

Master Of Real Estate Management

Prepared by
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Artificial Intelligence in Business

Lecture 3



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Chapter
02

AI: Methods and Techniques (Part 2)



Chapter

02

Learning Objectives

- ☐ Understand the concept of Artificial Neural Networks (ANN) and their main Components .
- ☐ Explain how neurons, synapses, weights, and learning processes work in ANN models.
- ☐ Differentiate between feedforward and feedback neural networks.
- ☐ Describe activation functions, transfer functions, and ANN training processes.
- ☐ Explain supervised and unsupervised learning approaches.
- ☐ Analyze the strategic role of Knowledge-Based Systems (KBS) in organizations.
- ☐ Apply ANN and KBS concepts to real estate applications such as valuation, forecasting, investment analysis, and smart property management.



Chapter 02

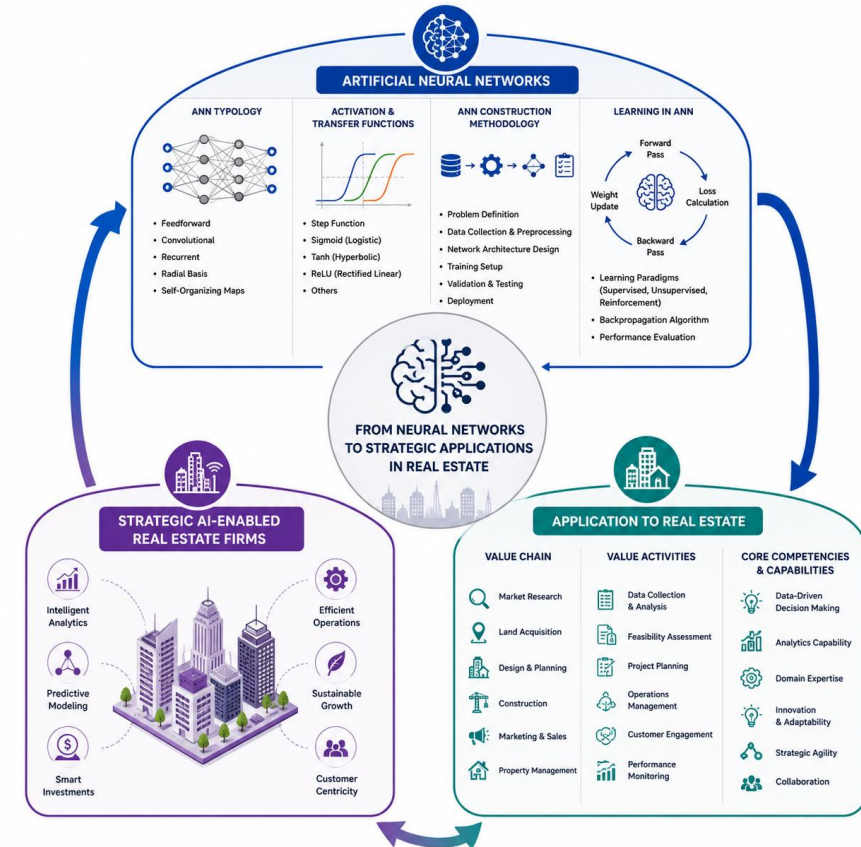
Chapter Roadmap

3. Artificial Neural Networks

- 3.3 ANN Typology
- 3.4 Activation and Transfer Functions
- 3.5 ANN Construction Methodology
- 3.6 Learning in ANN

4. Identification of Strategic KBS Applications

- 4.1 Value Chain and Value Activities
- 4.2 Core Competencies and Capabilities
- 4.3 Strategic AI-enabled real estate firms



Chapter 02

Introduction

This chapter explores two important approaches in Artificial Intelligence: Knowledge-Based Systems (KBS) and Artificial Neural Networks (ANN). It explains how ANN is inspired by the biological nervous system and how artificial neurons, synapses, signals, and neural connections support intelligent learning and pattern recognition. The chapter also discusses ANN structures, activation functions, learning processes, and network training methods used in prediction and decision-making.

In addition, the chapter examines the role of Knowledge-Based Systems in organizations, including expert systems, knowledge management, and strategic business applications. Finally, the chapter connects these AI concepts to real-world real estate applications such as property valuation, investment analysis, smart buildings, tenant management, and market forecasting.

