

DSA1 3302: Expert System

Week1: Introduction to Expert System

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Outline

- Introduction
- What is an Expert System?
- How Expert Systems Work?
- Components of an Expert System
- Types of Expert Systems
- Examples of Expert Systems
- Advantages and Limitations
- Future of Expert Systems
- Conclusion
- Questions

Introduction

- A machine is thought intelligent if it can achieve human-level performance in some cognitive task.
- To build an intelligent machine, we have to capture, organise and use human expert knowledge in some problem area.
- Knowledge-sparse, weak methods to domain-specific, knowledge intensive methods.
- This led to the development of expert systems – computer programs capable of performing at a human-expert level in a narrow problem area.

What is an Expert System?

- An Expert System is an AI-based system that emulates the decision-making ability of a human expert.
- These systems are designed to solve complex problems by reasoning through bodies of knowledge.
- Often used in fields requiring specialized expertise, such as medicine, finance, and engineering.

Cont.,

- Expert systems use human knowledge and expertise in the form of specific rules
- Distinguished by the clean separation of the knowledge and the reasoning mechanism.
- They can also explain their reasoning procedures.
- ‘knowledge acquisition bottleneck’ –extracting knowledge from human experts. **Difficult!!**
- Experts think in imprecise terms (very often and almost never, usually and hardly ever, frequently and occasionally, and use linguistic variables ((high and low, fast and slow, heavy and light).

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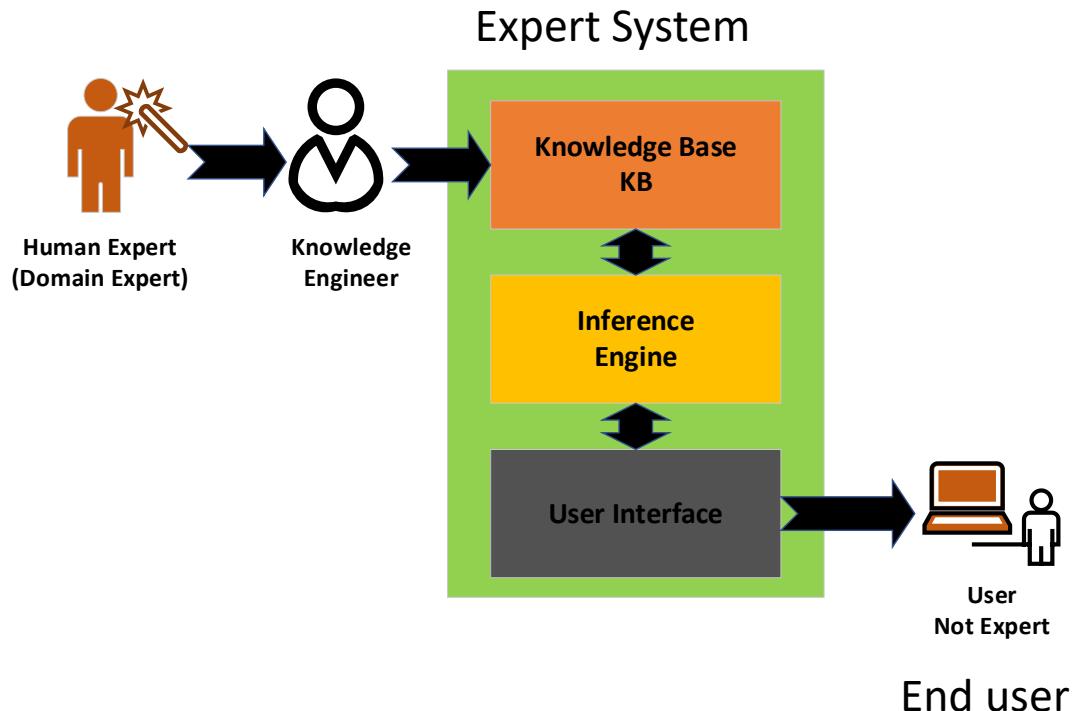
- Fuzzy logic or fuzzy set theory provides a means to compute with words.
- Expert systems can neither learn nor improve themselves through experience.
- Machine learning can accelerate this process significantly and enhance the quality of knowledge ,
How?, share with me a private response in Google class.
- Integration of expert systems and ANNs, and fuzzy logic and ANNs improve the adaptability, fault tolerance and speed of knowledge-based systems.

