MACHINE LEARNING METHODS IN A NEW TRANSPORTATION ERA
TRANSPORTATION AND MODERN ARTIFICIAL INTELLIGENCE

Academic Performance for ASTRAI

Diego Alejandro Rodriguez Yanez

AGENDA

1 First Approach: Artificial Intelligence and Its Components

2 But, what about Machine learning?

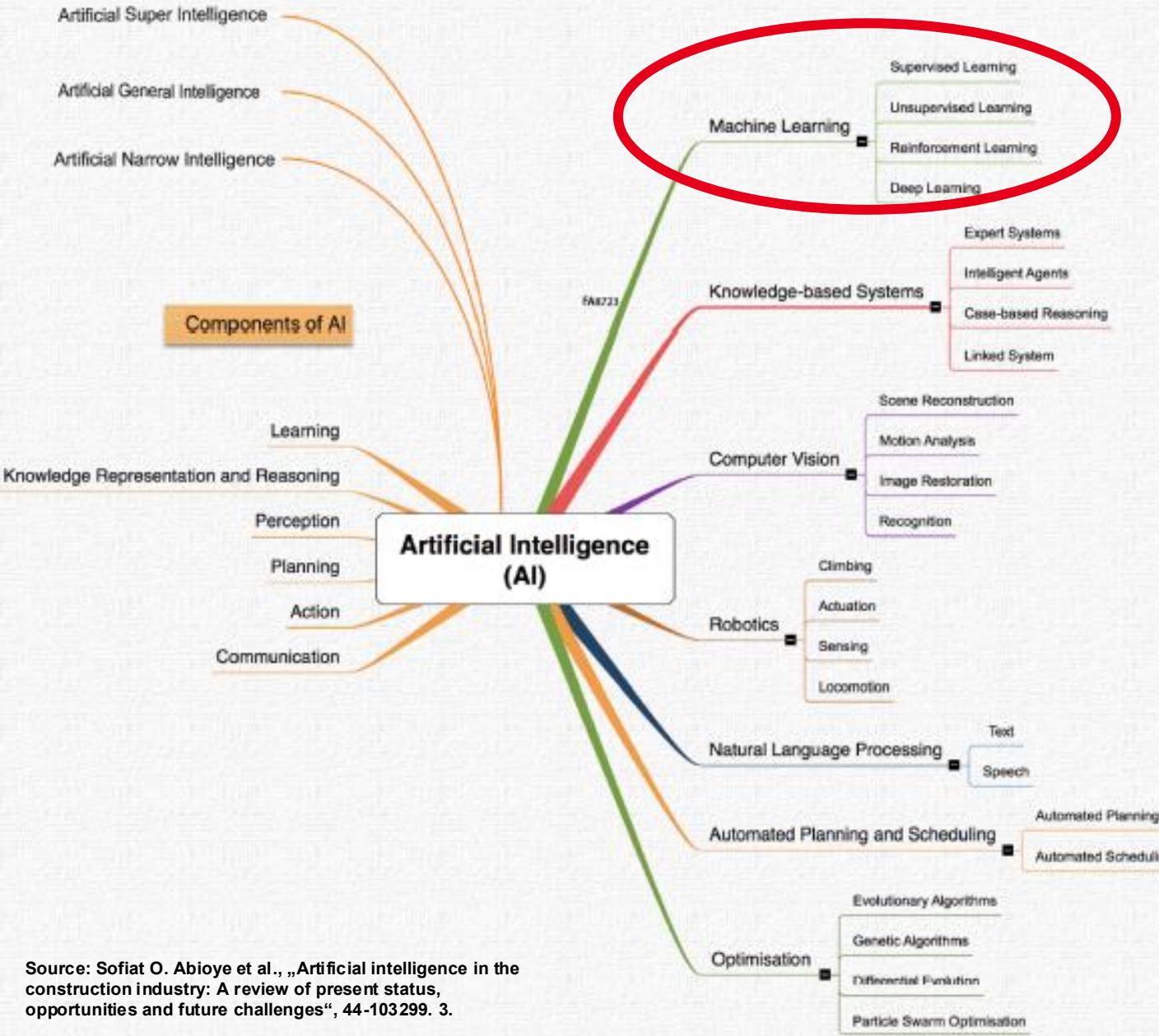**3** Types of Machine Learning

4 Key Methods and Algorithms

5 Applications in Civil Engineering

6 Applications in a new transportation era

7 Advantages and Challenges

8 Conclusion

Source: Sofiat O. Abioye et al., „Artificial intelligence in the construction industry: A review of present status, opportunities and future challenges", 44-103299. 3.