Chapter 02

3. Artificial Neural Networks

Artificial Neural Networks (ANN) are computational models inspired the human brain functions. An ANN consists of interconnected processing elements called artificial neurons that work together to solve specific problems.

The concept is based on the mathematical neuron model introduced by McCulloch and Pitts in 1943, where each neuron receives multiple inputs, processes the information, and generates a single output. During the learning process, the network improves its performance by adjusting the connection weights between neurons through training.

Study focus

The key difference from conventional programming is that ANN learns from data rather than following only fixed instructions.

Chapter 02

Main Components of ANN

In Artificial Neural Networks (ANN), neurons act as the basic processing units of the network, while synapses connect neurons and transmit information between them. Synaptic weights determine the strength and importance of each connection, and the total input represents the combined effect of incoming signals. The activation and output functions determine how the neuron responds to the received information, and through the learning process, the network adjusts synaptic weights to improve performance and behavior over time.

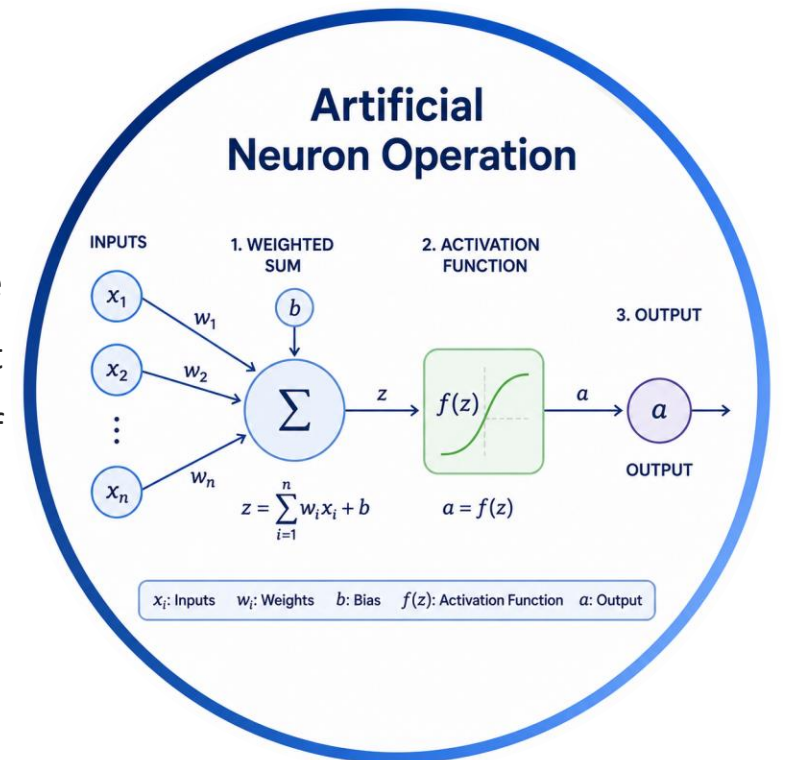
Real estate example

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

Chapter 02

Artificial Neuron Operation

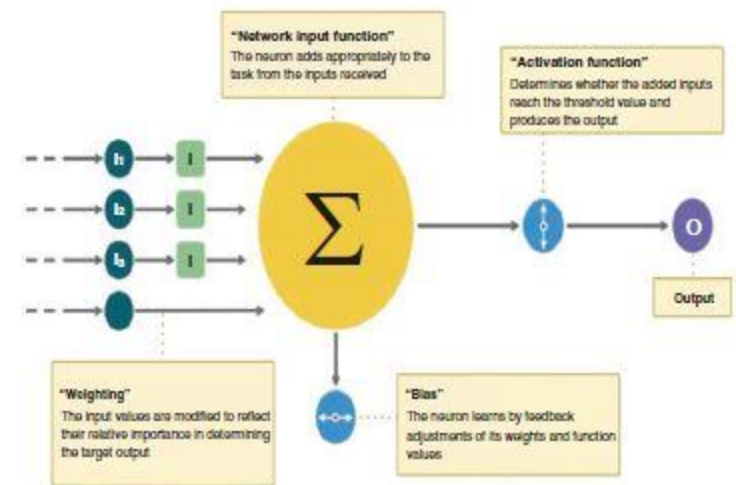
An artificial neuron receives multiple inputs, where each input is multiplied by a specific weight that reflects its importance. The neuron combines these weighted inputs to calculate the total input, then applies an activation function to determine the neuron's activation state. After that, a transfer function generates the final output or response, which is either passed to other neurons in the network or used as part of the final prediction.



