EMJ 47703 : IoT and Data Analytics
Ch 6 : Data Analytics in IoT

Lecturer: Ir. Dr. Huzein Fahmi b. Hawari
Office: Block Meka3B, Level 2, Room #: 40
Email: huzein@unimap.edu.my
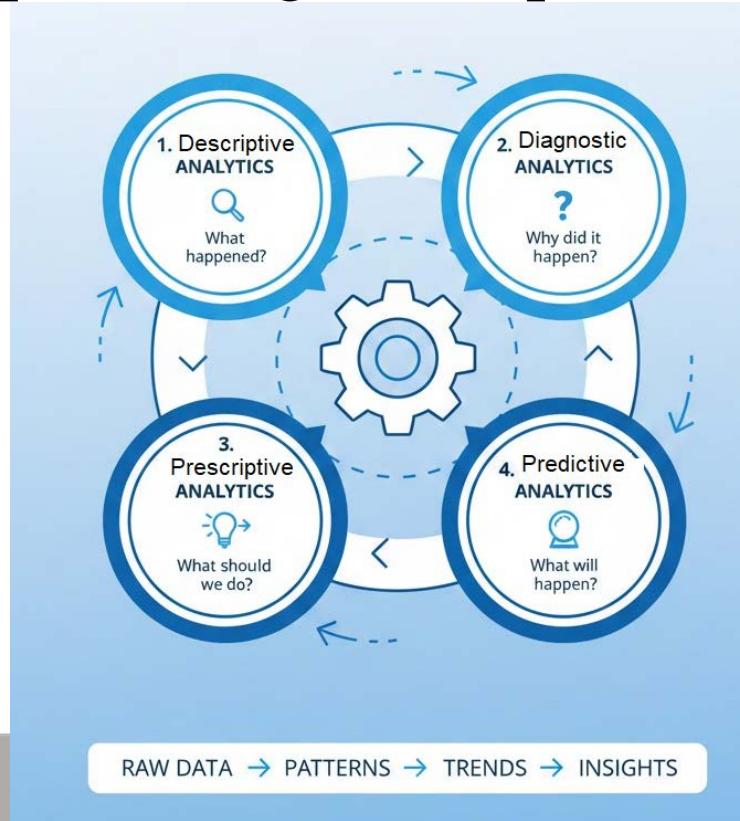
In this chapter, we will :

1. Explain the concepts, lifecycle, and analytical techniques used in IoT data analytics.

2. Apply suitable tools and analytics methods to interpret IoT data and propose solutions for real-world applications.

Introduction to Data Analytics

Data analytics involves examining raw data to uncover patterns, trends, and insights. It is categorized into four types: descriptive, diagnostic, predictive, and prescriptive analytics.

Introduction to Data Analytics

1. **Descriptive Analysis**

2. **Predictive Analysis**

3. **Prescriptive Analysis**

4. **Diagnostic Analytics**

What is happening now based on incoming data.

Google Analytics Tool is the best example for descriptive analysis. A business gets result from the web server through the tool which help understand what actually happened in the past and validate if a promotional campaign was successful or not based on basic parameters like page views.

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What might happen in the future

For example, Southwest Airlines analyses sensor data on their planes in order to identify patterns that indicate a potential malfunction, thus allowing the airlines to the necessary repairs before its schedule.

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What action should be taken.

Google's self-driving car is a perfect example of prescriptive analytics. It analyses the environment and decides the direction to take based on data.

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2. **Predictive Analysis**

3. **Prescriptive Analysis**

4. **Diagnostic Analytics**

Why did it happen

For a Social Media marketing campaign, you can use diagnostic analytics to assess the number of posts, mentions, followers, fans, page views, reviews, pins, etc. and analyse the failure and success rate of the campaign at a fundamental level.

The Intersection of IoT and Data Analytics

IoT generates vast amounts of data from connected devices. Data analytics processes this data to derive actionable insights, enabling smarter decision-making and automation in IoT systems.

