

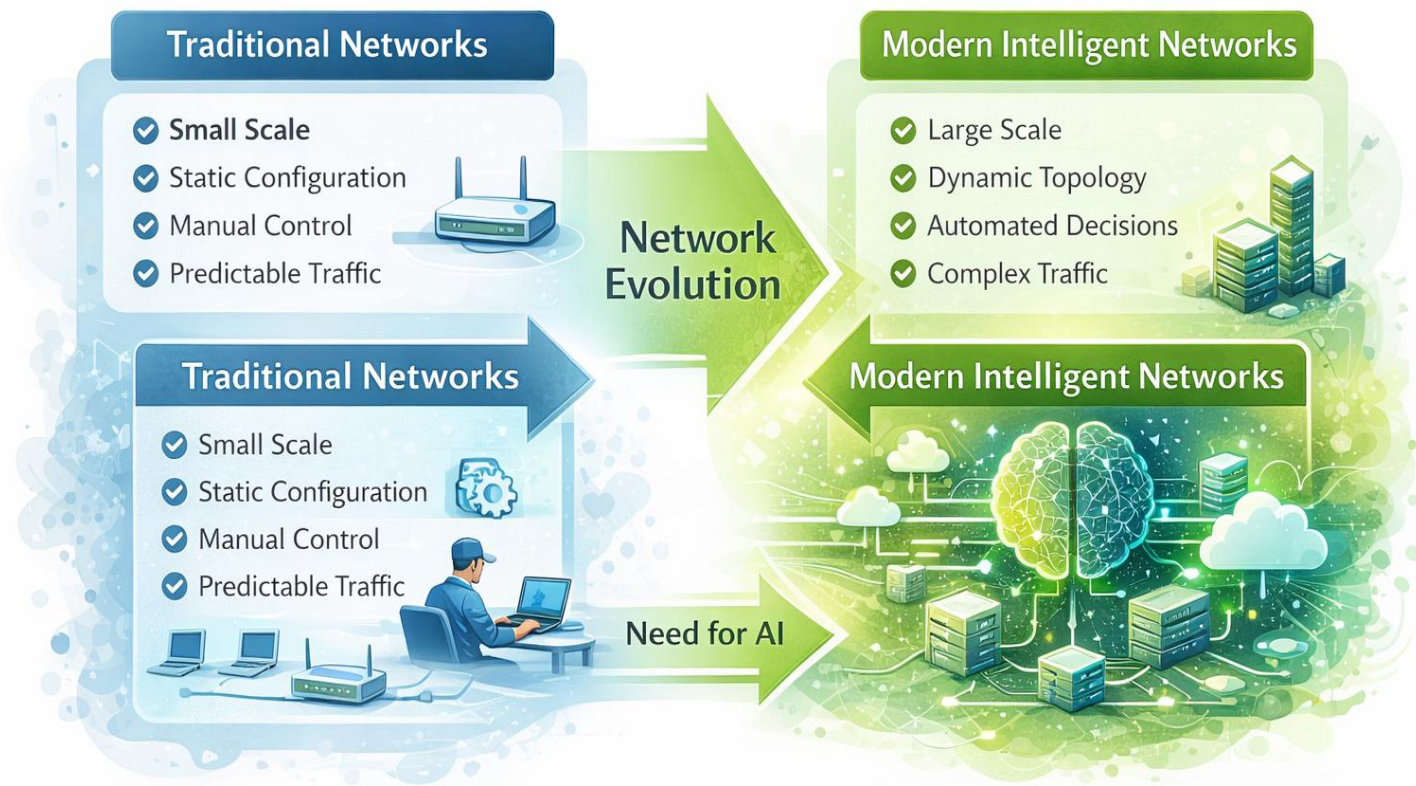
# AI Techniques for Computer Networks – Lecture 1

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# Evolution of Computer Networks and the Need for Intelligence