Chapter 02

Artificial Neuron Operation

The figure shows how an artificial neuron works by receiving multiple input signals, each multiplied by a weight that reflects its importance. The neuron combines these weighted inputs using the network input function, then applies an activation function to determine whether an output should be generated. The final output is transmitted to other neurons or used in prediction tasks, while the bias and learning process help improve the neuron's performance over time.



Schematic diagram of the functioning of an artificial neuron

Fig. 2.4 Schematic diagram of the functioning of an artificial neuron

Chapter 02

Hebbian Learning: Neurons That Fire Together Wire Together

Hebb's rule states that when neighboring neurons are activated together repeatedly, the connection between them becomes stronger. This principle helped explain simple learning processes and pattern recognition, but it was not sufficient for large neural networks that learn from errors. As neural networks became more complex, more advanced learning methods such as backpropagation were developed to improve learning accuracy and network performance.

Teaching analogy

If two property features frequently appear together with high value, the network may strengthen their association during learning.

Chapter 02

Backpropagation: Key Learning Breakthrough

- Backpropagation was a major breakthrough in Artificial Neural Networks because it made it possible to train networks with hidden layers effectively. The learning process begins with the forward pass, where the network receives input data and produces an output that may contain errors.
- In the backward pass, the algorithm adjusts the connection weights to reduce the difference between the predicted and desired outputs. This method significantly improved neural network learning and became the foundation of modern deep learning systems.

Chapter 02

Backpropagation: Key Learning Breakthrough

The figure illustrates the backpropagation process in an Artificial Neural Network (ANN), where input data passes through the input layer and hidden layers using weighted connections called synaptic weights to produce an output prediction. If the prediction is incorrect, the error is sent backward through the network during the backward pass, allowing the system to update the synaptic weights and improve prediction accuracy. Through repeated training and weight adjustments, the network gradually learns to recognize patterns and generate more accurate outputs over time.

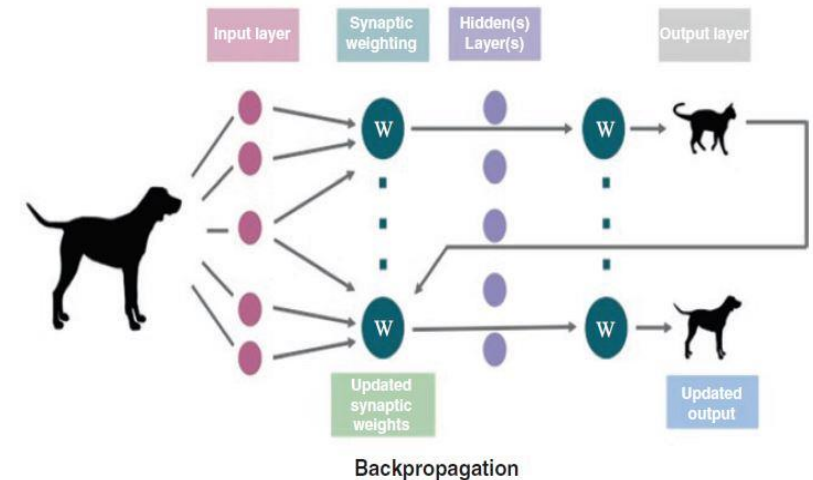


Fig. 2.5 Backpropagation diagram

Chapter 02

Loss Function and Gradient Descent

A loss function measures the difference between the predicted output and the desired output in an Artificial Neural Network. During learning, the network adjusts its weights to minimize this error, similar to moving down a landscape toward the lowest valley. Backpropagation helps determine how much each weight contributes to the error, and through repeated training, the network gradually improves its performance and prediction accuracy.

Study focus

Students do not need advanced mathematics here; they should understand that ANN learns by reducing error step by step.

3.3 ANN Typology

Artificial Neural Networks (ANNs) can be classified based on how information moves through the network. The two main types are feedforward networks and feedback networks. Feedforward networks process information in a single direction from input to output, while feedback networks allow signals to circulate and influence previous states until the network reaches stability. Different network structures are designed to solve different types of problems and applications.

