Module 3
Technologies, Systems and Organizational Impacts of Knowledge Management

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SCORE

Technologies for Applying Knowledge

Artificial Intelligence Techniques

1. Rule-based Reasoning Systems
2. Case-based Reasoning Systems
   - Exemplar based reasoning
   - Instance based reasoning
   - Analogy based reasoning
3. Constraint-based reasoning
4. Model-based reasoning (MBR)
5. Diagrammatic reasoning

Artificial Intelligence

- Enabling computers to perform tasks that resemble human thinking ability.
- Definitions for AI:
  - systems that act like humans
  - systems that think like humans
  - systems that think rationally(sensibly, logically) to solve a problem
  - systems that act rationally

"The science that provides computers with the **ability to represent and manipulate symbols** so they can be used **to solve problems not easily solved through algorithmic models".**

Artificial Intelligence

Definitions	Description
Systems that act like humans	Refer to those that **pass the turing test.** A computer passing a test by a human interrogator, who cannot tell whether the responses came from a person or not
Systems that think like humans	Refer to a computer program whose **input to output behavior matches those of humans**. Eg: playing chess
Systems that think rationally	Refer to those that follow a specific logic to solve a problem
Systems that act rationally	Refer to those **computer agents** that are expected to have specific characteristics that enable them to **operate autonomously within their environments**, and even adapt to change in the face of uncertainty.

Artificial Intelligence

- The term "artificial intelligence" was **coined by John McCarthy** during a workshop he organized at Dartmouth College in 1956.
- AI systems are based on the understanding that **intelligence** and **knowledge** are tightly **intertwined**.
- **Knowledge:**

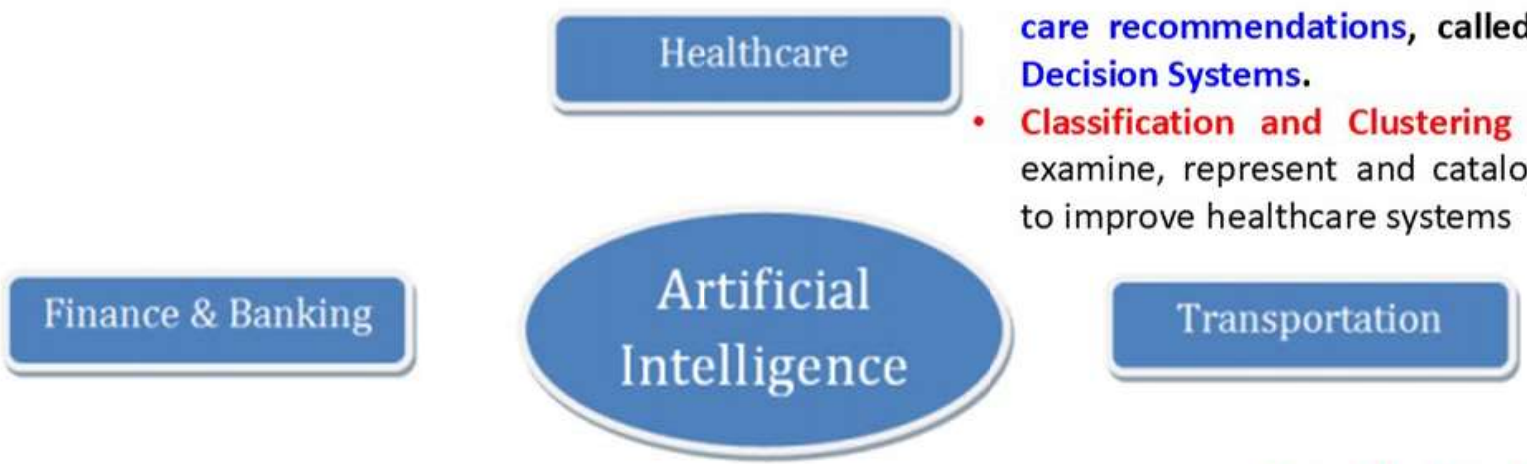
  Cognitive(Intellectual) symbols we manipulate.
- **Intelligence:**

  Ability to learn and communicate in order to solve problems.

Artificial Intelligence

- **Knowledge Application System:** AI system that try to **imitate the problem-solving capabilities** of skillful problem-solvers in a particular domain.
- **Natural language processing** to enable computer to communicate successfully in English or some other human language.
- **Knowledge representation** to store information provided before or during the interrogation.
- **Automated reasoning** to use the stored information to answer questions and to draw new conclusions.
- **Machine learning** to adapt to new circumstances and to detect and infer patterns.

