AMRITA VISHWA VIDYAPEETHAM

21AIE311 - REINFORCEMENT LEARNING

INTRODUCTION

A A NIPPUN KUMAAR
DEPARTMENT OF CSE
AMRITA SCHOOL OF ENGINEERING, BANGALORE

LECTURE OVERVIEW

- Course Overview
- Reinforcement Learning Defined
- Types of Machine Learning
- Why Reinforcement Learning
- Interesting Applications

COURSE OVERVIEW

- **Course Objectives**
  - This course will provide a solid introduction to the field of reinforcement learning.
  - It will also make the students learn about the core challenges and approaches, including exploration and exploitation.
  - The course will make the students well-versed in the key ideas and techniques for reinforcement learning
- **Course Outcomes**

Students will be able to:

- CO1: Define the key features of reinforcement learning that distinguish it from AI and non-interactive machine learning
- CO2: Decide if an application problem should be formulated as an RL problem; if yes be able to define it formally (in terms of the state space, action space, dynamics, and reward model), state what algorithm (from class) is best suited for addressing it
- CO3: Implement in code common RL algorithms
- CO4: Describe (list and define) multiple criteria for analyzing RL algorithms and evaluate algorithms on these metrics: e.g., regret, sample complexity, computational complexity, empirical performance, convergence, etc.
- CO5: Describe the exploration vs exploitation challenge and compare and contrast at least two approaches for addressing this challenge (in terms of performance, scalability, complexity of implementation, and theoretical guarantees)

COURSE OVERVIEW – TEXT BOOK / REFERENCE BOOKS

- 'Reinforcement Learning', Richard.S.Sutton and Andrew G.Barto, Second edition, MIT Press, 2018
- 'Grokking Deep Reinforcement Learning', Miguel Morales, Manning Publications, 2020.
- 'Hands-On Q-Learning with Python', Nazia Habib, O'Reilly, 2019.
- 'Reinforcement Learning- Industrial Applications with Intelligent Agents', Phil Winder, O'Reilly, 2020.
- 'Learning to Play- Reinforcement Learning and Games', Aske Plaat, Springer, 2020.

COURSE OVERVIEW – EVALUATION

- **Internal: 70 Marks**
  - 2 Quizzes : 10 Marks each - 20 Marks
  - Mid Semester Exam :20 Marks - 20 Marks
  - Lab Evaluations/Project Identification : 30 Marks - 30 Marks
- **External: 30 Marks**
  - Course Project : 30 Marks

HANDS-ON SESSION

- Python Programming
- Dynamic Programming
- Best Tools for Project

https://neptune.ai/blog/the-best-tools-for-reinforcement-learning-in-python

REINFORCEMENT LEARNING

REINFORCEMENT LEARNING (RL) IS AN INTERDISCIPLINARY AREA OF **MACHINE LEARNING** AND OPTIMAL CONTROL CONCERNED WITH HOW AN INTELLIGENT AGENT OUGHT TO TAKE **ACTIONS** IN A DYNAMIC **ENVIRONMENT** IN ORDER TO MAXIMIZE THE CUMULATIVE **REWARD**.

Wikipedia

REINFORCEMENT LEARNING

REINFORCEMENT LEARNING (RL) IS THE SCIENCE OF **DECISION MAKING**. IT IS ABOUT LEARNING THE OPTIMAL **BEHAVIOR** IN AN ENVIRONMENT TO OBTAIN MAXIMUM **REWARD**.

