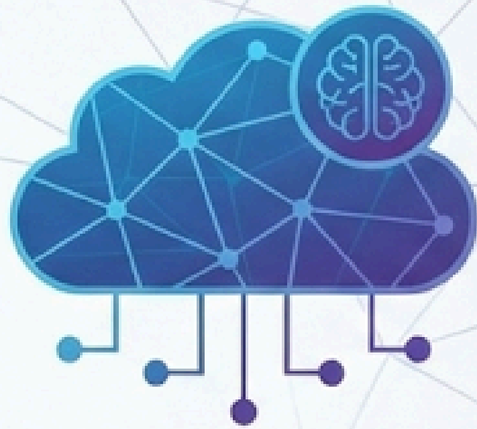
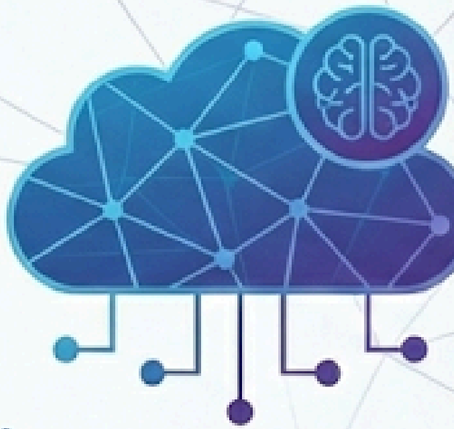


Machine Learning for IoT Data Analysis

Based on Posters & Scientific Journals

Background



1

IoT Device Growth

The number of IoT devices is growing rapidly, and each device continuously generates data.

2

Data Explosion (Big Data)

As a result, the amount of data increases very quickly and becomes difficult to manage.

3

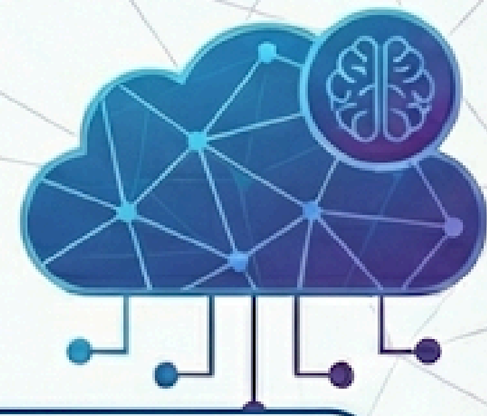
Need for Intelligent Analysis

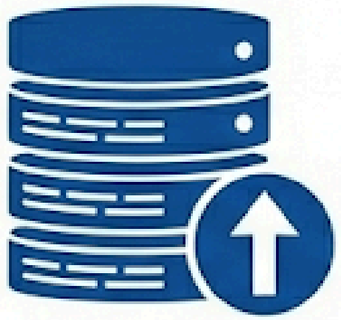
This situation creates a strong need for intelligent data analysis methods.

Internet of Things (IoT)

- **Connected Devices:** Physical objects connected to the internet.
- **Sensors & Actuators:** Equipped with sensors to collect data from the environment and actuators to take action.
- **Physical & Digital World Interaction:** Communicate with other systems automatically, without direct human involvement.

IoT Data Characteristics



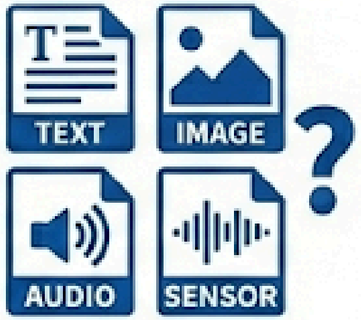


Large Volume

Produced in large volumes, often massive scales.

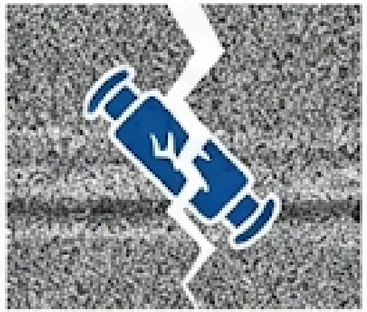
High Velocity

Arrives at high speed, often in real-time.



Diverse Variety

Comes in many different formats (structured, unstructured).



Varying Quality

Quality can vary due to sensor errors and environmental noise.

