Introduction to AI/ML

Dr. Nathanael L. Baisa

Lecture Content

▶ What is Artificial Intelligence (AI)?

▶ What is Machine Learning (ML)?

▶ References

What is Artificial Intelligence? (AI)

A quick overview

What is AI?

▶ Different **experts** define AI differently but with similar concept.

▶ Systems that think and act **like humans?**

    ▶ "…activities such as decision-making, problem solving, learning…" (Bellman, 1978)

▶ Systems that think and act **rationally?**

    ▶ "The study of computations that make it possible to perceive, reason, and act" (Winston, 1992)

▶ "Intelligent behaviour involves perception, reasoning, learning, communicating, and action in a complex environment" (Nilsson, 1998)
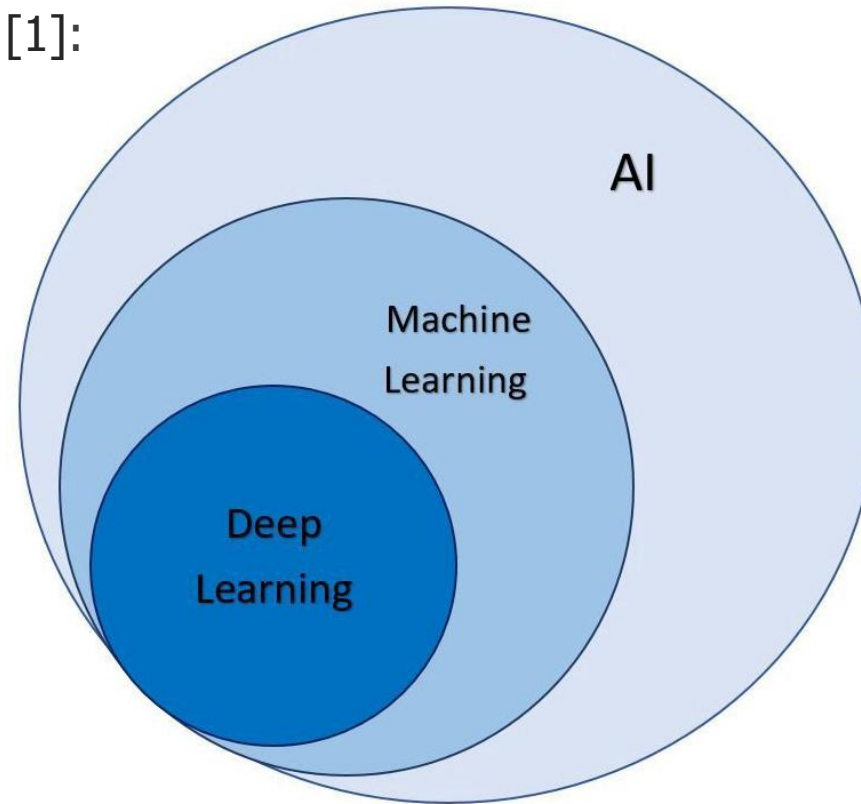
▶ What **common themes** are there to these ideas?

What is AI?

▶ Oxford University Press (OUP) defines AI as "the theory and development of computer systems able to perform tasks that normally require human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages."

▶ Wikipedia defines AI as "the capability of computational systems to perform tasks typically associated with human intelligence, such as learning, reasoning, problem-solving, perception, and decision-making. "

What is AI?

▶ The six disciplines that compose most of AI [1]:

  ➢ Knowledge representation

  ➢ Automated reasoning

  ➢ Machine learning

  ➢ Natural language processing

  ➢ Computer vision

  ➢ Robotics

[1]. S. Russell and P. Norvig, 'Artificial Intelligence: A Modern Approach, 4th Edition', Pearson Series, 2021.

What is AI?

► Computational Intelligence (CI) is a branch of AI.

► "The three main pillars of CI have been neural networks, fuzzy systems, and evolutionary computation" (IEEE Computational Intelligence Society).

  ➢ **Neural networks:** inspired by how information is sent around the brain.

  ➢ **Fuzzy systems** (systems based on fuzzy logic)**:** inspired by human reasoning.

  ➢ **Evolutionary computation:** mimics processes from evolution, e.g. genetic algorithm (GA).

