

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?

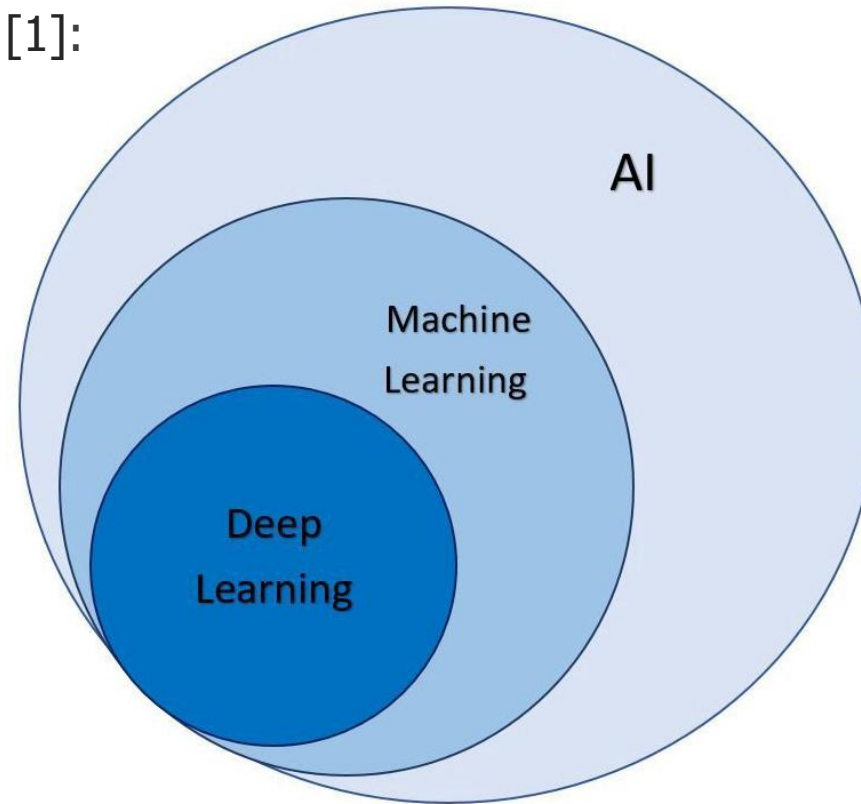
What is AI?

- ▶ 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



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?

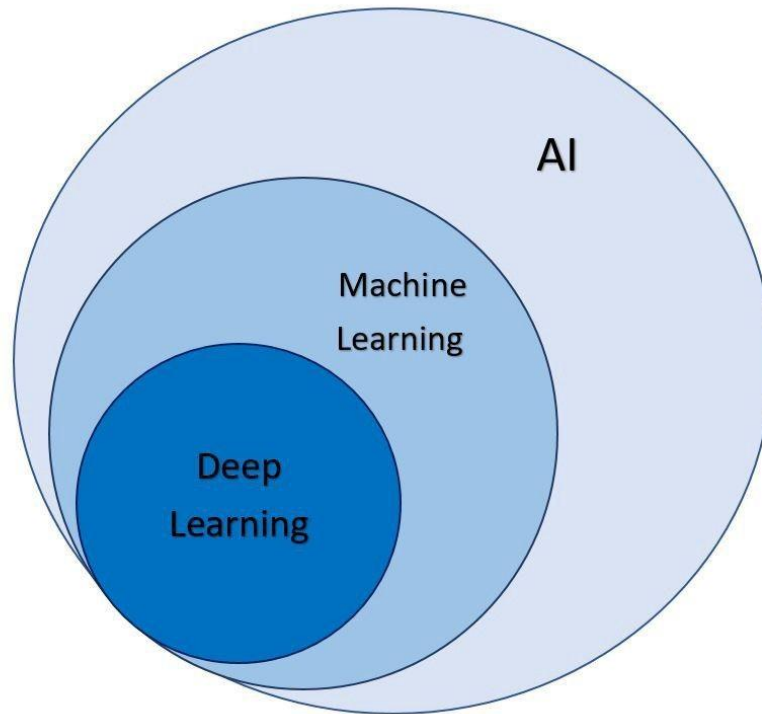
- ▶ 'Hard' computing vs 'Soft' computing:
 - **'Hard' computing** uses traditional mathematical methods, such as algorithms and mathematical models, to solve problems. These algorithms find **provably correct and optimal solutions** to problems.
 - Logic and facts.
 - Optimised for **certainty** and **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