Study focus

Network architecture should match the nature of the business problem.

Chapter 02

Feedforward Networks

- In feedforward networks, information flows in one direction only: from input layer to output layer.
- Neurons are usually organized in layers.
- Each layer receives signals from the previous layer and sends outputs to the next layer.
- There are no connections between neurons in the same layer.
- Feedforward networks can make rapid calculations because information passes through the network once.

Real estate application

Feedforward networks can predict property price from a fixed set of input variables such as size, location, age, and market indicators.

Chapter 02

Feedback Networks

- In feedback networks, neurons may be connected to other neurons in loops.
- Each neuron may recalculate its state several times until the network reaches stability.
- Feedback networks can better emulate the brain because feedback phenomena are common in biological neural systems.
- However, it may be difficult to know how long the network will take to stabilize.
- These networks are useful for dynamic problems and memory-like behavior.

Real estate application

Feedback structures can support market simulation where previous price changes influence future buyer behavior and investment expectations.

Chapter 02

Multilayer Networks with Lateral Feedback

Some multilayer neural networks include feedback connections within the same layer, allowing neurons to influence one another or even feed back on themselves. This structure creates more complex interactions compared to simple feedforward networks and makes the architecture closer to biological nervous systems. However, these networks are also more difficult to design, train, and analyze due to their complexity.

Study focus

More complex network architecture can improve capability, but it also increases design and interpretation challenges.

3.4 Activation and Transfer Functions

In Artificial Neural Networks, neurons receive input information, process it, and generate a response. The total input is typically calculated as the weighted sum of incoming signals, while activation functions determine the neuron's activation state based on the inputs and weights. Transfer functions then convert this activation into the final output, defining how the neuron behaves mathematically within the network.

Study focus

Activation and transfer functions are the mathematical heart of how artificial neurons respond.

Chapter 02

Total Input and Weighted Signals

- The total input to a neuron is the weighted sum of signals arriving from other neurons.
- Each incoming signal is multiplied by its connection weight.
- Excitatory connections have positive effects; inhibitory connections may have negative weights.
- The weighted sum represents the net influence of all inputs.
- This process allows the network to represent the relative importance of different variables.

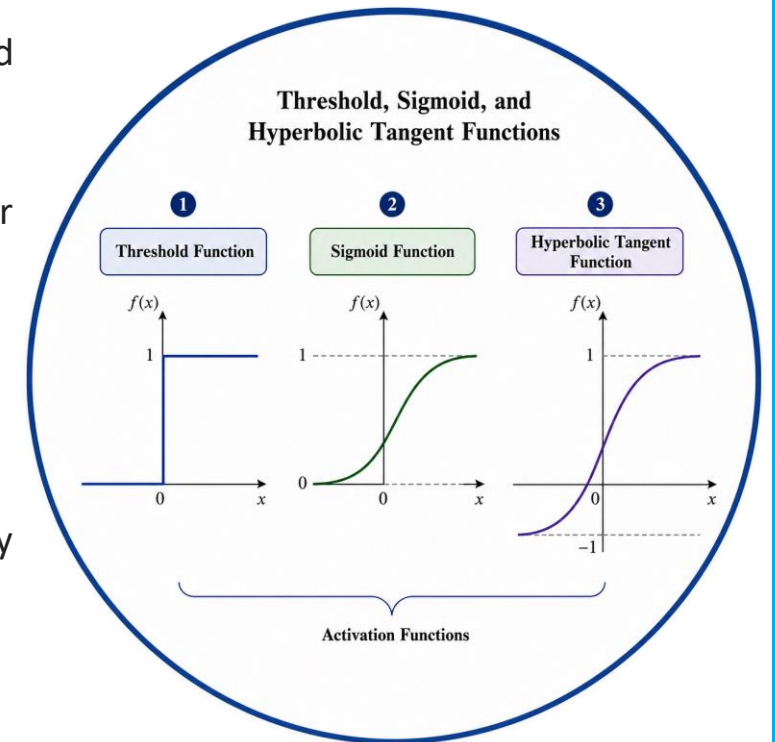
Real estate example

Location may receive a high positive weight in price prediction, while property age may receive a negative weight if older buildings reduce value.