Applications of Artificial Intelligence



- Recommender systems are used in healthcare to provide **physicians with evidence based patient care recommendations, called Clinical Support Decision Systems.**
- **Classification and Clustering** can be used to examine, represent and catalogue medical data to improve healthcare systems

- **In finance:** for **stock predictions and recommendations, automated trading, and high frequency trading.**
- **In Banks: they use AI for cheque fraud analytics and detecting fraudulent cheques**

- **Google's AI vehicles** that are capable of **driving safely on their own.**
- Fuzzy logic has been used in **subway and train systems in Japan**

- Siri Cortana
- **Voice Recognition**
- Software frontend
- Machine Learning backend

AI, Expert Systems and KM

- **Knowledge systems** solve difficult problems of the real world by **performing inference processes on explicitly stated knowledge**.
- **Knowledge Management** supports **expertise sharing** throughout the organization. Expert systems are an integral part of knowledge management.
- **Expert systems** can be used as the **integrative element linking various knowledge sources**. They can serve as the integrative mechanism for solving interdisciplinary problems.
- **Cognitive computing** is an umbrella term for **computerized models** designed to **mimic human thought processes, combining AI and KM.**

Reasoning in knowledge-based systems

- The following techniques for reasoning have been found useful:
  - Rule-based reasoning
  - Case-based reasoning
  - Constraint-based reasoning
  - Model-based reasoning
  - Diagrammatic reasoning
- The two most relevant intelligent technologies that underpin the development of **knowledge application systems: rule-based expert systems and case-based reasoning**.

Rule-based Reasoning (RBR)

- Traditionally, the development of knowledge-based systems had been based on the **use of rules or models to represent the domain knowledge**.
- The process of developing knowledge application systems requires **eliciting the knowledge from the expert and representing it a form that is usable by computers**. This process is called knowledge engineering.
- Knowledge engineers typically build knowledge application systems by first interviewing in detail the domain expert and **representing** the **knowledge more commonly in a set of heuristics, or rules-of-thumb**.
- In order for the computer to understand these rules-of-thumb, we represent them as production rules or IF-THEN statements.

Rule-based Reasoning (RBR)

- Rules are the most commonly used knowledge representation paradigm, perhaps due to their intuitive implementation.
- For example: IF the number of employees is less than 500, THEN the firm is a small business is one of the rules.
- The **IF portion** is the condition (also **premise or antecedent**), which tests the truth-value of a set of assertions.
- If the statement is true, the **THEN part** of the rule (also **action, conclusion, or consequence**) is also inferred as a fact.
- In addition to rules, **other paradigms to represent knowledge** include
  - Frames, predicates, associative, networks and objects.

Rule-based Reasoning (RBR)

- Rule-based systems have posed some **disadvantages**:
  - The **number of rules** that may be needed to properly represent the domain may be quite large.
  - **Difficulty in coding**, verifying, validating, and maintaining the rules.
  - **Reduction in the efficiency** of the inference engine executing the rules.
- As of one the alternatives, the use of cases is a popular method to represent knowledge.
- For problem solving in **complex, real-world situations** it is useful to **integrate RBR and CBR**.
- **Example:** In Autonomous Vehicles rule based reasoning can be used for enforcing the traffic laws.

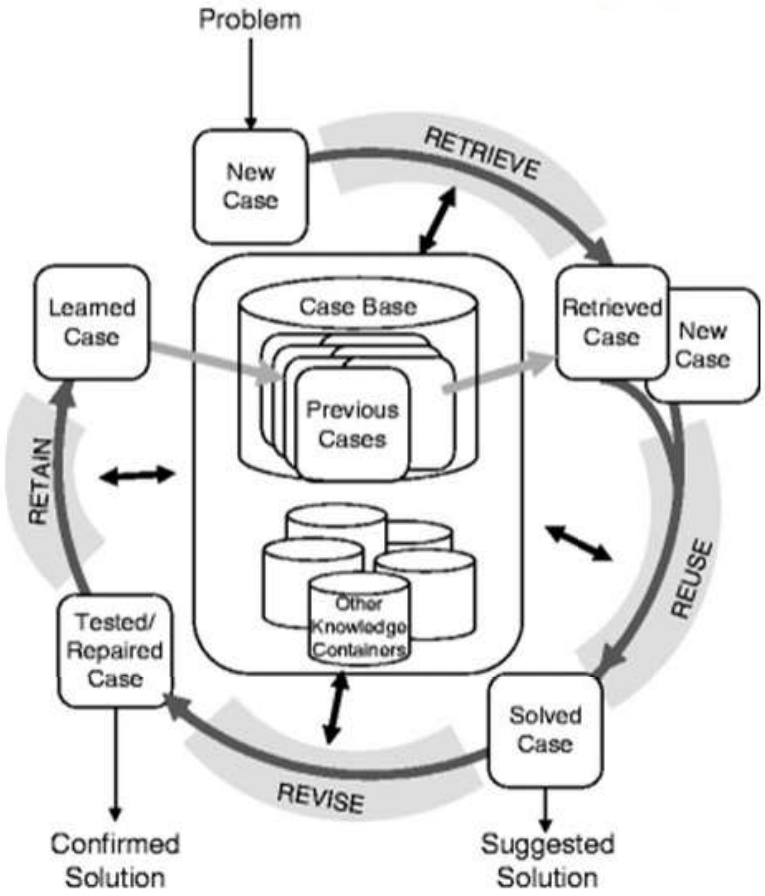
Case-based Reasoning (CBR)

