Introduction to Machine Learning

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ENCE 688P, Fall Semester 2021

October 16, 2021

Overview

Part 01

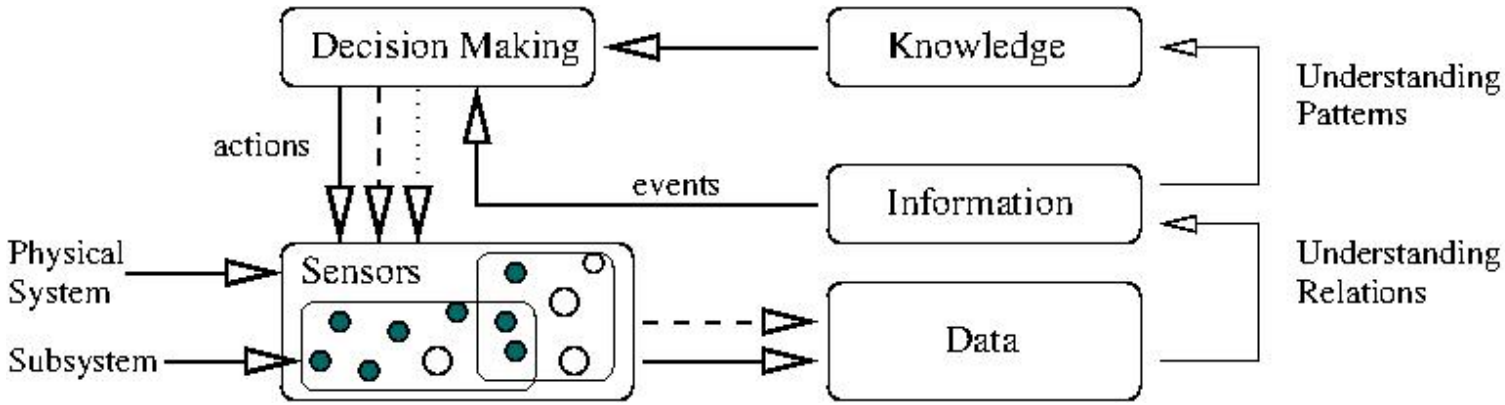
Quick Review

Man and Machine (Traditional View)

Man	Machine
• Good at formulating solutions to problems. • Can work with incomplete data and information. • Creative. • Reasons logically, but very slow. • Performance is static. • Humans break the rules.	• Manipulates Os and 1s. • Very specific abilities. • Requires precise decriptions of problem solving procedures. • Dumb, but very fast. • Performance doubles every 18-24 months. • Machines will follow the rules.

Importance of Sensor Networks

Pathway from sensing and data collection to ... action ... improved performance.



Chain of dependency relationships:

1. improved performance <-- actions
2. actions <-- ability to identify events.
3. identify events <-- data processing
4. data processing <-- types and quality of data
5. types and quality of data <-- sensor design and placement.

Pathway to System Efficiency

We need computational models that:

- Improve situational awareness – to understand what is actually happening in a building or city?
- Connect sensor measurements to short- and long-term urban needs (e.g., decisions on a bus stop; longer term urban planning).
- Capture the spatial, temporal, and intensity aspects of environmental phenomena (e.g., fires, flooding) and their impact on natural (e.g., air quality) and man-made systems (e.g., transportation networks, food chains).
- Look ahead and forecast future states of the system?

Artificial Intelligence and Machine Learning

Opportunity: **Can use AI/ML to solve problems in completely new ways.**

Artificial Intelligence (AI) and Machine Learning (ML)

Technical Implementation (2020, Google, Siemens, IBM)

- AI and ML will be deeply embedded in new software and algorithms.

Artificial Intelligence:

- Knowledge representation and reasoning with ontologies and rules. Semantic graphs. Executable event-based processing.