Chapter 02

Threshold, Sigmoid, and Hyperbolic Tangent Functions

- A threshold function activates the neuron only if total input exceeds a defined threshold.
- A sigmoid function produces continuous outputs between 0 and 1 and is useful for smooth learning.
- The hyperbolic tangent function produces outputs between -1 and 1 .
- These non-linear functions help networks model complex relationships.
- Non-linearity is essential because many real-world problems cannot be captured by simple linear relationships.



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Linear vs Non-Linear Neurons

- Linear neurons produce outputs that are proportional to inputs.
- Linear neurons can be unstable because small input changes may create large output changes.
- They may also struggle to handle both very small and very large signals appropriately.
- Non-linear neurons can produce bounded responses and improve stability.
- Modern neural networks rely heavily on non-linear functions because they allow deeper and more flexible modeling.

Study focus

Non-linearity allows ANN to capture complex business relationships that cannot be represented by simple straight-line models.

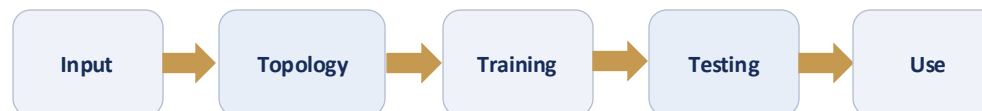
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3.5 ANN Construction Methodology

- Building an ANN-based solution requires a structured methodology.
- The first step is defining the input as numbers that the network can process.
- The second step is defining the network topology, including layers, neurons, and connections.
- The third step is training the ANN with examples.
- The fourth step is running the trained ANN to solve new examples of the problem.

Study focus

ANN construction is not magic. It is a disciplined process of input design, architecture design, training, testing, and deployment.



Chapter 02

Step 1: Defining Inputs

Inputs in Artificial Neural Networks (ANN) must be represented numerically so the network can process and learn from them effectively. Depending on the application, inputs may represent image pixels, sound parameters, financial ratios, customer behavior measures, operational metrics, or market indicators. Accurate input representation is essential because the ANN can only learn from information that is properly encoded and structured.

Real estate example

Inputs for property valuation may include area, bedrooms, building age, neighborhood score, distance to services, transaction history, and market demand.

Chapter 02

Step 2: Network Topology

- Network topology refers to the arrangement of neurons, layers, and connections.
- The designer must decide the number of layers and number of neurons in each layer.
- Each input must be connected to neurons in a way that allows the network to learn useful patterns.
- Initial synaptic weights may be equal, random, determined by designer judgment, or generated by algorithms.
- Topology design is one of the most important decisions affecting ANN performance.

Study focus

A poor network design may fail even when data is good. Architecture matters.

Chapter 02

Step 3: Training the ANN

Training in Artificial Neural Networks (ANN) involves repeatedly testing the network using sample problems and adjusting synaptic weights after each test to improve performance. The training process continues until the network reaches an acceptable accuracy level or no further improvement is achieved. Large amounts of high-quality training data are usually required because, similar to human learning, the quality and amount of practice strongly influence network performance and learning accuracy.

Step 4: Testing and Generalization

- After training, the ANN should be tested on data it has not seen before.
- Testing helps determine whether the network can generalize beyond training examples.
- Generalization means producing correct responses for new but similar cases.
- Reserving part of the dataset for testing is a common practice.
- In high-risk applications, testing must be rigorous because errors may have serious consequences.

Real estate example

Before using an AI valuation model commercially, it should be tested on recent sales not used during training.

3.6 Learning in ANN

Learning in Artificial Neural Networks (ANN) refers to the process of adapting network responses by adjusting synaptic weights based on input data and experience. During learning, connection weights may become stronger, weaker, zero, or even change direction from positive to negative depending on the learning rule applied. This ability to learn and improve from data is one of the main features that distinguishes ANN from traditional computer programs.

