

Master Of Real Estate Management

Prepared by
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Artificial Intelligence in Business

Lecture 2



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Chapter
02

AI: Methods and Techniques (Part 1)



Chapter
02**Learning Objectives**

- ❑ Explain AI problem-solving as the central mission of Artificial Intelligence.
- ❑ Describe Knowledge-Based Systems (KBS) and Expert Systems as symbolic AI approaches.
- ❑ Analyze rule-based systems, production rules, and reasoning mechanisms.
- ❑ Explain knowledge acquisition and organizational knowledge management.
- ❑ Understand the biological foundations of Artificial Neural Networks (ANN).

Chapter 02

Chapter Roadmap

1. Introduction

(Conditions for problem existence, Formal representation of problems, Symbolic and sub-symbolic AI approaches, Knowledge paradigm vs computational paradigm)

2. Knowledge-Based Systems (KBS)

(Expert Systems, Production systems and IF-THEN rules, Rule-based system architecture, Knowledge base and working memory, Inference engine and reasoning mechanisms, Forward and backward chaining, Knowledge acquisition techniques, Knowledge engineering, Organizational knowledge networks)

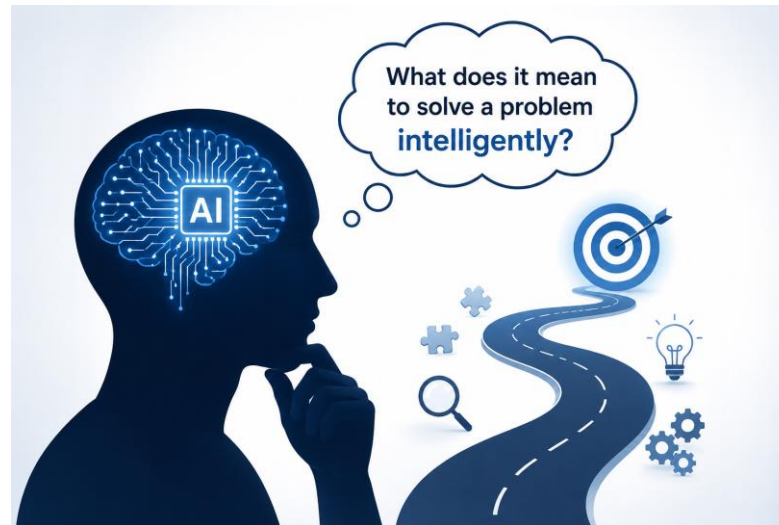
3. Artificial Neural Networks (ANN)

(Introduction to ANN, ANN for prediction and pattern recognition, Biological foundations of ANN, Biological neurons and synapses, Brain vs conventional computers)



1. Introduction

AI methods begin with a basic question: what does it mean to solve a problem intelligently?



Chapter 02

AI Problem-Solving: The Main Mission of AI

- There are three important approaches in Artificial Intelligence: Symbolic AI, Neural Networks, and Bayesian AI.
- An entity has a problem when it wants to achieve a goal but does not immediately know which action or sequence of actions will achieve it.
- The goal may be tangible, such as acquiring a physical object, or abstract, such as proving a theorem or making a strategic decision.
- AI systems support problem-solving by representing the current situation, evaluating possible actions, and searching for an acceptable or optimal solution.
- In organizations, AI problem-solving is valuable because business environments involve uncertainty, competing alternatives, and dynamic conditions.

Chapter 02

When Does a Problem Exist?

- A problem exists when there is at least one decision-maker, whether human or machine, operating within an environment.
- The decision-maker must have at least two alternative courses of action; otherwise, there is no meaningful choice.
- At least two possible outcomes must exist, and one outcome must be more desirable than the other.
- Each solution must affect the objective differently in terms of efficiency and effectiveness.
- The decision-maker has a problem only when they are uncertain about which course of action is best and want to resolve that uncertainty.



Chapter 02

Complex Problems in Organizations

- ❑ Real organizational problems are often more complex than individual decision problems.
- ❑ They may involve groups, departments, external stakeholders, dynamic environments, and multiple conflicting goals.
- ❑ Alternative actions may affect other groups, whose responses can be favorable or unfavorable.
- ❑ Business decisions are rarely isolated; one decision often triggers financial, operational, legal, and social consequences.
- ❑ AI becomes useful when it helps managers structure complexity, identify relevant data, and evaluate alternatives systematically.

Real estate example

Building a new development affects investors, municipalities, contractors, tenants, communities, and future buyers. AI can support scenario analysis across these groups.

Chapter 02

Conditions for Formal Problem Definition

A problem must be expressed in terminology clearly understood by the potential solver.