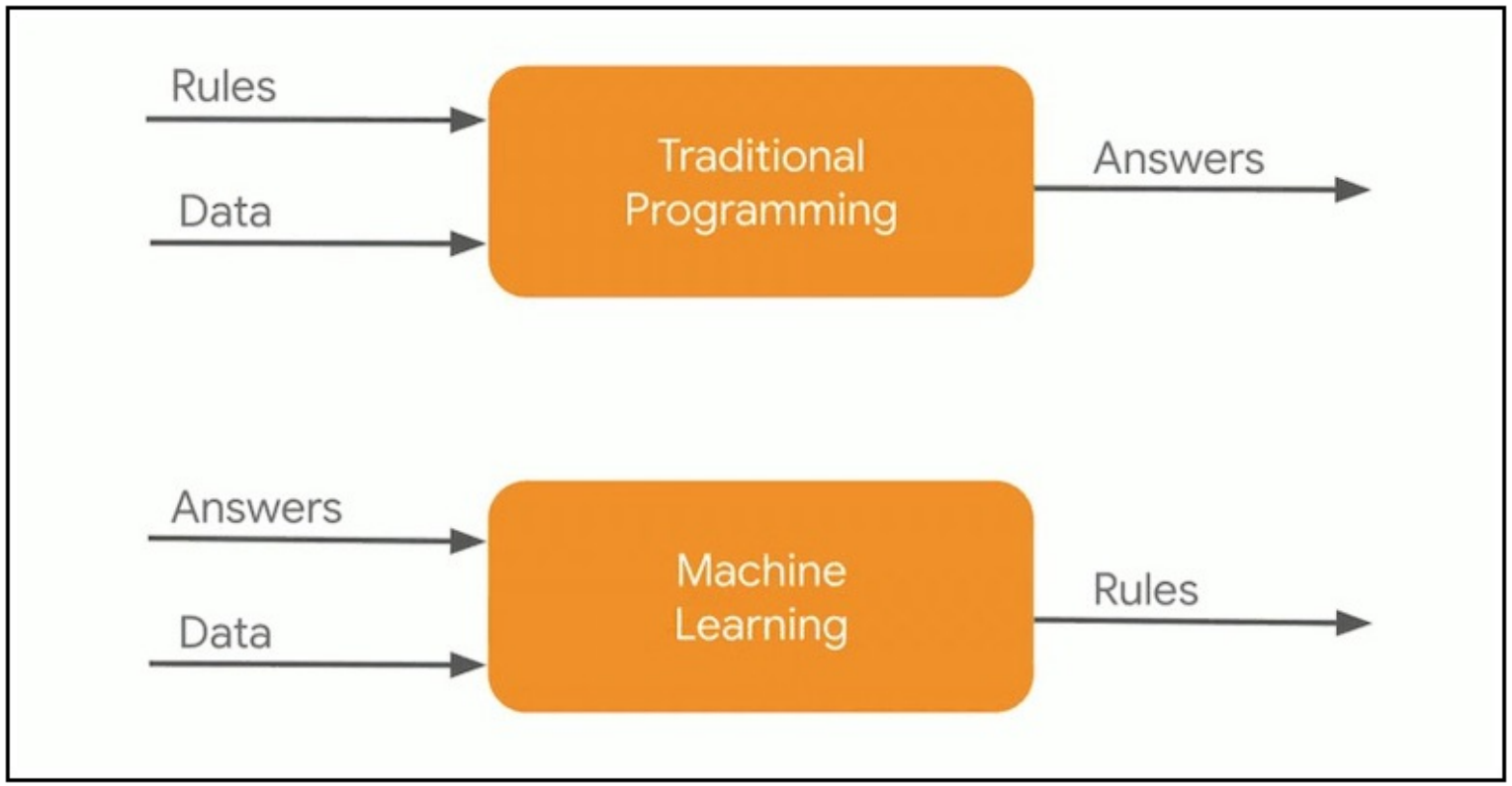
Machine Learning:

- Modern neural networks. Input-to-output prediction.
- Data mining.
- Identify objects, events, and anomalies.
- Learn structure and sequence. Remember stuff.