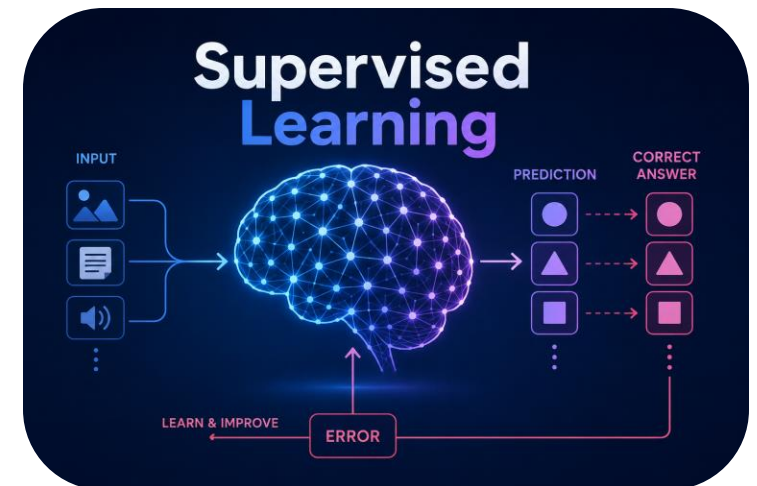
Study focus

ANN does not simply follow fixed instructions; it changes internal parameters through experience.

Chapter 02

Supervised Learning

- Supervised learning repeatedly presents the network with input patterns and correct responses.
- The network compares its output with the correct response.
- Based on the error, the system adjusts weights to improve future performance.
- The training set must be carefully designed because it contains the information the network needs to learn.
- Supervised learning is widely used for prediction, classification, and diagnosis.



Chapter 02

Unsupervised Learning

- In unsupervised learning, the network is not given correct answers.
- The system receives large amounts of data and discovers associations or structures by itself.
- Neurons organize themselves by identifying regularities in the input data.
- This approach is valuable when categories are unknown or when hidden patterns need discovery.
- Unsupervised learning is used in clustering, segmentation, and pattern discovery.

Real estate example

An AI system may discover hidden customer segments based on search behavior, income, location preferences, and investment style.

Chapter 02

Kohonen Self-Organizing Maps

Kohonen networks are an important example of unsupervised learning because they organize data based on similarity without requiring predefined outputs. They create a topological representation where similar patterns are positioned close to each other on the resulting map, allowing complex multi-dimensional data to be visualized in one or two dimensions. Kohonen maps help analysts understand how patterns and groups are formed within large datasets, making them useful for clustering, market segmentation, customer behavior analysis, and pattern discovery in business applications. They are also valuable for reducing data complexity and improving data interpretation and visualization.

Chapter 02

Case Study: ANN for Twin-Engine Flight Safety

An important ANN application is monitoring a twin-engine aircraft by analyzing parameters such as flight conditions, landing gear status, fuel level, engine temperature, engine speed, and altitude. The network processes these numerical inputs to determine whether the flight situation is normal or dangerous.

The figure shows how an Artificial Neural Network (ANN) analyzes different flight parameters, such as fuel level, landing gear, engine speed, and aircraft position, through input, hidden, and output layers to determine whether the flight condition is safe or dangerous.