The expected form and notation of the solution must be agreed upon.

The relevant data needed for the solution must be identifiable.

There must be conventions for measuring the validity and acceptability proposed solutions.

The old aphorism applies strongly to AI: a well-framed problem is a problem half solved.



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Formal Representation of a Problem: $P = \langle S, O, G \rangle$

A problem can be broadly represented as $P = \langle S, O, G \rangle$.

S represents the set of states or expressions, including assumptions, definitions, facts, and initial conditions.

O represents operations or actions that can be performed on states.

G represents the terminal expression or goal to be achieved.

This formal representation helps AI systems move from an initial state toward a desired goal through defined operations.

Real estate application

S = current property portfolio and market facts; O = pricing, investment, renovation, or leasing actions; G = higher occupancy, better ROI, or reduced risk.

S: States



O: Actions



G: Goal

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Destructive and Constructive Operations

Problem-solving in AI involves two main types of operations used to move from the initial state toward the desired goal.

Destructive operations produce new expressions at the cost of old ones; the previous state is replaced or modified.

Constructive operations produce new expressions by adding to the existing set without destroying old expressions.

In logical and algebraic problems, operations are often constructive because they add new conclusions to existing knowledge.

In business AI, constructive reasoning is useful when systems accumulate new facts and update conclusions over time.

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Two Paths to AI Problem-Solving

There are two major approaches for developing intelligent systems capable of solving problems effectively.

The first is the symbolic path, which treats the brain as an information processor and uses symbols, rules, and logic.

The second is the sub-symbolic or connectionist path, which imitates biological systems and encodes knowledge in connections between neurons.

Symbolic AI emphasizes explicit knowledge representation and reasoning.

Connectionist AI emphasizes learning from examples and discovering patterns in data.

Chapter 02

Power Paradigm vs Knowledge Paradigm

Within the symbolic path, the chapter distinguishes between the heuristic or power paradigm and the epistemological or knowledge paradigm.

The power paradigm uses intensive computation, search processes, and the computational strength of machines.

The knowledge paradigm views AI as the science of obtaining, representing, and using general and common-sense knowledge.

Knowledge-Based Systems are the most visible manifestation of the knowledge paradigm.

Effective Artificial Intelligence requires both strong computational capabilities and meaningful knowledge to support intelligent decision-making and problem-solving.

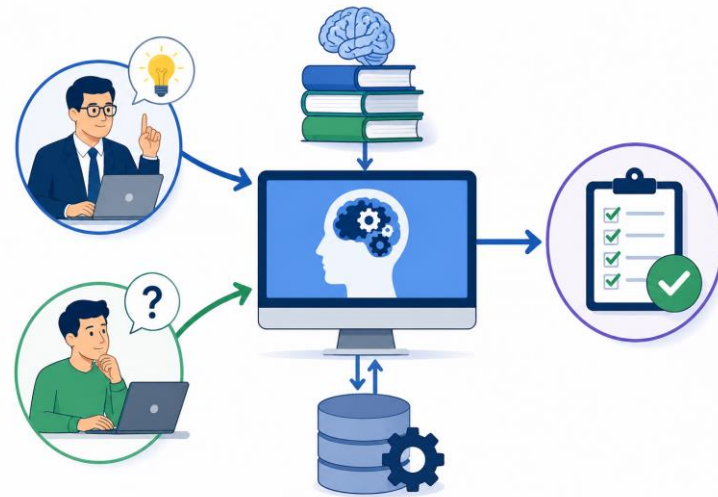
Business implication

Real estate AI is not only about computing power. It also requires domain knowledge about pricing, zoning, finance, location, and consumer behavior.

Chapter 02

2. Knowledge-Based Systems: Expert Systems

KBS converts expert knowledge into systems that can reason, advise, and support decisions.



Chapter 02

What Are Knowledge-Based Systems?

Knowledge-Based Systems are AI systems that store and use knowledge to solve problems.

They represent the knowledge paradigm in AI because they focus on how knowledge is obtained, represented, and applied.

KBS can support decisions that require expertise, interpretation, and reasoning rather than simple data storage.

When KBS contains expert knowledge from a specific field, it is called an Expert System.

In organizations, KBS transforms knowledge into a tangible asset that can be reused, shared, and improved.

Real estate example

A property investment expert system can capture rules used by senior analysts and apply them consistently to new investment opportunities.

Chapter 02

Expert Systems: Core Idea

Expert Systems imitate the reasoning of human experts in a specific domain.

They do not attempt to solve every possible problem; instead, they perform well in a specialized area where expert rules can be captured.