Smart Data Concept

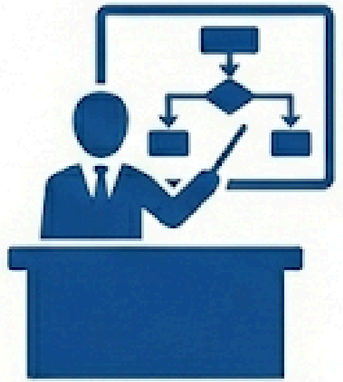
Raw IoT Data

Collecting data.

Processing & Enrichment

Smart Data
(Valuable & Contextual)

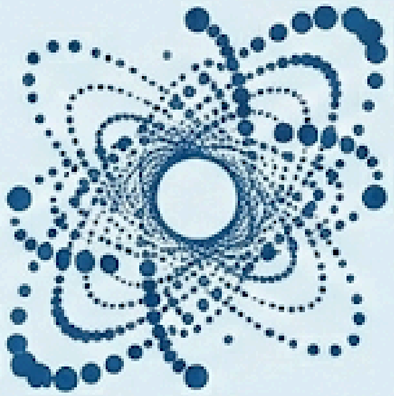
Information that is meaningful and useful.



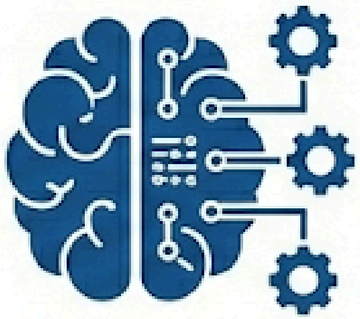
Better Understanding & Decision-Making

Support better understanding and decision-making.

Role of Machine Learning



Large & Complex IoT Data



Machine Learning Models
(Learning Patterns)

Pattern Extraction

Identifying hidden patterns.

Prediction & Classification

Forecasting future events & categorizing data.

Automatic Analysis

Performing analysis more efficiently without human intervention.

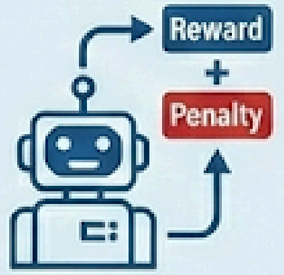
Categories of Machine Learning

Supervised Learning

Learning from labeled data (input-output pairs). Commonly used for classification and regression in IoT.

Unsupervised Learning

Finding hidden patterns in unlabeled data. Used for anomaly detection and clustering.



Reinforcement Learning

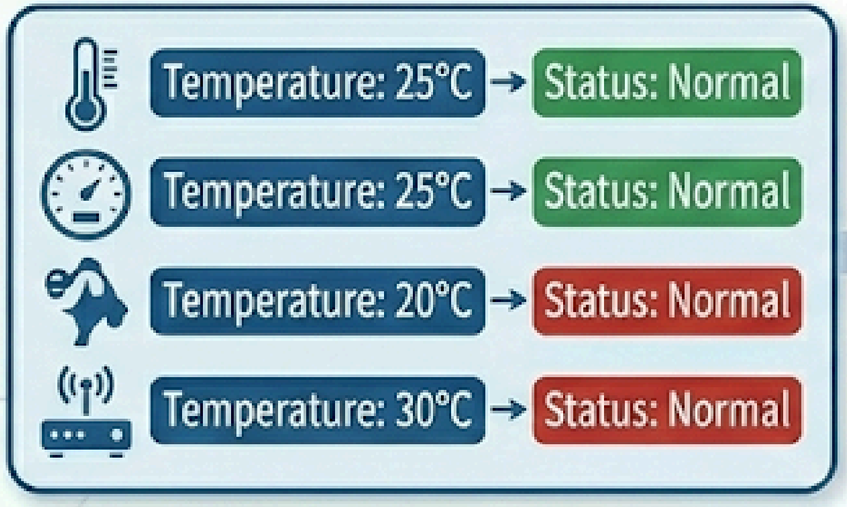
Learning through trial and error with rewards. Less common in typical IoT but used in autonomous systems.

Note: Supervised and Unsupervised are most frequent in IoT applications.

Supervised Learning

- **Supervised** Learning
- Labeled data

- Classification
- Regression



Labeled Data
(Input-Output)

Machine Learning Model
(Training)

Classification

Predicting categories.
Example: Forecasting traffic levels (Low, Medium, High).