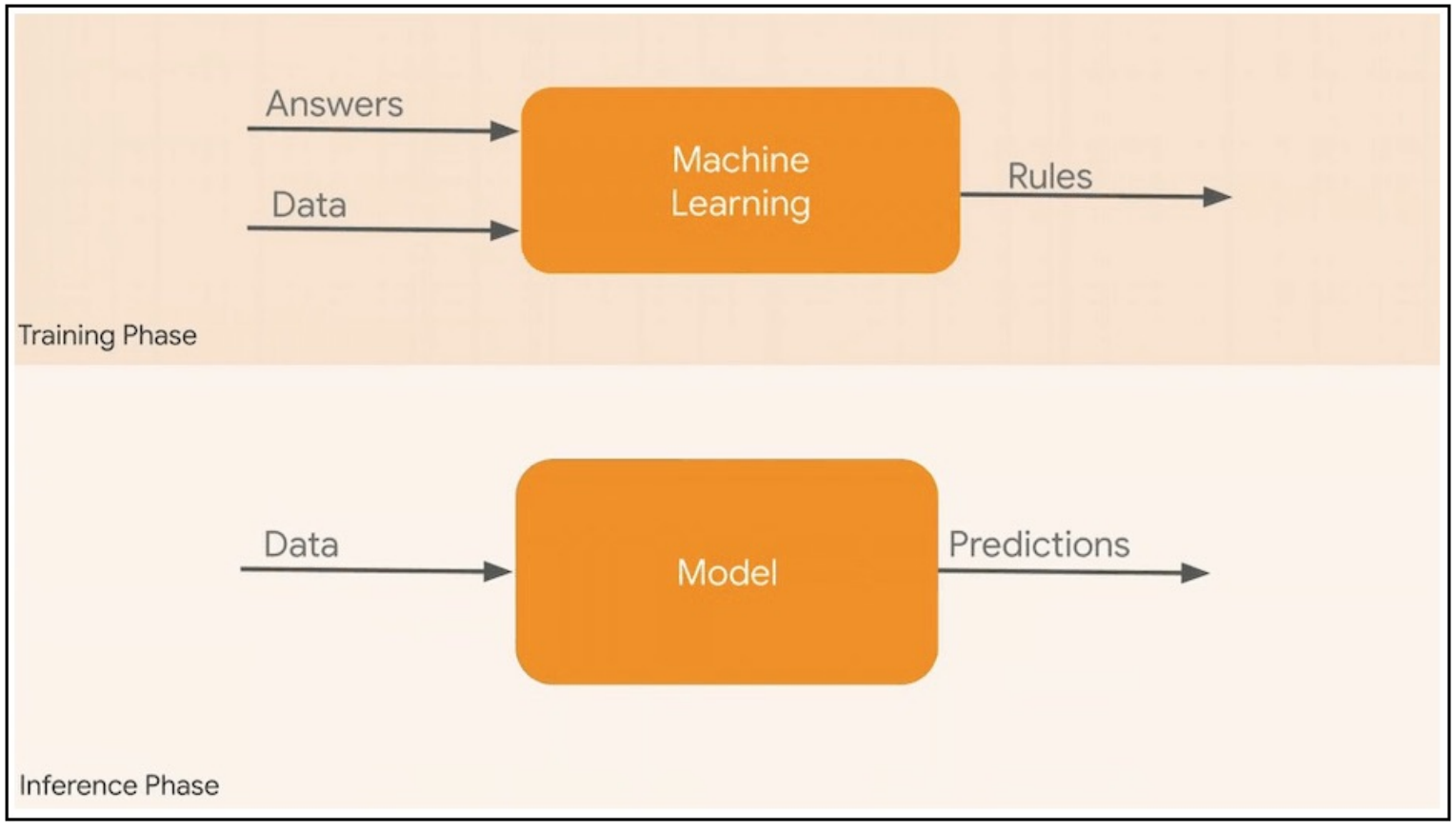
Man and Machine (AI-ML View)

Man	**AI-ML Machine**
• Good at formulating solutions to problems. • Can work with incomplete data and information. • Creative. • Reasons logically, but very slow. Forgetful. • Performance is static. • Humans make the rules, then they break them.	• Manipulates Os and 1s. • Can work with incomplete data and information. • Creative. • Fast logical reasoning. • Performance doubles every 18-24 months. • Data mining can discover the rules.