Expert Systems use a knowledge base, fact base or working memory, and an inference engine.

Their value comes from making specialist knowledge available to non-experts and improving decision consistency.

They are especially useful where mistakes are costly, expertise is scarce, and decisions are repetitive.

Case application

A real estate firm can use an expert system to screen properties using expert criteria for ROI, vacancy risk, zoning constraints, and financing conditions.

Chapter 02

2.1 Production Systems

Production systems are formal systems that represent knowledge using condition-action rules.

The most common expression is: IF condition(s) THEN action(s).

Production rules are powerful because they mirror a basic structure of human behavior and decision-making.

The chapter notes that this structure has deep historical roots in grammar, logic, linguistics, and symbolic reasoning.

Production systems became central to Expert Systems because they translate expert reasoning into rules that computers can process.

Chapter 02

Why IF-THEN Rules Are Useful

IF-THEN rules are easy for experts to understand, explain, and validate.

They allow expert knowledge to be written in a form that a computer can execute.

They support transparency because users can often see why a conclusion was reached.

They make it possible to divide complex reasoning into smaller, manageable rules.

However, rule-based systems may become difficult to maintain if the number of rules becomes very large.

Study focus

Expert Systems are powerful when rules are clear, stable, and validated by domain experts.

They are weaker when knowledge is vague, changing, or difficult to express.

Chapter 02

Production Rule Example: Real Estate Credit Decision

A production rule can combine several conditions before authorizing an action.

Example: IF borrower income is verified AND credit score is acceptable AND property value is confirmed AND loan-to-value ratio is within policy THEN approve mortgage pre-screening.

This structure allows systems to process complex decisions in a transparent way.

In business contexts, rules often combine qualitative and quantitative conditions.

Rule-based AI is especially suitable for compliance, eligibility, risk screening, and process automation.

Real estate application

Mortgage pre-screening, tenant eligibility checks, maintenance prioritization, lease compliance, and property approval workflows.

Chapter 02

2.2 Structure of Rule-Based Systems

Rule-based systems are more flexible than rigid sequential programs because they can respond to changing facts and stimuli.

Instead of following one fixed path, the system evaluates the state of the world and activates relevant rules.

This makes rule-based systems suitable for complex and rapidly changing environments.

The basic components are the knowledge base, inference engine, fact base or working memory, and interface with the external world.

These components allow the system to store knowledge, evaluate facts, reason logically, and communicate results.

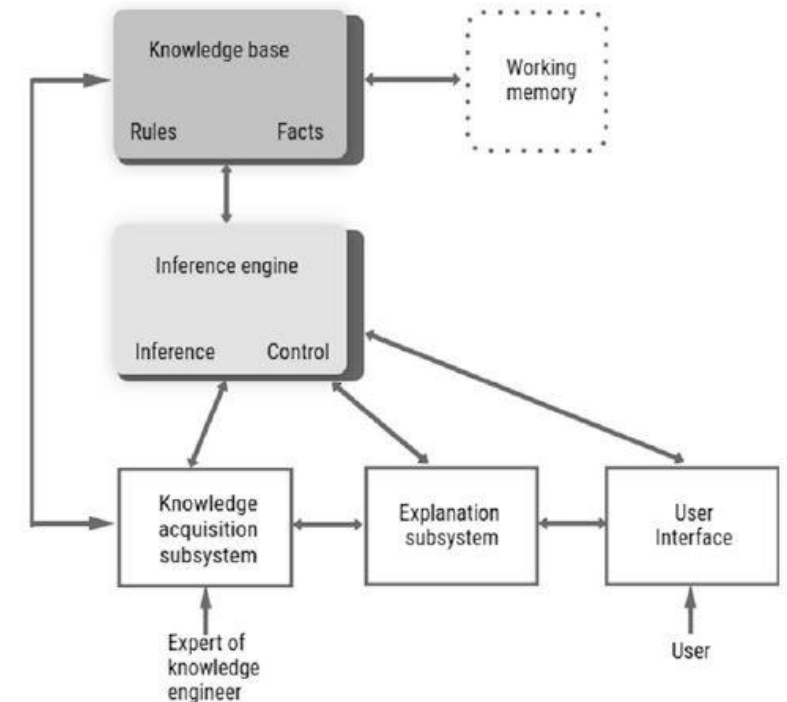


Fig. 2.1 Rule-based system's general outline

Chapter 02

Knowledge Base and Meta-Rules

The knowledge base contains rules, concepts, and static relationships between concepts.

It also may contain meta-rules, which help the system choose which normal rules should be executed first.