30 billion RFID tags today
(1.3B in 2005)

4.6 billion camera phones world wide

100s of millions of GPS enabled devices sold annually
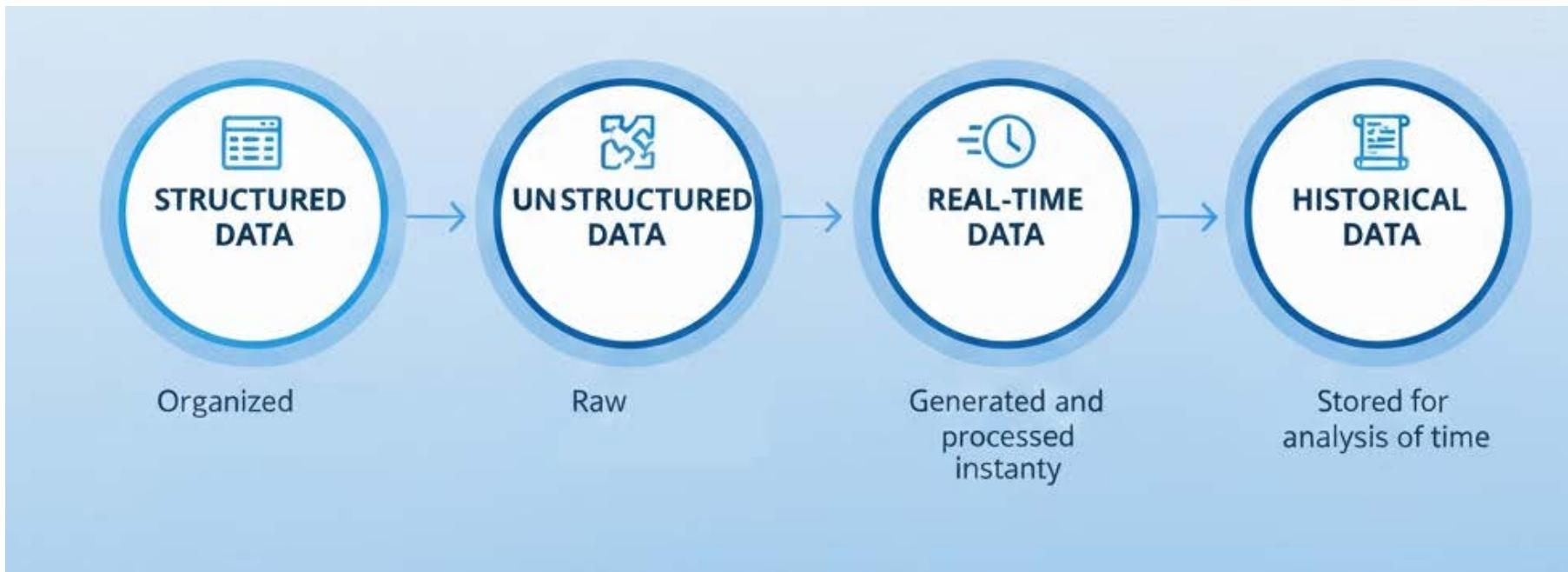
2+ billion people on the Web by end 2011

76 million smart meters in 2009…
200M by 2014

IoT Data Lifecycle

The IoT data lifecycle includes:

Types of IoT Data

| STRUCTURED DATA	UNSTRUCTURED DATA	REAL-TIME DATA	HISTORICAL DATA
Organized	Raw	Generated and processed instanty	Stored for analysis of time
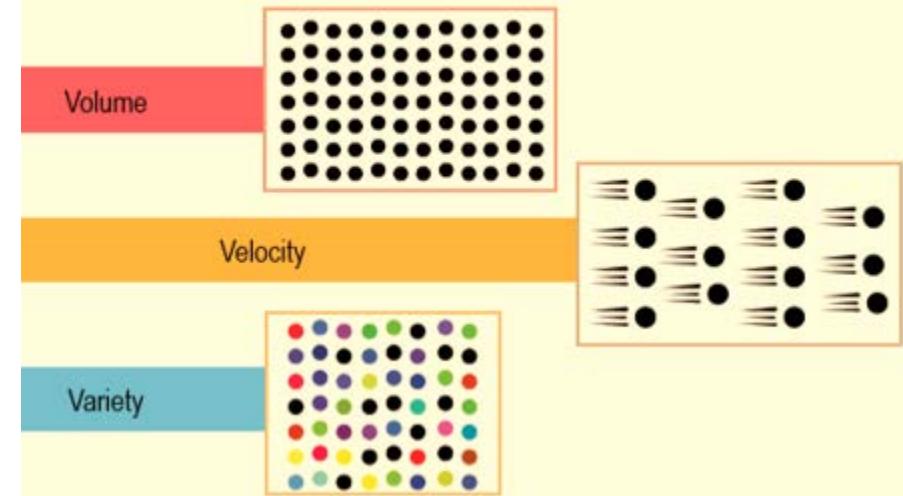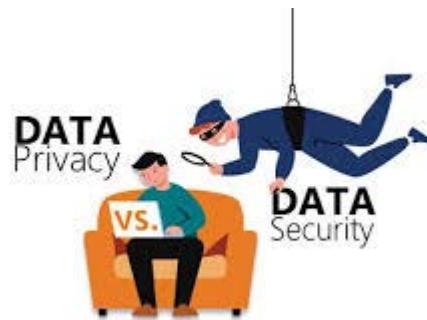
Challenges in IoT Data Analytics