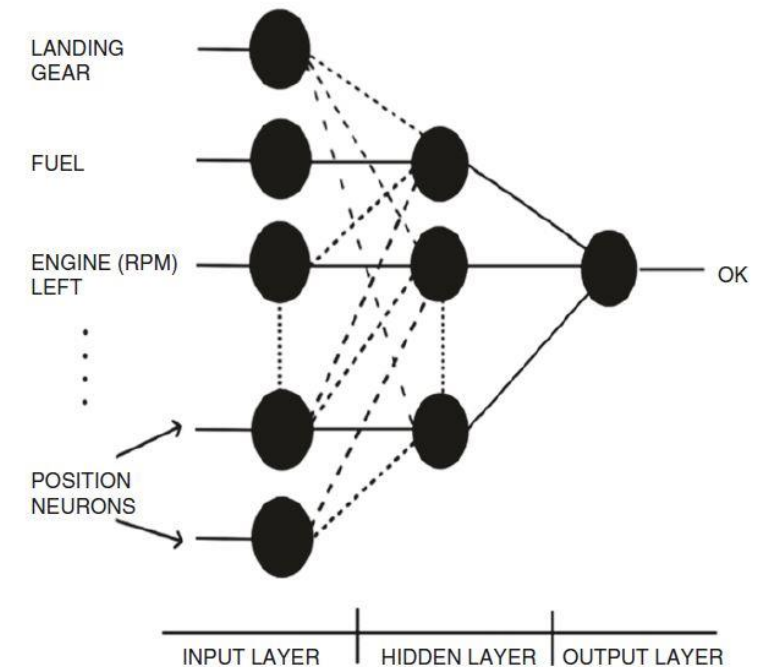


Fig. 2.6 ANN figure of twin-engine flight status assessment

Chapter 02

Case Study: ANN for Real Estate Valuation

- A real estate valuation ANN uses historical market data to estimate property values.
- Inputs may include property size, building age, location, amenities, recent sales, interest rates, and demand indicators.
- Hidden layers detect complex relationships between these variables.
- The output may be predicted market value, rent level, or investment score.
- The model must be tested carefully because biased or outdated data can produce misleading valuations.

Class discussion

What variables should be included in a Jordanian real estate price prediction model?

Chapter 02

4. Identification of Strategic KBS Applications

A technically successful AI system is valuable only when it also creates strategic business benefits for the organization. This means that the AI system should not only function correctly from a technical perspective, but also improve organizational performance, support decision-making, reduce costs, increase efficiency, enhance customer experience, or strengthen competitive advantage. In business and real estate environments, AI must contribute to real organizational goals and generate measurable value rather than simply demonstrating advanced technology.



Chapter 02

Strategic Importance of KBS Applications

- KBS applications may fail to impress top management if they do not create long-term competitive advantage.
- A KBS project is more likely to receive support when it is linked to strategic benefit.
- Strategic KBS applications should improve high-value decisions, reduce bottlenecks, or strengthen core capabilities.
- Technical sophistication alone is not enough.
- Managers must identify where AI can create measurable value.

Real estate example

A KBS for lease document storage is useful, but a KBS that reduces vacancy or improves investment selection is more strategic.

Chapter 02

4.1 Value Chain and Value Activities

Strategic Knowledge-Based System (KBS) applications can be identified by analyzing the organization's value chain and focusing on activities that create high business value. Activities connected to critical operations, decision points, bottlenecks, or boundaries between departments often involve intensive knowledge processing and are strong candidates for KBS implementation. These systems can improve efficiency, decision-making, and coordination across important organizational activities.

Study focus

Ask: where does knowledge create the most value, and where does poor knowledge slow the organization down?

Chapter 02

High-Value Activities

High-value activities are business activities that contribute significantly to the company's competitive advantage and strategic performance. The knowledge and decision-making processes within these activities should be analyzed carefully to determine whether they can be improved through Knowledge-Based Systems (KBS). If expert knowledge can be captured and reused effectively, the activity becomes a strong candidate for AI investment. In real estate, examples of high-value activities include property valuation, investment analysis, leasing strategies, and asset management.



Chapter 02

Activities Interfacing with High-Value Activities

Some organizational activities may not seem highly valuable on their own, but they strongly support and influence major value-creating activities. Knowledge-Based Systems (KBS) can improve the flow of knowledge and coordination between these supporting and high-value activities, increasing overall organizational performance. In real estate, functions such as marketing, customer analytics, maintenance, and finance can significantly affect investment success and overall value creation.

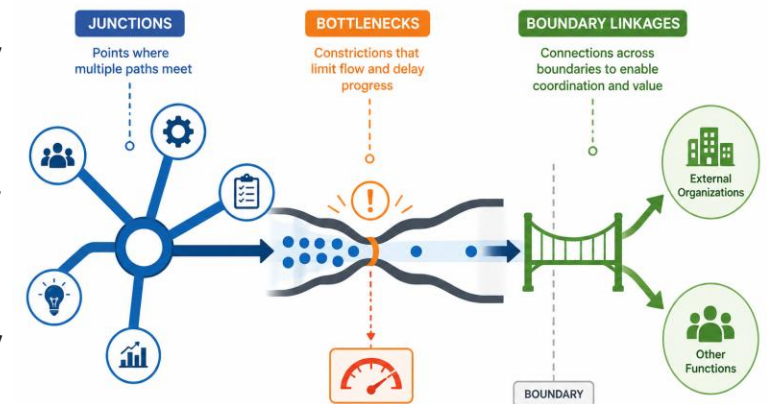
Real estate example

Better tenant analytics can improve leasing decisions, which then improves cash flow and asset valuation.