Meta-rules improve efficiency because they guide the selection and prioritization of rules.

The knowledge base represents formalized expertise and organizational knowledge.

For KBS success, the knowledge base must be accurate, up-to-date, and aligned with the problem domain.



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Fact Base and Working Memory

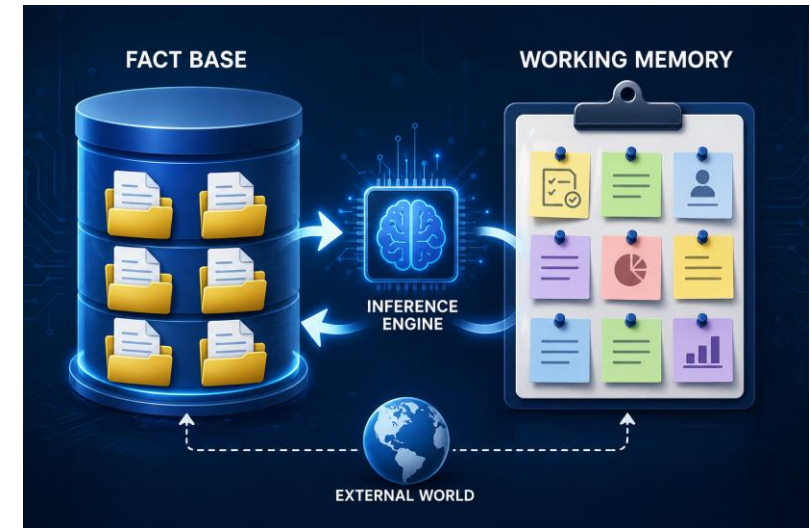
The fact base or working memory contains established facts used to determine which rules can be applied.

Facts may exist as initial conditions, results of previous reasoning, or new data from sensors, users, or databases.

Working memory represents the current state of the system.

It interacts with the outside world by receiving non-inferential information.

As the inference process progresses, new facts are added, modified, or removed.



Chapter 02

Inference Engine: Rule Selection Phase

The inference engine manages the reasoning process by selecting and applying appropriate rules. It begins by narrowing the facts base and rules base to the most relevant subsets, then identifies candidate rules whose conditions match the available facts. When several rules satisfy the conditions at the same time, conflict resolution techniques determine which rule should be activated based on heuristics such as rule priority, specificity, matching order, or the most recent fact.

Business implication

Rule priority matters. In property management, safety-related rules should normally have higher priority than cost-saving rules.

Chapter 02

Inference Engine: Action Stage

After selecting the appropriate rule, the system enters the action stage where the chosen rule is applied. During this process, new facts may be added, existing facts may be modified or removed, and external actions such as reports, messages, or control signals may be triggered. The reasoning cycle continues until the system reaches a conclusion or no additional rules can be activated. This step-by-step process enables Expert Systems to simulate logical reasoning and intelligent decision-making.

Real estate application

IF water leak alert is confirmed
THEN create urgent
maintenance ticket, notify
property manager, and update
tenant communication status.



Chapter 02

2.3 Modes of Reasoning

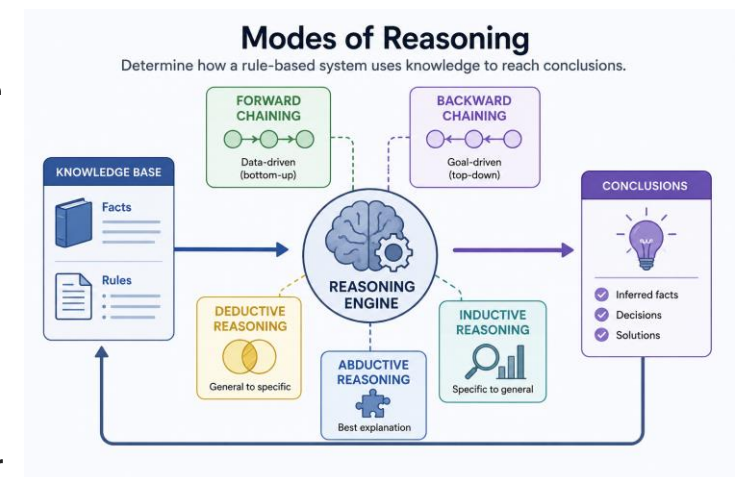
Modes of reasoning determine how a rule-based system uses knowledge to reach conclusions.

KBS and Expert Systems were created because rule systems are compatible with human modes of expression and computer processing.

The two most common modes are forward chaining and backward chaining.

Forward chaining starts from known facts and moves toward conclusions.

