Introduction to Modelling

Formative Activities

Activity 1

What are knowledge-based Modelling techniques?

Knowledge-based modelling Techniques are methods used to represent, structure, and manage knowledge so that machines (or humans) can use it for problem-solving, reasoning, learning, and decision-making.

1. **Linguistic Knowledge Bases:** Designed to analyse the structure and meaning of natural language. They focus on words, grammar, and semantic relationships using tools like WordNet, FrameNet, and ConceptNet. Use Cases include NLP, semantic search, and chatbots.
2. **Expert Knowledge Bases:** Capture domain-specific knowledge using rules and logic. They are often rule-based or use fuzzy logic to replicate expert decision-making. **Use Cases include medical** diagnosis, fault detection, and decision support.
3. **Ontologies:** Provide a formal, structured way to model domain knowledge through concepts and relationships. Tools include OWL, RDF, and Protégé. Use Cases include Semantic web, data integration, and knowledge graphs.
4. **Cognitive Knowledge Bases:** Simulate human-like reasoning by combining linguistic, expert, and ontological models. They support personalisation through learner modelling and adaptive responses. Use Cases include Adaptive learning, intelligent tutoring, and cognitive AI.

What are the three knowledge bases identified by the authors?

- **Domain Knowledge Base:** This represents what is taught, such as the subject (concepts, principles, and rules related to the domain).
- **Pedagogical Knowledge Base:** The way of presenting the content, including pedagogical methods, feedback mechanisms, and even assessment methods.
- **Learner Knowledge Base (Student Model):** This captures the learner's identity, including prior knowledge, learning style, emotional state, and progress.

What are the differences between them?

- The **Domain KB** provides structured content (e.g., math concepts, science facts).
- The **Pedagogical KB** adapts the delivery method (e.g., guided discovery, scaffolding).
- The **Learner KB** supports personalization based on learner profiles (e.g., learning styles, prior knowledge, progress).

How are these related to ontologies?

- **Domain Knowledge Base & Ontologies:** Ontologies define the concepts, relationships, and rules within a subject area in a formal, machine-readable format.
- **Pedagogical Knowledge Base & Ontologies:** Ontologies model instructional strategies, learning activities, and feedback types, enabling adaptive teaching decisions.

- Learner Knowledge Base & Ontologies: Ontologies capture learner attributes such as preferences, skills, learning styles, and performance data.

Activity 2

How does the author define a 'Knowledge-Based Economy'?

As per Leydesdorff a knowledge-based economy (KBE) is an economic system whereby knowledge production, codification, distribution and application are the primary engines of innovation, productivity and economic growth.

Key characteristics include:

- Codification of knowledge, enabling it to be standardized, decontextualized and then marketed (unlike tacit knowledge).
- Functions through reflexive feedback loops: knowledge perpetually reconstituting institutions and expectations.
- Fuelled by three interplaying sub-dynamics:
 1. Markets (industry: Wealth Generation)
 2. Science and technology (university) as knowledge production,
 3. Governance and regulation (government)

What is the triple helix model?

According to the Triple Helix Model developed by Leydesdorff and Etzkowitz, there are three core institutional spheres that interact:

- University – creates new knowledge/innovation through research.
- Industry — uses knowledge to create goods, service and economic value.
- Government — devises policies and offers support for knowledge creation and innovation.

Activity 3

What are the components of OntoKnowledge model/framework?

1. A Toolset for Semantic Information Processing and User Access
2. OIL (Ontology Inference Layer)
3. An Associated Methodology
4. Validation by Industrial Test Cases

What are the example use cases given for the framework?

Swiss Life – Organisational Memory

- Used on an intranet to centralize and semantically enrich:
 - Skills databases
 - Sales team insurance product documentation
 - 1,000-page international accounting standards document, searchable and annotated with the ontology

BT (British Telecom) – Call Centres

- Improved helpdesk knowledge base including:
 - Expert knowledge
 - Best practices for service support and problem-solving

EnerSearch – Virtual Enterprise

- Helped with knowledge transfer across:
 - Collaborative research groups from various countries and fields
 - Shareholding firms are given an access to updated R&D findings