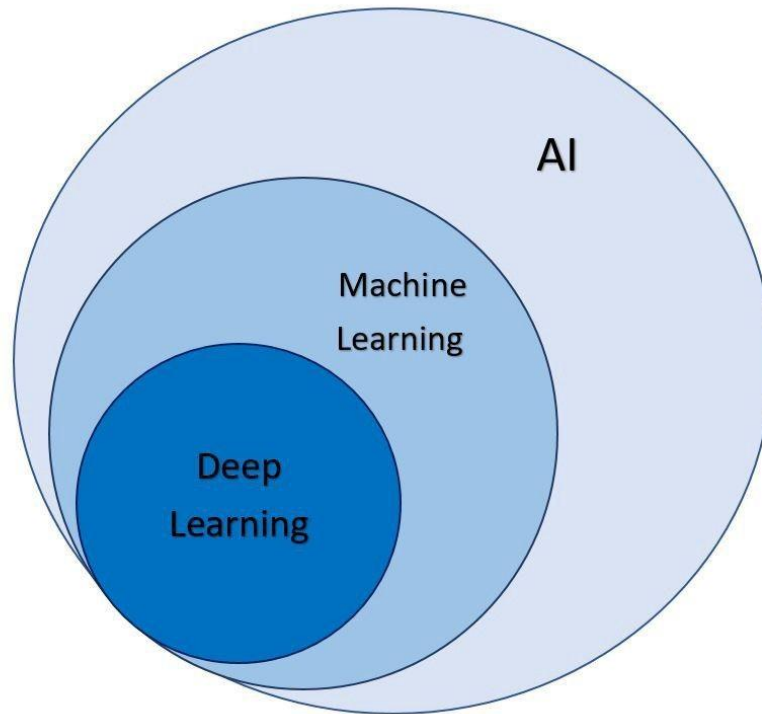► Hence, fuzzy systems and evolutionary computation are also part of AI.

What is AI?

► 'Hard' computing vs 'Soft' computing:

➢ **'Hard' computing** uses traditional mathematical methods, such as algorithms and mathematical models, to solve problems. These algorithms find provably correct and optimal solutions to problems.

  ➢ Logic and facts.

  ➢ Optimised for certainty and precision.

➢ **Soft computing** is a set of algorithms, including neural networks, fuzzy logic, and evolutionary algorithms. These algorithms are tolerant of imprecision, uncertainty, partial truth and approximation.