How Expert Systems Work

1. User provides a query or problem.
2. Inference engine matches the query with the knowledge base using rules.
3. System processes data and generates solutions or answers.
4. Explanation facility provides reasoning for the conclusions.
5. User receives output and has the option to query further or end the interaction.



Components of an Expert System



Cont,. Extended components

1. Knowledge Base: Stores all the domain-specific information, rules, and facts.
2. Inference Engine: Processes the knowledge to draw conclusions and solve problems.
3. User Interface: Allows users to interact with the system to input queries and receive answers.
4. Explanation Facility: Provides reasoning and justifications for conclusions.
5. Knowledge Acquisition Facility: Allows updates to the knowledge base by integrating new information.

Types of Expert Systems

- Rule-Based Systems: Use a set of if-then rules to solve specific problems.
- Frame-Based Systems: Use data structures (frames) for organizing information about a topic.
- Fuzzy Expert Systems: Use fuzzy logic to handle uncertainty and approximate reasoning.
- Neural Expert Systems: Combine expert systems with neural networks to enhance decision-making.
- Real-Time and hybrid Expert Systems: Designed for real-time applications where responses are time-sensitive.

Examples of Expert Systems

Examples of early Expert Systems

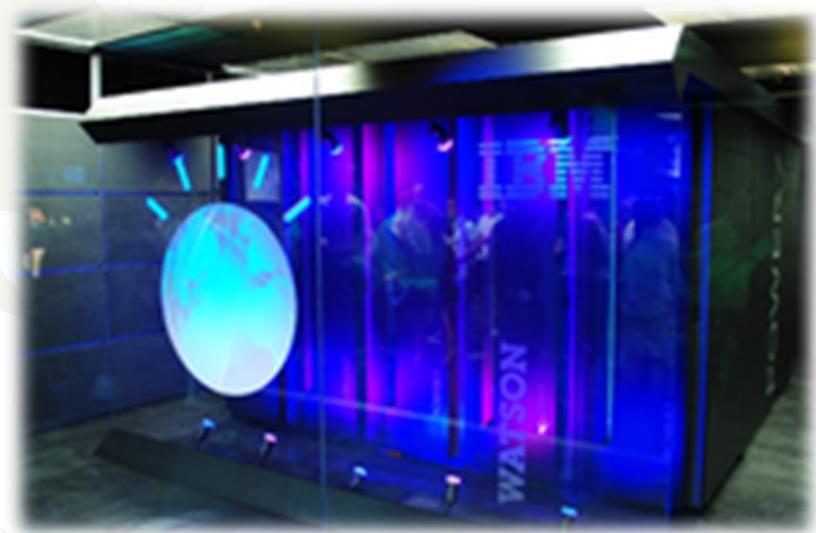
- MYCIN: Medical diagnosis expert system for infectious diseases.
- DENDRAL: Chemical analysis system to determine molecular structure.
- XCON (R1): Configuration of complex computer systems.

Examples of recent ES

IBM Watson for Oncology:

Purpose: Assists oncologists in recommending personalized cancer treatments.

- How It Works: Analyzes medical literature, clinical trial data, and patient records to provide treatment options.
- Impact: Helps doctors make informed decisions, reducing research time and improving treatment accuracy.
- More Info: [IBM Watson Health]([https://en.wikipedia.org/
wiki/IBM_Watson](https://en.wikipedia.org/wiki/IBM_Watson))



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EXPERTISE2 (Renewable Energy Management)

Purpose: Optimizes renewable energy systems by analyzing usage and predicting needs.

- How It Works: Collects data from energy sources and applies rule-based algorithms for real-time distribution.
- Impact: Enhances energy efficiency and reduces waste, supporting sustainable energy solutions.



Cont.,

KARISMA (Legal Case Management)

Purpose: Aids in legal case documentation, compliance, and procedural steps.

- How It Works: Uses legal guidelines, case history, and compliance rules to provide insights.
- Benefits: Improves productivity by organizing cases and ensuring consistency in documentation.





- DSS (Decision Support Systems) in Smart Farming**
- Purpose: Guides farmers on crop management, pest control, and irrigation.
- Cont.,
- How It Works: Analyzes environmental data and weather forecasts to provide recommendations.
 - Impact: Increases crop yield and promotes sustainable farming practices.