Key challenges include:

- Managing the volume, velocity, and variety of IoT data

- Ensuring data security and privacy

- Integrating IoT data with existing systems

Tools and Technologies for IoT Data Analytics

Popular tools and technologies include:

- IoT platforms: AWS IoT, Azure IoT Hub

- Data analytics tools: Python, R, Tableau

- Big data technologies: Hadoop, Spark

Key Techniques in IoT Data Analytics

KEY DATA ANALYTICS TECHNIQUES

Methods for Extracting Insights

1. DATA PREPROCESSING
Cleaning & transforming raw data

MACHINE LEARNING & AI
Pattern recognition & prediction

STATISTICAL ANALYSIS
Quantitative insights & trends

4. DATA VISUALIZATION
Storytelling with charts & graphs

POWERING SMARTER DECISION-MAKING

Applications of IoT Data Analytics

IoT data analytics is applied in various domains, including:

- Smart cities & Urban systems

- Healthcare & Well-being

- Smart Industry & Manufacturing

- Agriculture & Aquaculture

- Environment

Case Study: Smart Cities

IoT and data analytics improve urban living by enabling:

- Traffic management

- Energy optimization

- Waste management

- Public safety enhancements

Case Study: Healthcare

IoT devices in healthcare, such as wearables and remote monitoring systems, use data analytics to enhance patient care, monitor health conditions, and predict potential issues.

Case Study: Smart Industry & Manufacturing

IIoT leverages data analytics for:

- Predictive maintenance

- Process optimization

- Reducing downtime and improving efficiency

Case Study: Agriculture & Aquaculture

IoT and data analytics enable precision farming by:

- Monitoring soil conditions

- Predicting crop yields

- Optimizing resource usage (e.g., water, fertilizers)

Real-Time Analytics in IoT

Real-time analytics processes IoT data instantly to enable:

- Immediate decision-making

- Real-time monitoring and alerts

- Enhanced responsiveness in critical systems

Predictive Analytics in IoT

Predictive analytics uses historical and real-time IoT data to:

- Forecast future events

- Enable predictive maintenance

- Improve operational efficiency

Prescriptive Analytics in IoT

Prescriptive analytics provides recommendations for decision-making by:

- Analyzing data trends

- Suggesting optimal actions

- Automating processes

Role of Machine Learning in IoT Analytics

Machine learning algorithms analyze IoT data for:

- Anomaly detection

- Classification and clustering

- Predictive modeling

Data Visualization in IoT Analytics

Data visualization tools, such as Power BI and Tableau, help present IoT data insights in:

- Graphs

- Charts

- Dashboards

Security and Privacy in IoT Data Analytics

Key concerns include:

- Protecting sensitive IoT data

- Preventing unauthorized access

- Ensuring compliance with data privacy regulations

Edge Analytics in IoT

Edge analytics processes data at the edge of the network, enabling:

- Reduced latency

- Faster decision-making

- Lower bandwidth usage

Cloud Analytics in IoT

Cloud analytics leverages cloud computing for:

- Scalable data storage

- Advanced analytics capabilities

- Seamless integration with IoT devices

Future Trends in IoT Data Analytics

Emerging trends include:

- AI and IoT convergence

- 5G and its impact on IoT analytics

- Autonomous IoT systems

Benefits of IoT Data Analytics

Benefits include:

- Improved decision-making

- Cost savings

- Enhanced efficiency and productivity

Limitations of IoT Data Analytics

Limitations include:

- High implementation costs

- Complexity of IoT systems

- Data quality issues

Summary

In this chapter, we have covered:

- **IoT & Data Generation:**
  IoT devices produce massive real-time data from sensors, machines, and connected systems, requiring structured methods to collect, process, and analyze information.

- **IoT Data Lifecycle:**
  Key stages include data collection, transmission, storage, processing, and visualization—forming the backbone of IoT analytics workflows.

Summary

In this chapter, we have covered:

- **Analytics Techniques:**
  Four main types are used:
    - **Descriptive:** What happened?
    - **Diagnostic:** Why did it happen?
    - **Predictive:** What will happen next?
    - **Prescriptive:** What should be done