  ➢ **CI** is a form of soft computing.
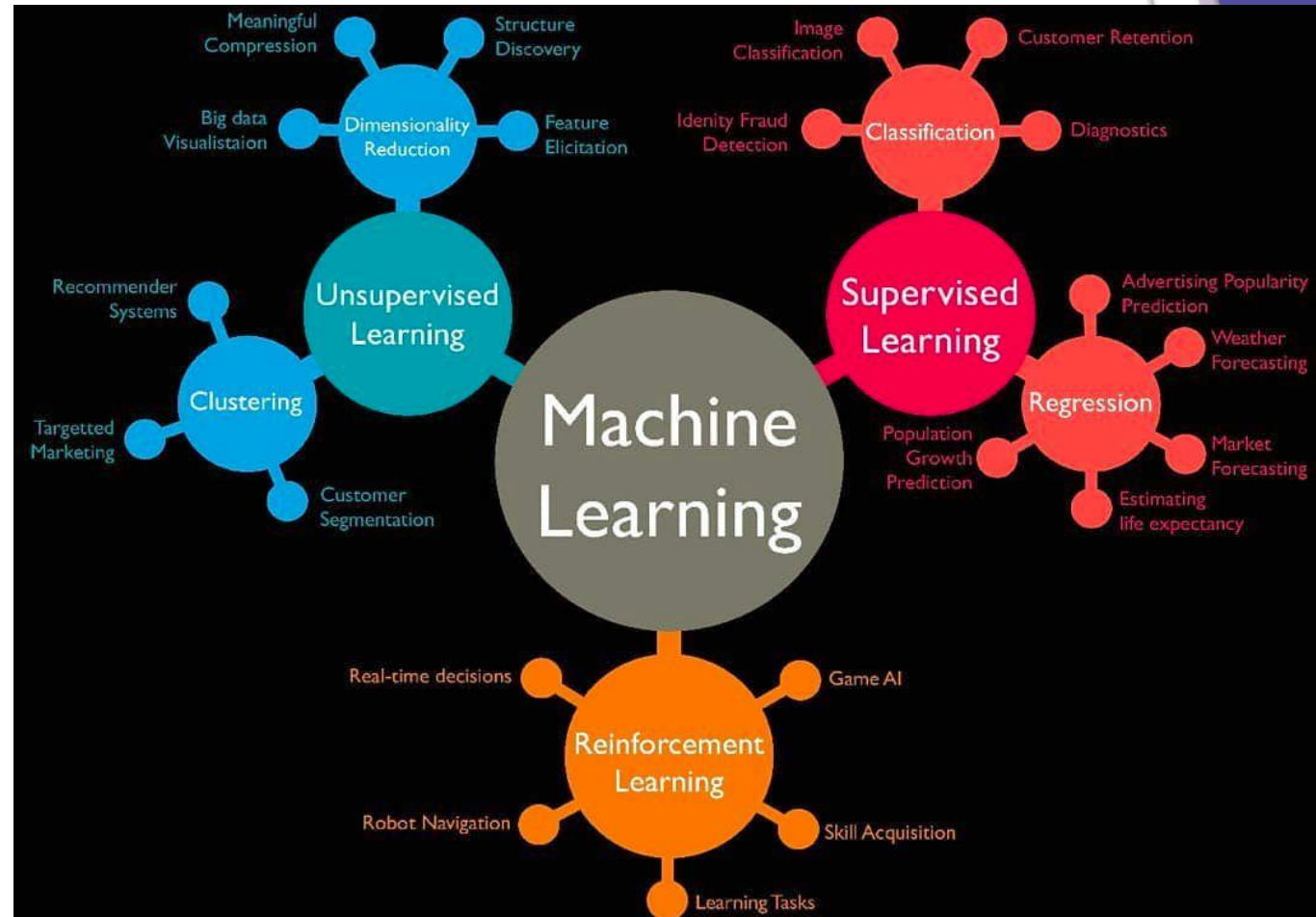
What is Machine Learning (ML)?

A quick overview

What is ML?

▶ Machine learning (ML) is a core subfield of AI.

▶ ML is a study of algorithms that enable systems to learn and improve from experience without being explicitly programmed.

What is ML?

▶ ML has 3 main branches for different applications:

What is ML?

▶ **Supervised learning:** learns a model from a labelled training data.

  ➢ Labelled training data: for each input sample data x_i, there is label y_i.

  ➢ Regression – predicts continuous valued output. E.g. linear regression, non-linear regression, etc.

  ➢ Classification - predicts discrete valued output. E.g. logistic regression, perceptron, neural networks, decision trees, SVM, etc.

▶ **Unsupervised learning:** Unlabelled training data.

  ➢ Discovers hidden patterns in unlabelled data i.e. knowledge discovery. E.g. k-means clustering, principal component analysis (PCA), etc.

▶ **Reinforcement learning:** No training data.

  ➢ Learns through trial and error. It learns from its mistakes. It uses input from the environment. E.g. Q-learning, Temporal Difference (TD) learning, etc.

References

▶ S. Russell and P. Norvig, 'Artificial Intelligence: A Modern Approach, 4th Edition', Pearson Series, 2021.

▶ C. Bishop, 'Pattern Recognition And Machine Learning', Springer, 2006.

▶ K. Murphy, 'Machine Learning: A Probabilistic Perspective', MIT Press, 2012. [https://probml.github.io/pml-book/]

▶ I. Goodfellow, Y. Bengio, A. Courville, 'Deep Learning', MIT Press, 2016: https://www.deeplearningbook.org/

▶ Understanding Deep Learning: https://udlbook.github.io/udlbook/

▶ Dive into Deep Learning: https://d2l.ai/

▶ The Little Book of Deep Learning: https://fleuret.org/francois/

▶ Deep Multi-Task and Meta Learning: https://cs330.stanford.edu/

▶ Optimization Methods in ML: https://arxiv.org/abs/1906.06821

▶ R. Sutton and A. Barto, 'Reinforcement Learning: An Introduction, 2nd Edition', MIT press, 2018.

▶ R. Szeliski, 'Computer Vision: Algorithms and Applications', Springer, 2021. [https://szeliski.org/Book/]