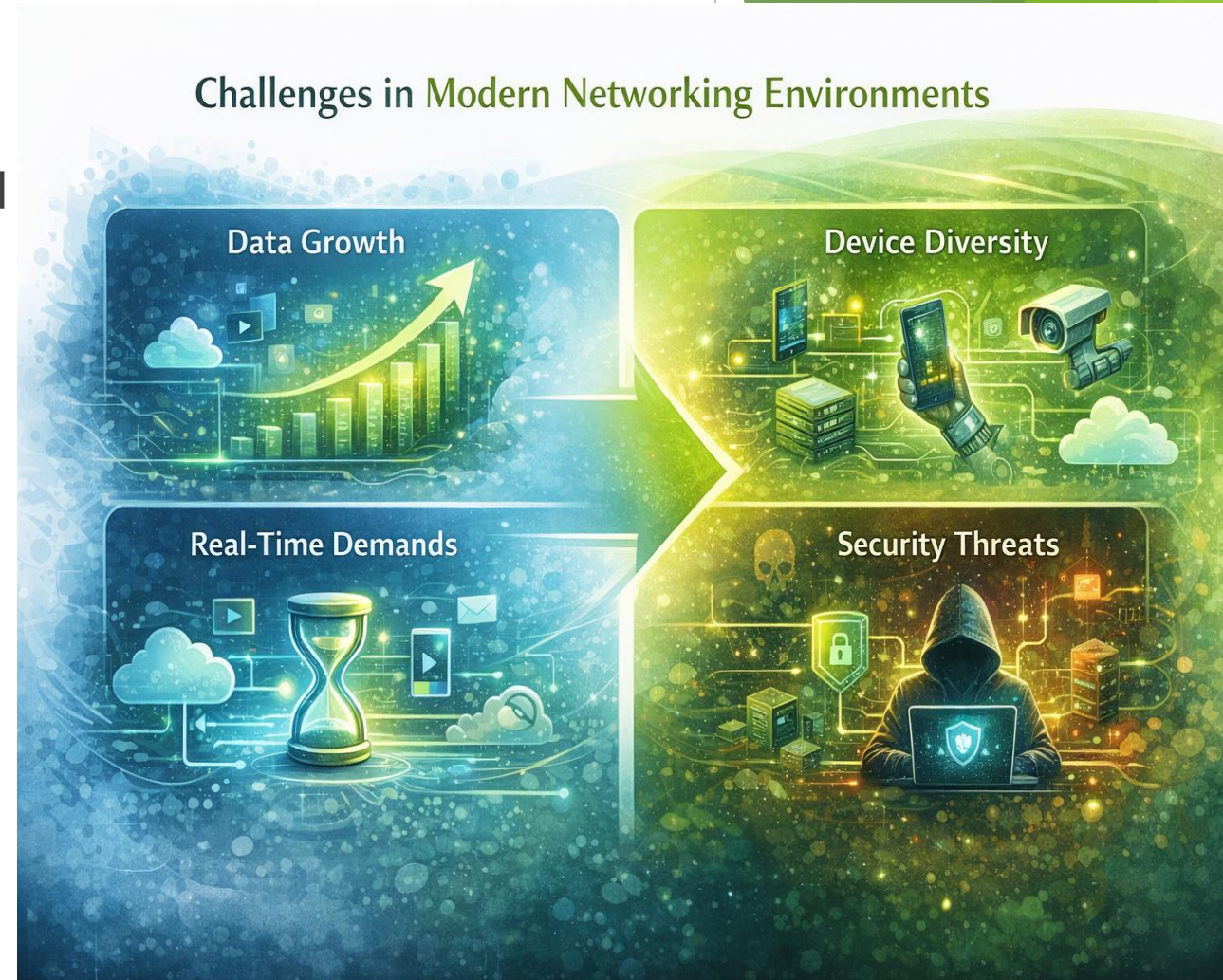
- Early computer networks were **small, stable, and predictable**.
- Network management relied on **static configurations and manual control**.
- Traditional approaches worked well for **limited-scale networks**.
- Modern networks are **large-scale, dynamic, and highly complex**.  
Static and rule-based management is **no longer sufficient**.
- This evolution has led to the **adoption of Artificial Intelligence in networking**.

## Evolution of Computer Networks and the Need for Intelligence



# Challenges in Modern Networking Environments

- Modern networks operate in **highly complex and dynamic environments**.
- Exponential growth in **data traffic** due to cloud services, streaming, and real-time applications.
- Support for **heterogeneous devices** (smartphones, servers, IoT, sensors) with diverse requirements.
- Increasing demand for **real-time, high-quality services** sensitive to delay and packet loss.
- **Security threats** are more frequent, sophisticated, and harder to detect.
- Traditional manual and rule-based management is **no longer sufficient**, requiring **intelligent solutions**.



# Limitations of Traditional Network Management

- Based on **static configurations and predefined rules** with limited adaptability.
- Operates in a **reactive manner**, responding only after problems occur.
- Relies heavily on **manual human intervention**, making it hard to scale.
- **Slow response** to congestion, failures, and performance degradation.
- Struggles with **uncertainty, dynamic traffic, and new security threats**.
- Fails to fully **exploit large volumes of network data** for proactive decisions.



# Motivation for AI-Based Networking

- Modern networks are **too complex and dynamic** for static, rule-based management.
- AI enables systems to **learn from data and adapt** to changing network conditions.
- Transforms network management from **reactive to proactive and predictive**.
- Supports **scalability** by automating analysis of large-scale network data.
- Improves **efficiency and resource utilization** through intelligent optimization.
- Enhances **network security** by detecting advanced and unseen cyber threats.