Backward chaining starts from a goal or hypothesis and searches for supporting facts.



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Forward Chaining: Data-Driven Reasoning

Forward chaining starts with the available facts stored in the working memory. The system examines which rules can be activated by these facts, and when a rule is applied, it generates new facts that may trigger additional rules. This process continues until a conclusion or goal is reached. Forward chaining is especially useful for monitoring systems, prediction, alerts, and environments where new data continuously enters the system.

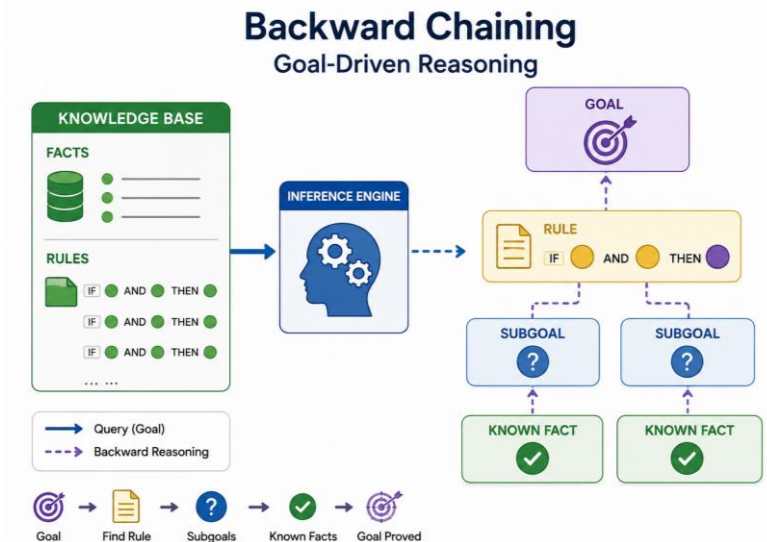
Real estate case

Smart building sensors detect rising energy use, increasing occupancy, and high outdoor temperature; the system recommends cooling optimization.

Chapter 02

Backward Chaining: Goal-Driven Reasoning

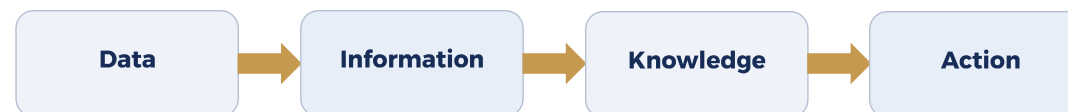
- Backward chaining starts with a goal or hypothesis and works backward to verify whether supporting facts exist.
- The system asks: what must be true for this conclusion to be accepted?
- It is useful in diagnostic, advisory, and verification systems.
- Backward chaining can reduce unnecessary computation because it searches only for facts relevant to the goal.
- In business, it is helpful when managers begin with a question and need evidence-based validation.



Chapter 02

Information, Data, News, and Knowledge

Knowledge is considered part of the broader concept of information, which includes media, signs and signals, data, news, and knowledge itself. Data represent values related to variables such as temperature, price, rent, or occupancy rate, while knowledge gives meaning to these data and connects them to action and decision-making. In Knowledge-Based Systems (KBS), knowledge is especially important because it helps the system understand what the data means and how it should be used effectively.



Chapter 02

Explicit, Implicit, and Tacit Knowledge

Expert Systems depend on three important types of knowledge: explicit, implicit, and tacit knowledge. Explicit knowledge is easily available and accessible through documents, manuals, reports, and formal organizational policies, while implicit knowledge is often represented through specialized forms such as formulas, models, technical diagrams, and expert terminology. Tacit knowledge is more difficult to capture because it is based on expert experience, intuition, judgment, and accumulated practical skills. As a result, Expert Systems often face the greatest challenges when trying to represent and utilize tacit knowledge effectively.

Real estate case

Smart building sensors detect rising energy use, increasing occupancy, and high outdoor temperature; the system recommends cooling optimization.

Chapter 02

Why Tacit Knowledge Is Difficult

- Experts may know how to make good decisions without being able to fully explain their reasoning.
- Some expertise develops through years of repeated practice, pattern recognition, and intuition.
- Experts may also be reluctant to share their knowledge if they fear losing status or becoming replaceable.
- This creates a non-technical barrier to Expert System development.
- Knowledge acquisition therefore requires trust, communication, and structured methods.