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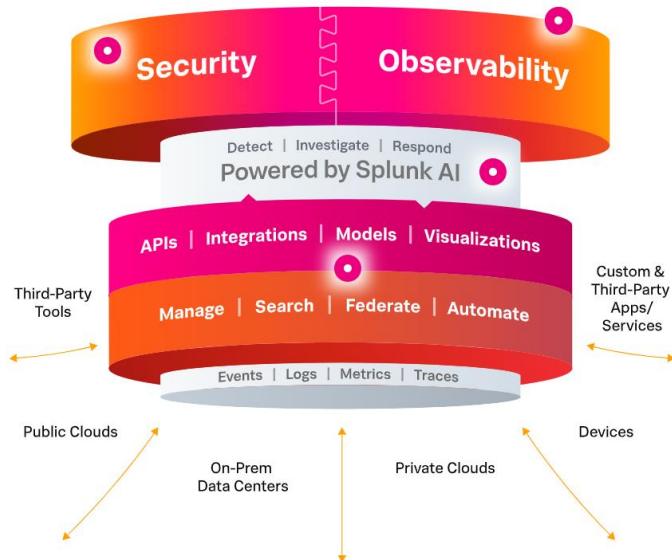
SOPHiA DDM (Genomic Data Interpretation)

Purpose: Assists in interpreting genomic data for personalized medicine.

- How It Works: Analyzes genomic data and connects it to medical information to identify mutations.
- Outcome: Allows for accurate diagnosis and treatment, especially for genetic conditions.
- More Info: [SOPHiA Genetics](<https://www.sophiagenetics.com>)



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Splunk IT Service Intelligence (IT Monitoring)

Purpose: Monitors IT systems, detects issues, and prioritizes responses.

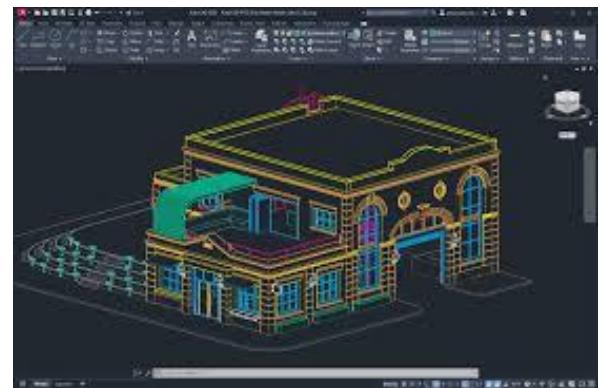
- How It Works: Analyzes IT data to identify problems and suggests solutions.
- Outcome: Reduces downtime and improves service reliability.
- More Info:
[Splunk](<https://www.splunk.com>)

Cont.,

AutoCAD Architecture Expert System

Purpose: Guides building designs based on structural and regulatory requirements.

- How It Works: Uses rules to ensure compliance with building codes and efficiency standards.
- Advantage: Speeds up design and ensures compliance, especially for complex projects.
- More Info: [AutoCAD Architecture](<https://www.autodesk.com/products/autocad-architecture>)



Cont.,

SAP Leonardo (Manufacturing & Supply Chain)

Purpose: Optimizes manufacturing and supply chains using machine learning and rule-based systems.

- How It Works: Predicts maintenance needs and optimizes inventory via IoT sensor data.
- Benefits: Improves process efficiency and reduces downtime.
- More Info: [SAP Leonardo](<https://www.sap.com/products/leonardo.html>)

Advantages and Limitations

Advantages:

- ✓ Can solve complex problems quickly and consistently.
 - ✓ Reduces the need for human expertise in repetitive tasks.
 - ✓ Enhances decision-making in fields like medicine, finance, and engineering.

Limitations:

- ❖ Limited to the knowledge coded into the system; can't adapt like humans.
 - ❖ Expensive and time-consuming to develop and maintain.
 - ❖ Difficult to handle new, unknown cases without updating the knowledge base.

Future of Expert Systems

- Expert systems are expected to evolve with advancements in machine learning and AI.
- Integration with neural networks and deep learning may improve adaptability.
- Real-time expert systems and hybrid systems (e.g., combining neural and rule-based) will likely grow.
- Continued importance in high-stakes fields where human-like expertise is critical, such as healthcare, legal, and environmental management.

Conclusion & Questions

- Rules form a foundation for knowledge representation in expert systems.
- Upcoming lecture: More in-depth exploration of expert systems.
- Can generative AI enhance the performance of expert system? How?



Using any generative AI tools!