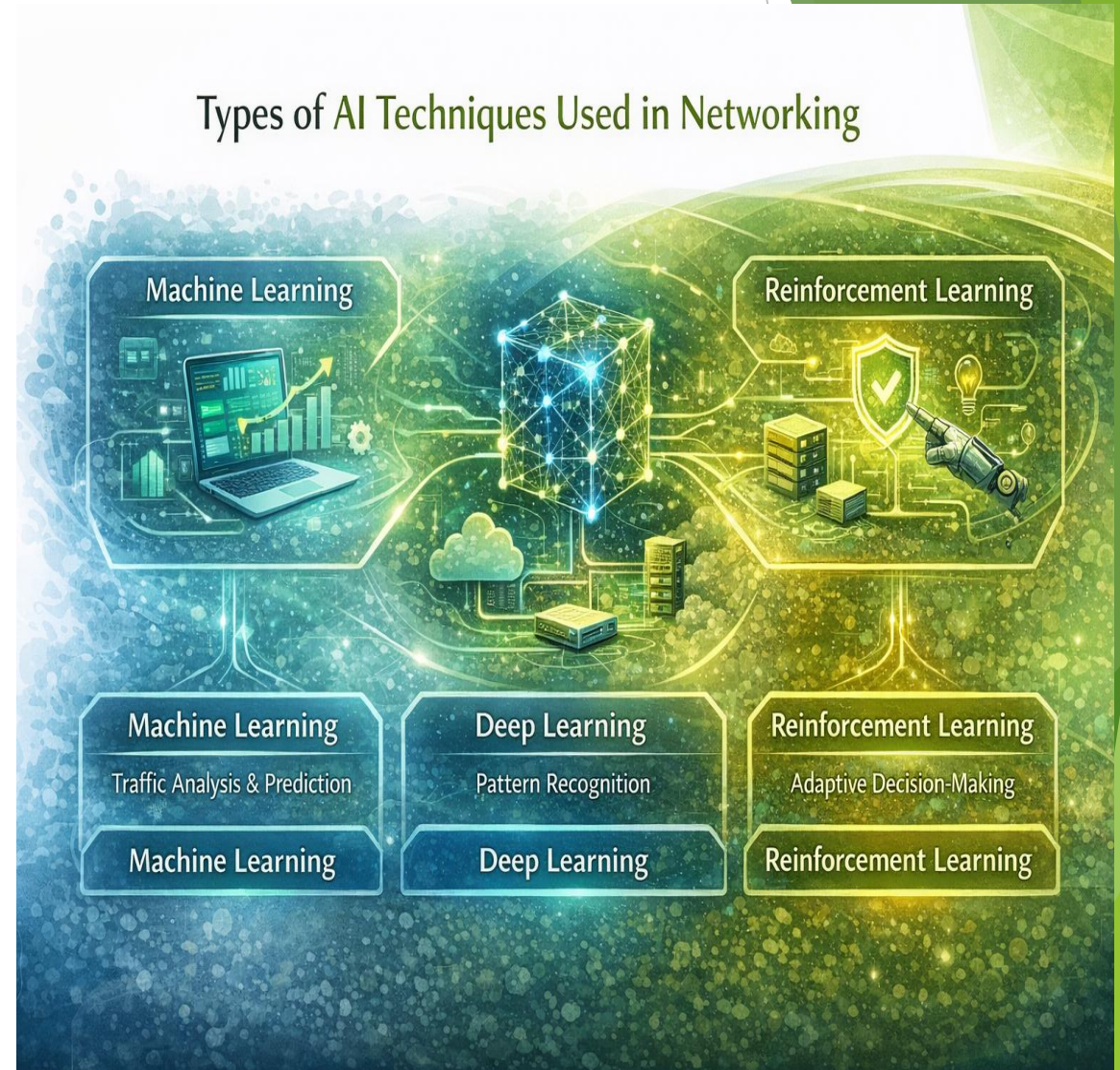
# Artificial Intelligence in the Context of Networking

- Artificial Intelligence enables machines to **learn, reason, and make decisions**.
- In networking, AI **does not replace protocols**, but enhances their operation.
- AI systems **analyze network data** to improve performance, reliability, and security.
- They learn from **historical and real-time data** to detect anomalies and faults.
- Unlike rule-based systems, AI can **adapt to unseen and dynamic conditions**.
- AI in networking includes techniques such as **Machine Learning, Deep Learning, and Reinforcement Learning**.

# Types of AI Techniques Used in Networking (Overview)

- AI in networking consists of **multiple complementary techniques**, not a single approach.
  - The main categories are **Machine Learning, Deep Learning, and Reinforcement Learning**.
  - **Machine Learning** is used for traffic analysis, anomaly detection, and performance prediction.
  - **Deep Learning** handles complex, large-scale data and non-linear pattern recognition.
  - **Reinforcement Learning** focuses on adaptive decision-making for routing and resource control.
- Each technique has **distinct strengths**, making them suitable for different networking problems.

## Types of AI Techniques Used in Networking



# High-Level AI Workflow in Networking

- AI-based networking follows a **structured workflow** from data to decisions.
- **Data collection** from network devices (traffic, logs, performance metrics).
- **Feature extraction and data preparation** to remove noise and select meaningful information.
- **Learning phase**, where AI models identify patterns and trends.
- **Decision-making**, producing predictions or control actions.
- **Action and feedback**, enabling continuous learning and improvement.

# Lecture Summary

- Reviewed the **evolution of computer networks** and challenges of modern networking environments.
- Explained the **limitations of traditional, static, rule-based network management**.
- Introduced **AI-based networking** as an enhancement to existing networking principles.
- Presented key AI techniques: **Machine Learning, Deep Learning, and Reinforcement Learning**.
- Explained a **high-level AI workflow** from data collection to intelligent actions.
- Outlined the **course learning path**, progressing from fundamentals to advanced AI-based networking applications.