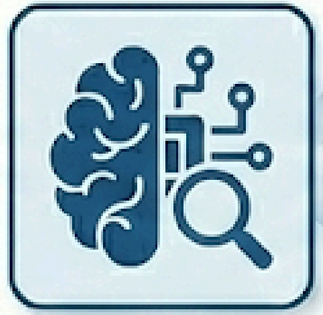
Regression

Predicting continuous values.
Example: Estimating energy usage (kWh).

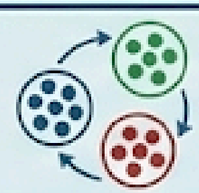
Unsupervised Learning

- **Unsupervised** Learning
- Data tanpa label
- Clustering
- Ekstraksi fitur

Unlabeled Data
Data without labels.



Machine Learning Model
(Discovering Patterns)



Clustering

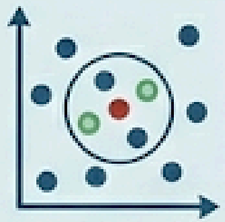
Grouping similar data.
Useful for discovering hidden patterns.

Feature Extraction

Reducing data complexity.
Essential for large amounts of IoT data.

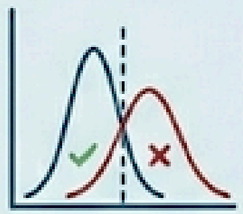
Common Machine Learning Algorithms

- **Algoritma Populer IoT**
- KNN
- Naive Bayes
- SVM
- Neural Network



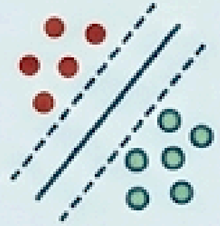
K-Nearest Neighbors (KNN)

Simple, instance-based. Classifies based on proximity to neighbors. Used for classification and regression.



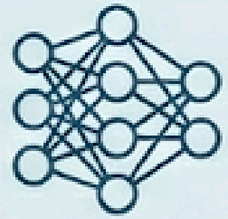
Naive Bayes

Probabilistic, assumes independence. Fast and efficient for text classification and simple problems.



Support Vector Machines (SVM)

Finds the best boundary (hyperplane) to separate data. Effective for high-dimensional data and complex classification.



Neural Networks

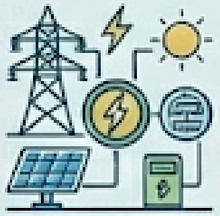
Inspired by the human brain. Deep learning models, capable of handling complex non-linear data and patterns.

Smart City as a Use Case

• **Use Case Smart City** • Smart Traffic • Smart Energy • Smart Health • Smart Environment

Smart Traffic

Real-time traffic management & route optimization.



Smart Energy

Efficient energy management & smart grids.

Smart Health

Remote health monitoring & medical analytics.

Smart Environment

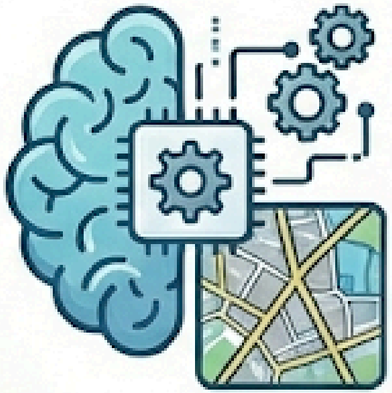
Monitoring air, water, & waste quality.

Smart Traffic Example

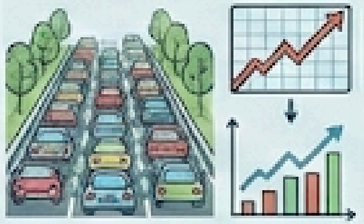
• **Example: Smart Traffic** • Congestion Prediction • Traffic Pattern Analysis • Real-time Decision Making

Input Data Sources

Data from sensors & cameras.

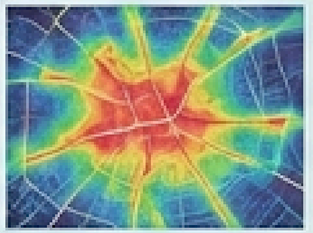


Machine Learning Model
(Analysis & Prediction)



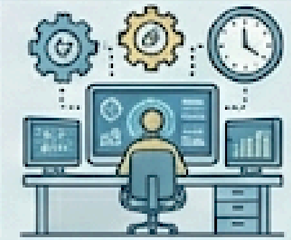
Congestion Prediction

Predicts congestion and traffic flow.