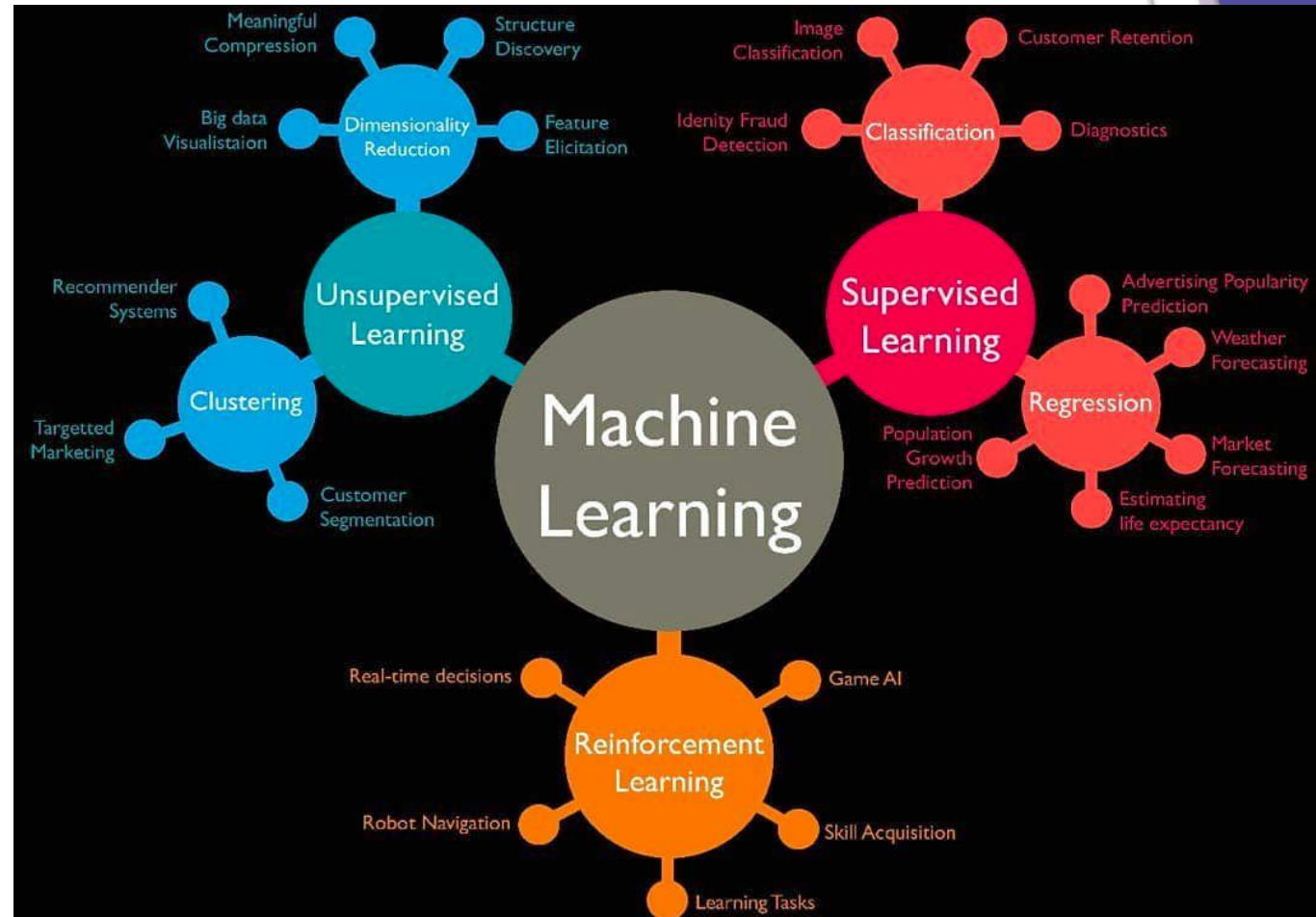
What is ML?

- ▶ 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.
- ▶ R. Sutton and A. Barto, 'Reinforcement Learning: An Introduction, 2nd Edition', MIT press, 2018.
- ▶ Optimization Methods in ML: <https://arxiv.org/abs/1906.06821>
- ▶ R. Szeliski, 'Computer Vision: Algorithms and Applications', Springer, 2021.
[<https://szeliski.org/Book/>]