- It is an AI technique designed to mimic human problem solving. It offers a useful approach **to building applications that support decisions based on past experience**.
- It is used to solve problems by **finding similar, past cases and adapting their solutions**.
- CBR is well suited to domain experts who attempt to solve problems by recalling approaches which have been taken to similar situations in the past.
- This is **most appropriate in domains** which are **not well understood**, or where any **rules** that may have been devised **have frequent exceptions**.
- **For example**, **Google Maps uses case-based reasoning** to tell you **how long your journey will take by examining the patterns of past users** to see how long it took them to get from point A to point B.

Case-based Reasoning (CBR)

1. Search the case library for similar cases
2. Select and retrieve the most similar case(s).
3. Adapt the solution for the most similar case.
4. Apply the generated solution and obtain feedback.
5. Add the newly solved problem to the case library

Case-based Reasoning (CBR)



- **Retrieve**
  - Find most similar cases and create a case DB.
- **Reuse (Case Adaption)**
  - Use old case to solve current case.
- **Revise**
  - If the similar case cannot fit the new background or scenario exactly, the retrieved case needs to be adjusted and applied to the problem.
- **Retain**
  - Save the correct solution as new case in the database/case library.

Variants of Case-based Reasoning (CBR)

1. Exemplar-based reasoning

- These systems seek to **solve problems through classification**, that is, **finding the right class** for the **unclassified exemplar**.
- The class of the **most similar past case then becomes the solution** to the classification problem, and the set of classes are the possible solutions to the problem.

2. Instance-based reasoning

- These systems require a **large number of instances (or cases)** that are typically simple; that is, they're defined by a small set of attribute vectors.
- The **major focus** of study of these systems is **automated learning, requiring no user involvement.**

Variants of Case-based Reasoning (CBR)

3. Analogy-based reasoning

- These systems are typically used to solve new problems **based on past cases from a different domain**.
- Analogy-based reasoning focuses on case reuse, also called the mapping problem, which is finding a way to **map the solution of the analogue case to the present problem.**

Case-based Reasoning (CBR) Issues

- Decide what to store
- Choosing the appropriate structure
- Organizing memory
- General knowledge

Why Case-based Reasoning (CBR) is Good?

- Low maintenance
- Improves with use
- Uses learned knowledge plus general knowledge
- Case representation is easy to understand

When to use Case-based Reasoning (CBR)?

- CBR is more suitable for the following problems:
  - –The problem domain **is complex** and not amenable to complete mathematical modeling.
  - – An explicit model is extremely **difficult** to elicit and **represent with rules .**
  - – **Historical data exists** within the organization .
  - – The **domain experts** have considerable **difficulty in writing** down the **decision rules**. But, they are comfortable in providing well-proven heuristics and experiences, to incorporate into the case base as cases. They have little difficulty in recalling concrete cases, which they have encountered in the past.
  - – The domain is such that it **needs reasoning** for the system's solutions.

Application areas of Case-based Reasoning (CBR)

- The common application areas of CBR include
  - help-desk and customer service
  - recommender systems in electronic commerce
  - knowledge and experience management,
  - medical and image processing applications ,
  - law enforcement,
  - technical diagnosis, design, planning and
  - computer games and music domain
  - Diagnosing problems
  - Decision making when considering past similar situations

Rule Based Reasoning (RBR) vs Case-based Reasoning (CBR)

- **RBR requires** us to elicit **an explicit model of the domain** whereas it is not needed in CBR.
- **Developing a CBR system is much faster** and **easier** than constructing a rule-based equivalent. Even non-computer experts can add cases to the existing structure.
- **Maintenance with a Rule Based System** may be a **nightmare** whereas Case Based Systems are much easier and straightforward.
- **When rules are added or deleted** from a rule-based system**(RBR),** the system has to be **checked for conflicting rules and redundant rules** whereas it is not needed in CBR.
- In **RBR** the **difficulty** lies in **getting the experts to list down the decision rules** which they use whereas they usually have little difficulty in recalling concrete cases, which they have encountered in practice.