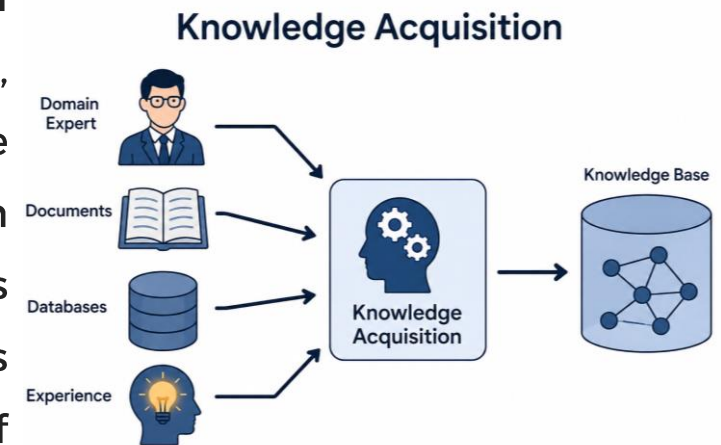
Teaching point

AI implementation is not only technical. It is also human, organizational, and political.

Chapter 02

2.4 Knowledge Acquisition

Knowledge acquisition refers to the process of collecting, extracting, organizing, and formalizing expert knowledge so it can be used by AI and Expert Systems. It is considered one of the most important, difficult, and costly stages in Expert System development because much of the valuable knowledge exists as tacit knowledge stored in experts' experience and judgment. Knowledge acquisition helps transform explicit, implicit, and tacit knowledge into structured forms that AI systems can understand and apply effectively. The success of this process largely determines whether an Expert System becomes truly useful and intelligent or remains limited and superficial.



Chapter 02

Knowledge Acquisition Techniques

Knowledge acquisition techniques vary depending on the type of knowledge and complexity of the domain. Manual methods include interviews, questionnaires, and observation of experts, while semi-automatic and automatic methods may use structured elicitation techniques, decision trees, and data-driven algorithms. Group techniques such as brainstorming and the Delphi method are also used when knowledge is collected from multiple experts.

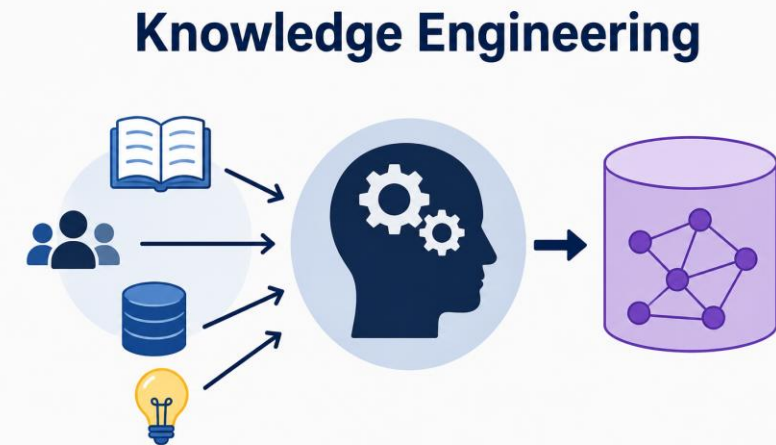
Study focus

Use interviews for deep tacit knowledge, questionnaires for structured rules, observation for practice-based expertise, and data mining for pattern discovery.

Chapter 02

Knowledge Engineering

Knowledge Engineering is the process of designing and developing Expert Systems by transforming expert knowledge into structured knowledge bases, fact bases, and inference mechanisms. Knowledge engineers must understand both the business domain and AI system design while also considering risks, strategies, priorities, and probabilities. Modern Expert Systems often use ontologies and reusable problem-solving methods to improve intelligent decision-making and system performance.



Chapter 02

Expert System Development Methods

Methods such as CommonKADS, IDEAL, and KLICyMIKE are used to support the structured design and development of knowledge-based systems. These methodologies help organizations manage the complexity of Expert Systems, improve knowledge capture, reduce inconsistent rules, and enhance system reliability, reuse, and long-term value. They also provide systematic frameworks that support efficient implementation, maintenance, and continuous improvement of AI-based systems.

Study focus

Expert Systems should not be built informally. They require disciplined knowledge engineering.

Chapter 02

2.5 Knowledge Networks and Organizational Knowledge

Knowledge-Based Systems (KBS) play an important role in organizational knowledge management by capturing and storing valuable expert knowledge within the organization. A KBS transforms part of the organization's intellectual capital into a structured information system, creating a knowledge asset that can be shared, reused, and applied across different departments and business activities.

Unlike traditional information systems, KBS can store not only documents and data, but also how experts interpret and use knowledge. This makes KBS valuable for preserving organizational expertise and supporting organizational learning.

Real estate example

A property management firm can capture expert maintenance prioritization knowledge and make it available across all branches.