1. ARTIFICIAL INTELLIGENCE AND ITS COMPONENTS

"Artificial intelligence is transforming transportation systems by enabling predictive, adaptive, and automated mobility solutions."

— Litman (2020)

2. WHAT IS MACHINE LEARNING

- Enables computers to learn patterns from data and make predictions without explicit programming.

- Used to turn raw data into actionable insights for better decision-making.

Source: https://www.marketingparaindustria.com.br, 2022

"..Instead of coding rules, we let the system learn from examples.."

— Tom M. Mitchell

3. TYPES OF MACHINE LEARNING

Type	Description	Example
Supervised Learning	Model learns from labeled data	Predicting concrete strength
Unsupervised Learning	Finds hidden patterns in unlabeled data	Grouping similar soil types
Reinforcement Learning	Learns by interacting with environment	Optimizing construction schedules
Deep Learning	Neural networks for complex data	Detecting cracks from images

4. KEY METHODS AND ALGORITHMS OF MACHINE LEARNING

Linear & Logistic Regression

- Linear & Logistic Regression: Numerical and classification tasks
- Decision Trees / Random Forests: Interpretable and accurate

Unsupervised Learning

- K-Means Clustering: Grouping by similarity
- Principal Component Analysis (PCA): Reducing data complexity

Reinforcement & Deep Learning

- Q-Learning / Deep Q-Networks (DQN): Adaptive decision-making
- Convolutional Neural Networks (CNN): image recognition
- Recurrent Neural Networks (RNN): time-series prediction (sensor data)

5. APPLICATIONS IN CIVIL ENGINEERING

Structural Health Monitoring

Detecting stress or damage using sensor data

Predictive Maintenance

Anticipating equipment or material failure

Construction Management

Forecasting cost overruns or delays

Source: https://biblus.accasoftware.com

Safety Analytics

Identifying accident risks based on historical data

Smart Infrastructure

Adaptive control of traffic lights or HVAC systems

Material Science

Optimizing concrete mix for strength and sustainability

6. APPLICATIONS IN A NEW TRANSPORTATION ERA

Supports maintenance planning

Allowing maintenance to be done before failures happen, based on real machine data instead of fixed service intervals.

Source: https://biblus.accasoftware.com

Improve efficiency

doing the right thing, at the right time, with the right resources, based on data instead of guesses.

Improves Sustainability

using fewer resources, create less pollution, and extend the life of infrastructure and equipment.

7. ADVANTAGES AND CHALLENGES

Advantages

- Handles large, complex datasets
- Reduces manual analysis time
- Enables predictive and real-time insights
- Supports data-driven decision making

Challenges

- Requires high-quality, well-structured data
- Model interpretability can be limited
- Training may demand significant computational power
- Integration into existing workflows may be complex

8. CONCLUSION

.. The next generation of civil engineers won't just build structures — they'll build intelligent systems..

— Ayyub & McCuen

Thank you!

SOURCES

Bergmann, D. (2024). What is machine learning? IBM Think.
https://www.ibm.com/think/topics/machine-learning ibm.com

Brown, S. (2021, April 21). Machine learning, explained. MIT Sloan Ideas Made to Matter.
https://mitsloan.mit.edu/ideas-made-to-matter/machine-learning-explained mitsloan.mit.edu

GeeksforGeeks. (2025, July 29). Introduction to Machine Learning.
https://www.geeksforgeeks.org/machine-learning/introduction-machine-learning/