Constraint-based Reasoning

- An artificial intelligence technique that uses essentially "what cannot be done" to guide the process of finding a solution.
- A **problem is modeled in terms of hypotheses and conclusion constraints**, and it is **solved via constraint satisfaction**.
- This technique is **useful in** naturally constrained tasks such as **planning and scheduling**.
- For example, to schedule a meeting, **all the individuals who needs to attend must be available at the same time, otherwise the "availability constraint" will be violated.**

Model-based Reasoning (MBR)

- It is an intelligent reasoning technique that **uses a model of an engineered system to simulate its normal behavior.**
- The simulated operation is compared with the behavior of a real system and noted discrepancies can lead to a diagnosis.
- With this approach, **the main focus** of application development **is developing the model.**
- **The model could be a mathematical equation.**
- For example, **a hurricane model** can be designed and implemented to **predict a hurricane's trajectory**, given the set of current weather conditions such as wind speed, presence of a cold front, temperature, and so forth.

Model-based Reasoning (MBR)

- **Climate modeling**, for example, allows computers to take information about current weather conditions and run it through a model to provide information about budding tropical storms and other meteorological events of concern.
- **Car driving simulator** for training.

Diagrammatic Reasoning

- It is an artificial intelligence technique that **aims to understand concepts and ideas using diagrams that represent knowledge**.
- These technologies are radically different from rule based systems or CBR systems and have very specific application areas.
- It involves the use of diagrams, chart or graphical models to reason about a problem.
- **Example:** A **diagrammatic reasoning test** is a type of aptitude test used by employers to assess the problem-solving, abstract reasoning and critical thinking abilities of the employees. Typically, a standard diagrammatic test will look at how well they can uncover shared patterns across diagrams and shapes.

Technologies for Knowledge Application System

Technology	Domain Characteristics
Rule-based Systems	Applicable when the domain knowledge can be defined by a manageable set of rules or heuristics.
Case-based Reasoning	Applicable in weak-theory domains, that is, where an expert either doesn't exist or does not fully understand the domain. Also applicable if the experience base spans an entire organization, rather than a single individual.
Constraint-based Reasoning	Applicable in domains that are defined by constraints, or what cannot be done.
Model-based Reasoning (MBR)	Applicable when designing a system based on the description of the internal workings of an engineered system. This knowledge is typically available from design specifications, drawings, and books, and can be used to recognize and diagnose its abnormal operation.
Diagrammatic Reasoning	Applicable when the domain is best represented by diagrams and imagery, such as when solving geometric problems.

Developing Knowledge Application System

- **CASE-Method Cycle:** It is a methodology that describes an **iterative approach to effectively develop CBR** and knowledge application systems in general.
  - **System development process**

    To develop a knowledge application system that will **store** new cases and **retrieve** relevant cases.
  - **Case library development process**

    To develop and **maintain a large-scale case library** that will adequately support the domain in question.
  - **System operation process**

    It is based on standard **software engineering and relational database management procedures**.

    To define **the installation, deployment, and user support** of the knowledge application system.

Developing Knowledge Application System

- **Database mining process**

  Uses rule inference techniques and statistical analysis to **analyze the case library**. infer new relationships between the data.

- **Management process**

  Describes **how the project task force will be formed** and what **organizational support** will be provided.

- **Knowledge transfer process**

  Describes the **incentive systems** to encourage user acceptance and support of the knowledge application system.

Subprocess in Case library development process

- **Case Collection:**
  - Entails the **collection of seed cases**, which provide an **initial view of the application.**
  - Seed cases were used to define a format for the collection of future cases and for the design of the **database structure**.
- **Attribute-Value Extraction and Hierarchy Formation:**
  - Essential for **indexing and organizing the case library**.
  - Extracts the attributes that define the **case representation and indexing.**
  - Create a **list of attributes** that define each case, a **list of values** for each attribute, a possible **grouping of such attributes** and their relationships
    - **Create a concept hierarchy for each attribute with similarities between values**
  - Mapping of a hierarchy into a relational database or flat case library.

Subprocess in Case library development process

- **Feedback:**
  - Provide necessary feedback to those supplying the cases to the CBR system, so the quality of the cases can be improved.