Chapter 02

KBS as Organizational Intellectual Capital

Knowledge-Based Systems (KBS) help transform human expertise into reusable organizational knowledge, reducing dependence on individual experts and improving consistency within the organization. KBS integrates both tangible knowledge assets, such as manuals and databases, and intangible assets, such as expert judgment and experience. In digital organizations, these knowledge assets play an important role in innovation, competitiveness, and organizational learning.

Business implication

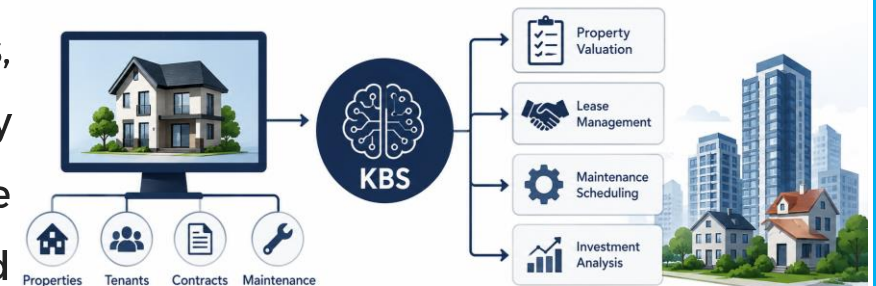
If a senior property analyst leaves, a well-designed KBS can preserve part of their expertise for future decisions.

Chapter 02

Case Study: KBS in Real Estate Management

A real estate company managing residential and commercial properties can use a Knowledge-Based System (KBS) to support decisions related to rent adjustment, maintenance priorities, tenant evaluation, investment opportunities, and regulatory compliance. By encoding expert rules into the system, the company can improve decision consistency, reduce errors, speed up operations, and preserve valuable organizational knowledge.

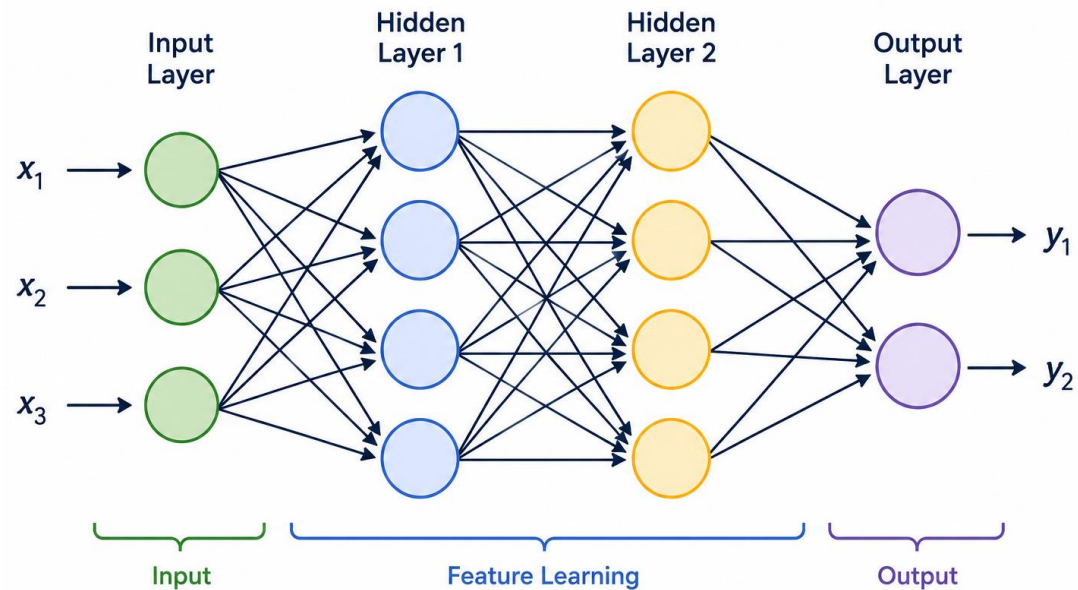
Case Study: KBS in Real Estate Management



3. Artificial Neural Networks

ANNs move from explicit rules toward learning patterns from data.

Artificial Neural Networks



Chapter 02

3.1 Introduction to ANN

- Artificial Neural Networks (ANN) are part of the connectionist approach to AI. Unlike rule-based systems, ANN represents knowledge through connections and weights between artificial neurons, allowing the system to learn from data and experience.
- ANN is useful when problems are too complex to model manually. It is widely used for forecasting, classification, pattern recognition, and prediction under uncertain conditions.