Traffic Pattern Analysis

Analyzes historical traffic patterns.

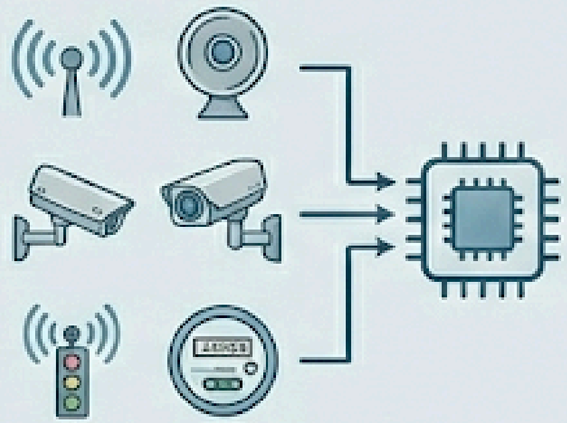


Real-time Decision Making

Enables real-time decisions for city authorities.

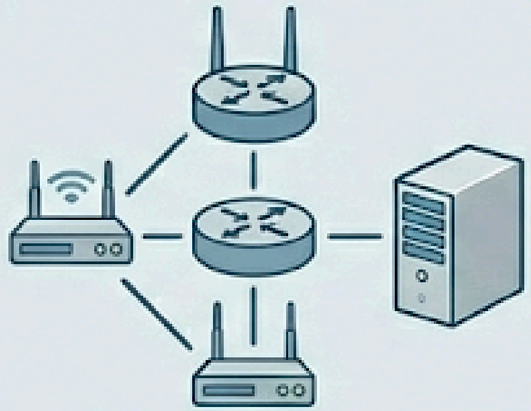
IoT Computing Architecture

- **Arsitektur Komputasi IoT**
- Edge Computing
- Fog Computing
- Cloud Computing



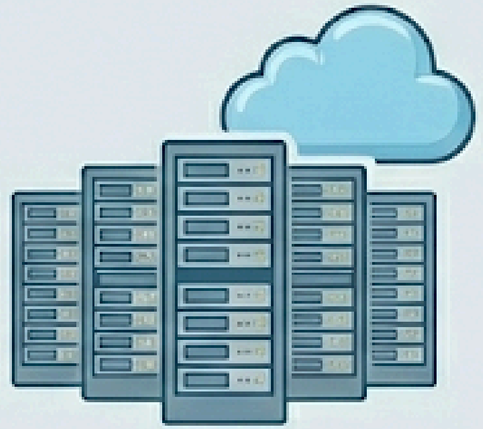
Edge Computing

Processing data near the source (devices).
Low latency, real-time response.



Fog Computing

Processing data at the local network level.
Balancing latency and processing power.



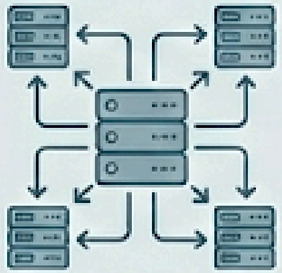
Cloud Computing

Processing data in remote data centers.
High processing power and storage for complex analysis.

Challenges in IoT Data Analysis

Despite its advantages, IoT data analysis still faces challenges. These include handling large-scale data, maintaining data quality, and ensuring security and privacy for users and systems.

- **Scalability (Skalabilitas)**



Scalability (Skalabilitas)

Handling large-scale data volumes and growth.

- **Data Quality (Kualitas data)**

Data Quality (Kualitas data)

Maintaining data accuracy and consistency amidst errors and noise.

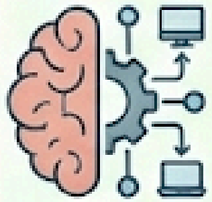
- **Security & Privacy (Keamanan & privasi)**

Security & Privacy (Keamanan & privasi)

Ensuring security and protecting user privacy for systems and data.

Conclusion

To conclude, Machine Learning plays a vital role in making IoT systems more intelligent. Smart City applications clearly show its potential, and future research is needed to further improve efficiency, accuracy, and security.



- **ML kunci Smart IoT** (ML is the key to Smart IoT)
  Machine Learning is essential for intelligent IoT systems.

- **Smart City sebagai contoh utama** (Smart City as a prime)
  Smart City demonstrates the potential of ML in IoT.

- **Peluang riset masa depan** (Future research opportunities)
  Research needed for better efficiency, accuracy, & security.