Traditional Programming vs AI-ML Workflow

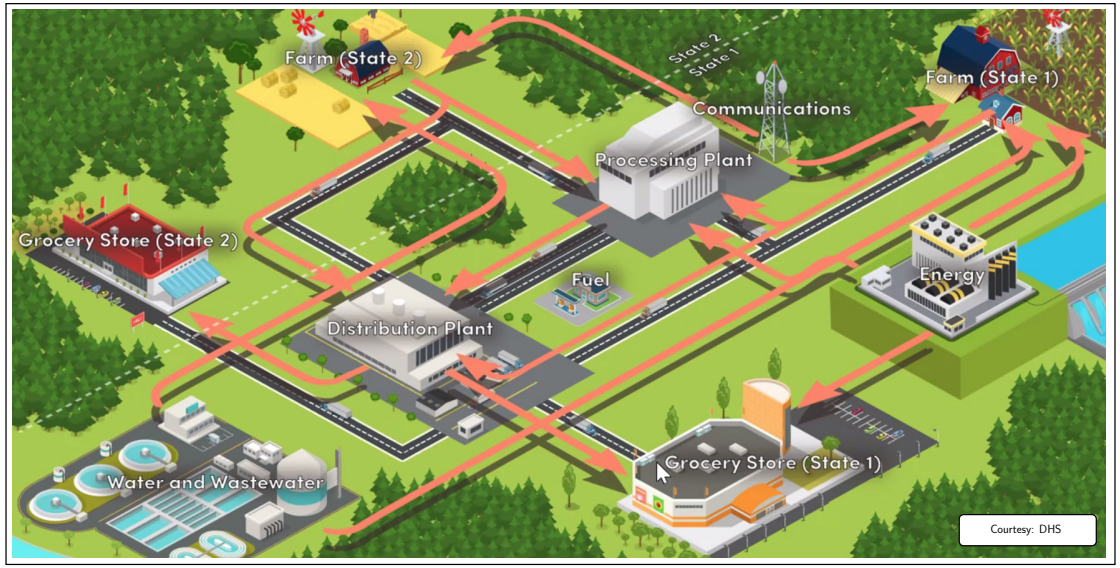


Traditional Programming vs AI-ML Workflow



Sensor Networks and AI-ML Enabled Decision Making

Dependencies Among Systems in Built Environment:

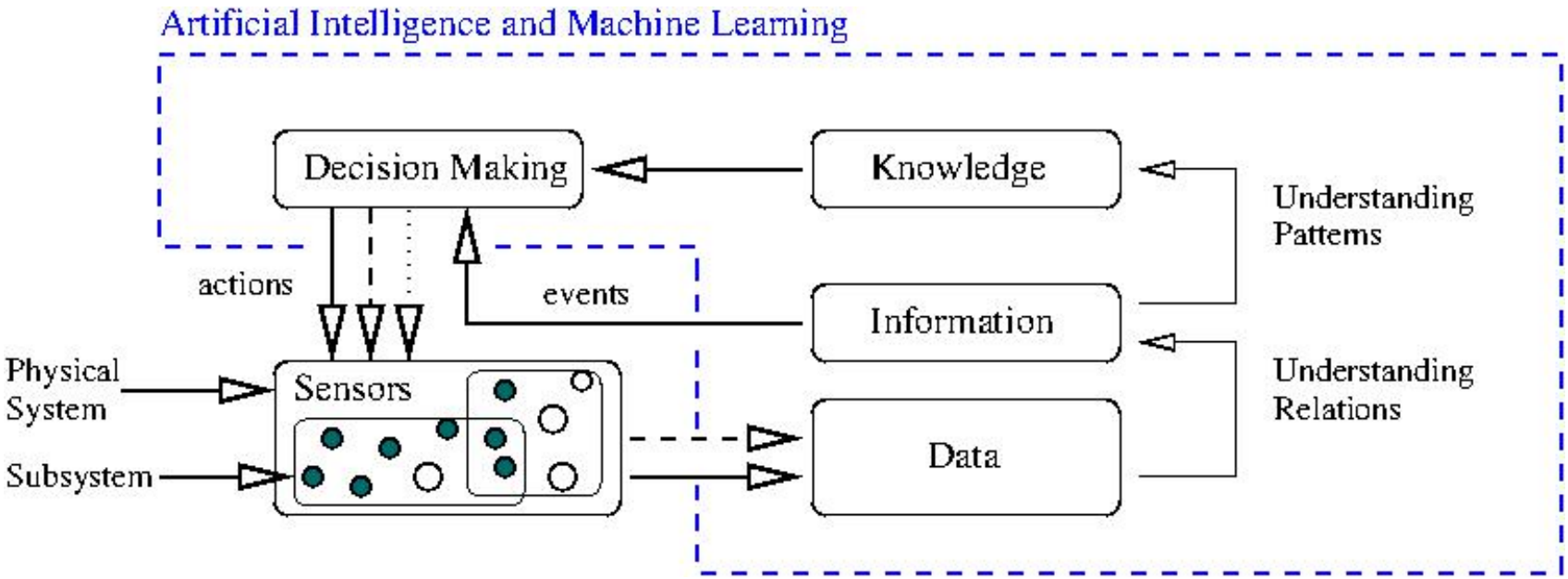


Pathway to Enhanced Situational Awareness/Decision Making:

- Gather and process sensed data.
- Mine data to understand relationships.
- Integrate predictions into decision making framework.

Sensor Networks and AI-ML Enabled Decision Making

Pathway from sensing and data collection to ... action ... improved performance, now enabled by AI and ML capabilities:



Software Support in Python and Java

Software Support in Python:

- Pandas (for data analysis).
- TensorFlow (open source library for machine learning).
- Keras (neural network library).
- Jupyter Notebook (for web-based authoring of documents).
- Anaconda (packages to perform data science in Python/R).

Software Support in Java:

- Apache Jena (for knowledge representation and reasoning).
- Weka (for data mining).
- Deep Learning for Java (DL4J) (for machine learning).

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