Chapter 02

Junctions, Bottlenecks, and Boundary Linkages

Junctions between organizational activities often involve intensive knowledge processing and coordination, making them important areas for Knowledge-Based System (KBS) applications. Bottleneck activities can slow value creation and may benefit from AI automation, while boundary linkages connect the organization with suppliers, customers, and internal departments. KBS helps improve knowledge flow and coordination across these boundaries, showing that strategic AI success often comes from improving organizational integration and collaboration rather than only optimizing isolated tasks.



Chapter 02

AI Across the Real Estate Value Chain

- In property acquisition, AI supports market analysis, valuation, and investment screening.
- In development, AI supports feasibility studies, cost estimation, and risk assessment.
- In leasing, AI supports customer segmentation, pricing, and tenant matching.
- In operations, AI supports predictive maintenance, energy optimization, and service automation.
- In asset management, AI supports portfolio analysis, performance monitoring, and strategic planning.

Study focus

Strategic value comes when AI is embedded across the real estate value chain, not used as a disconnected tool.

Chapter 02

4.2 Core Competencies and Capabilities

- Core competencies are areas of intense knowledge processing within an organization.
- They represent coordination and integration of diverse skills.
- From a knowledge-management perspective, a company leverages core competencies by identifying, collecting, integrating, and disseminating knowledge.
- KBS can support knowledge collection, integration, coordination, and sharing.
- Capabilities refer to skills developed across activities in core business processes.

Real estate example

A real estate company's core competence may be identifying undervalued properties before competitors.

Chapter 02

How KBS Builds Core Competencies

- KBS can collect diverse knowledge elements from across the company.
- It can integrate and coordinate complex knowledge related to core competencies.
- It can distribute specific knowledge to relevant departments and decision-makers.
- It helps organizations avoid losing critical knowledge when experts leave.
- By sharing expertise across the organization, KBS supports stronger organizational capabilities.

Business implication

Knowledge must move from individuals to systems and from systems to organizational routines.

Chapter 02

Capabilities and Core Processes

- Capabilities develop across different activities in core business processes.
- Organizations build capabilities by identifying core processes and sharing relevant knowledge across activities.
- KBS targeted at organizational and knowledge-link levels can help share critical knowledge.
- This supports coordination within and across core processes.
- Strong capabilities allow firms to respond faster and more intelligently to market changes.

Real estate example

An integrated KBS can link acquisition, finance, legal, marketing, and property operations into one knowledge-supported decision process.

Chapter 02

4.3 Strategic Case: AI-Enabled Real Estate Firm

- Imagine a real estate firm that builds a KBS to support acquisition, leasing, maintenance, and asset management.
- The system stores expert rules for investment screening and risk classification.
- It uses ANN models for price forecasting and market segmentation.
- It connects knowledge across departments and supports consistent decision-making.
- This hybrid AI capability becomes a strategic asset that competitors may find difficult to imitate.

Class activity

Ask students to identify one real estate process where KBS would create strategic advantage and justify why.

Chapter 02

Implementation Risks and Ethical Considerations

- AI systems may fail if knowledge is incomplete, outdated, biased, or poorly represented.
- ANN models may produce inaccurate predictions if training data is noisy or unrepresentative.
- Expert Systems may become rigid if rules are not updated with market changes.
- Real estate AI must consider privacy, fairness, transparency, and potential discrimination.
- Strategic AI adoption requires governance, monitoring, and human oversight.

Real estate risk

An AI rental screening system may unintentionally discriminate if historical data reflects biased approval patterns.

Chapter 02

Chapter 2: Part 2 - Summary

- ❑ Artificial Neural Networks (ANN) are AI systems inspired by the biological nervous system and designed to learn from data.
- ❑ ANN uses neurons, weights, activation functions, and learning processes to support prediction and pattern recognition.
- ❑ Different ANN architectures, such as feedforward and feedback networks, are used for different business problems.
- ❑ Knowledge-Based Systems (KBS) help organizations capture expert knowledge and improve decision-making.
- ❑ In real estate, AI supports valuation, forecasting, investment analysis, and smart property management.

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. How do Artificial Neural Networks learn from data?
2. What is the difference between feedforward and feedback networks?
3. Why are Knowledge-Based Systems important for organizations?
4. How can AI improve real estate decision-making?
5. What ethical risks may appear when organizations use AI systems?





Thank You