Real estate example

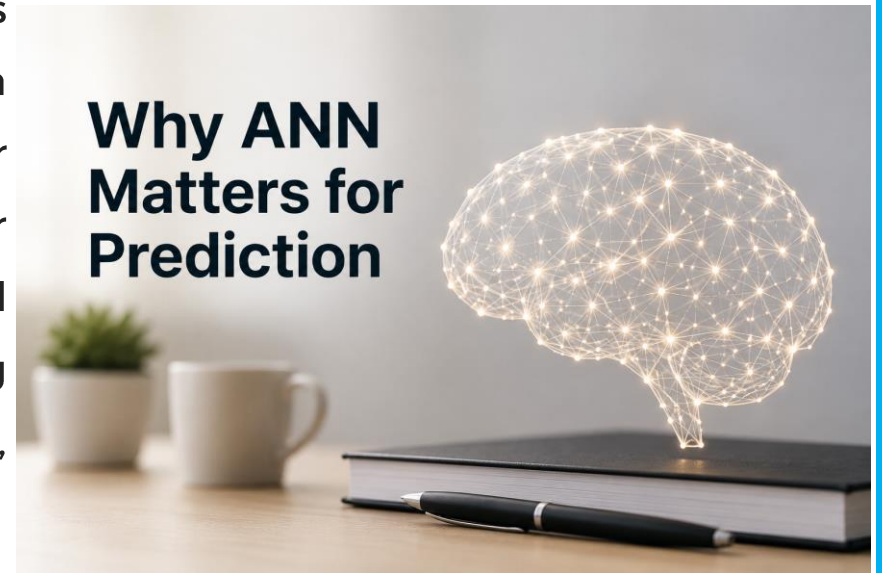
Property prices are influenced by many interacting factors. ANN can learn pricing patterns from historical transactions even when the exact formula is unknown.

Chapter 02

Why ANN Matters for Prediction

One of the main challenges in science is identifying functions that explain observed data and predict future outcomes. In many real-world situations, the data may contain uncertainty or noise, and the exact mathematical model may be unknown or too complex to define manually. In such cases, Artificial Neural Networks (ANN) can learn patterns directly from data, making them highly useful in business, finance, real estate, healthcare, and other complex domains.

Why ANN Matters for Prediction



3.2 Biological Foundations

- Artificial Neural Networks (ANN) were inspired by the human nervous system, which is considered one of the most complex structures in nature. The nervous system receives, processes, and transmits information to produce different intellectual and physical responses. Biological neurons provided the basic inspiration for designing artificial neurons in AI systems.
- Although ANN does not fully replicate the human brain, it uses important concepts such as connections, signals, weights, activation, and learning. This is why ANN is structured as networks of interconnected units that work together to process information and learn from data.

Study focus

ANN is not the brain; it is a computational model inspired by selected brain-like features.

Chapter 02

Brain vs Conventional Computers

- The brain performs some complex tasks, such as recognizing faces and patterns, more efficiently than conventional computers.
- Computers are fast and reliable for certain numerical processes, but pattern recognition can be difficult using traditional algorithms.
- ANN was developed partly to model this pattern-recognition strength.
- ANN processes information differently from conventional sequential programs.
- This difference explains why neural networks are useful for images, speech, classification, and forecasting.

Real estate example

Recognizing property defects from images may be difficult to define by rules but suitable for neural-network image analysis.

Chapter 02

Chapter 2: Part 1 - Summary

- ❑ Artificial Intelligence focuses on solving problems using symbolic and sub-symbolic approaches to support intelligent decision-making.
- ❑ Knowledge-Based Systems (KBS) use rules, knowledge bases, and inference engines to simulate expert reasoning and organizational knowledge.
- ❑ Expert Systems help organizations improve consistency, preserve expertise, and support complex business decisions.
- ❑ Knowledge acquisition transforms expert knowledge into structured forms that AI systems can use effectively.
- ❑ Artificial Neural Networks (ANN) are inspired by the biological nervous system and learn patterns from data to support prediction, classification, and decision-making.
- ❑ In real estate management, AI helps improve valuation, forecasting, investment analysis, property management, and customer services.

Final real estate message

AI becomes valuable in real estate when it turns data and expertise into better valuation, forecasting, operations, investment, and customer decisions.

Chapter 02

Discussion Questions

1. What is the difference between symbolic AI and sub-symbolic AI approaches?
2. Why are Knowledge-Based Systems important for business and organizational decision-making?
3. What challenges are associated with knowledge acquisition in Expert Systems?
4. How are Artificial Neural Networks inspired by the biological nervous system?
5. How can AI applications improve real estate management and investment decisions?





Thank You