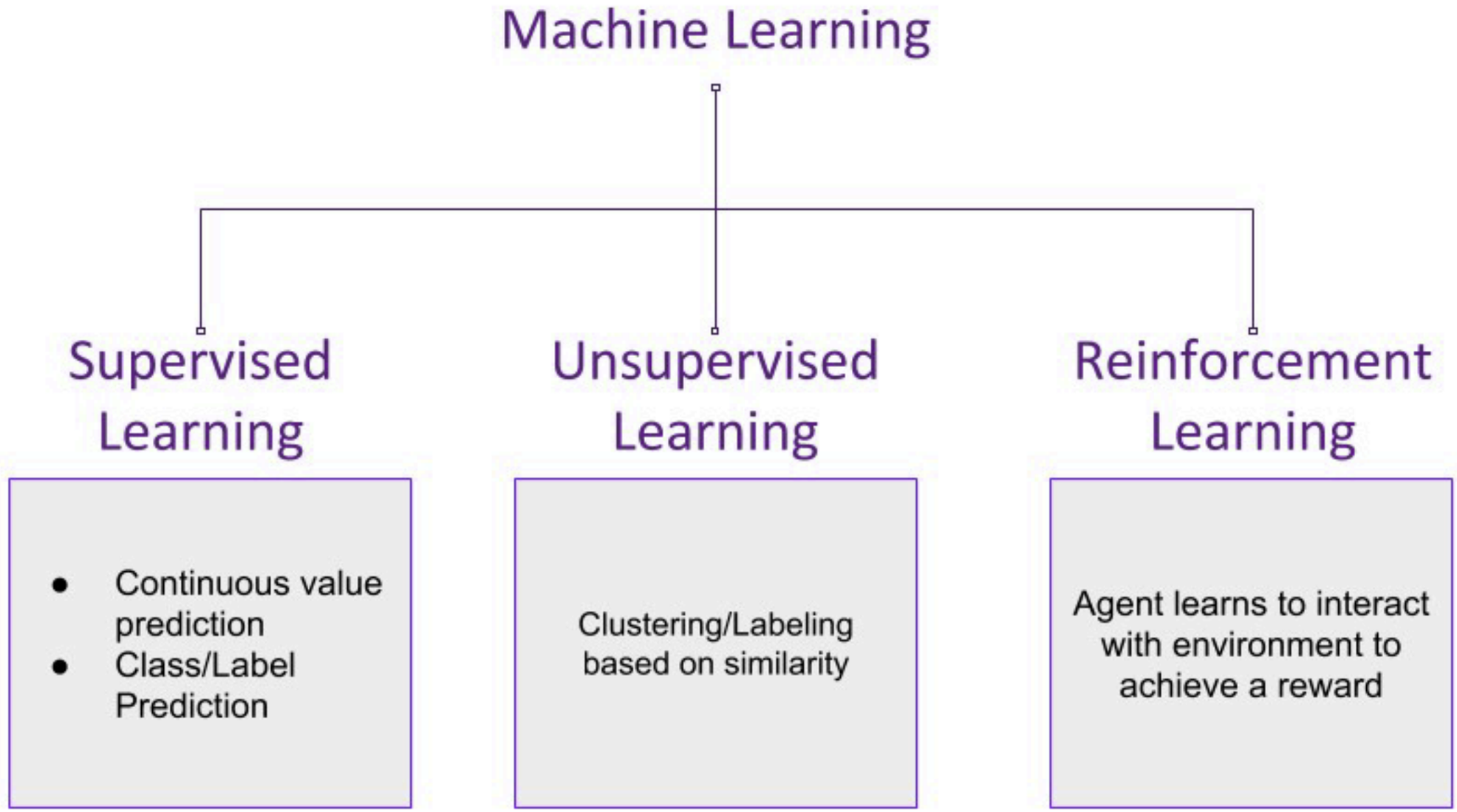
GeeksforGeeks

REINFORCEMENT LEARNING

REINFORCEMENT LEARNING IS A **MACHINE LEARNING** TRAINING METHOD BASED ON **REWARDING** DESIRED BEHAVIORS AND **PUNISHING** UNDESIRED ONES.

Tech target

MACHINE LEARNING

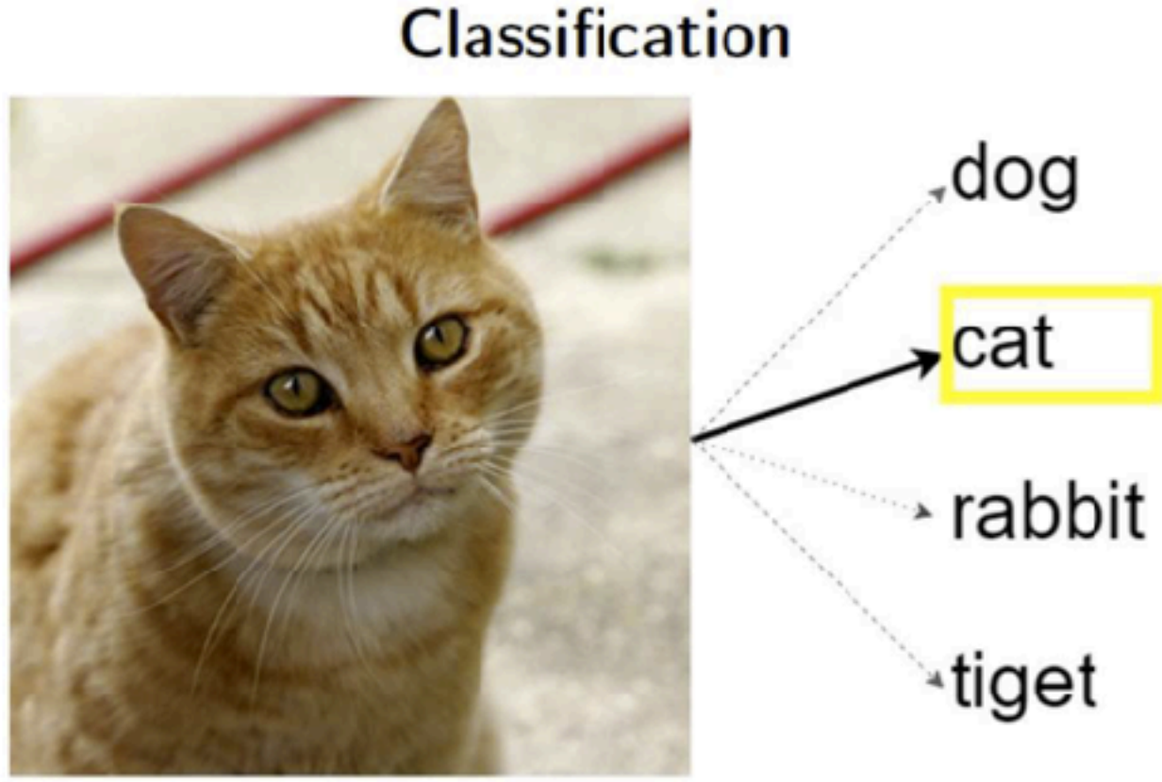


SUPERVISED LEARNING

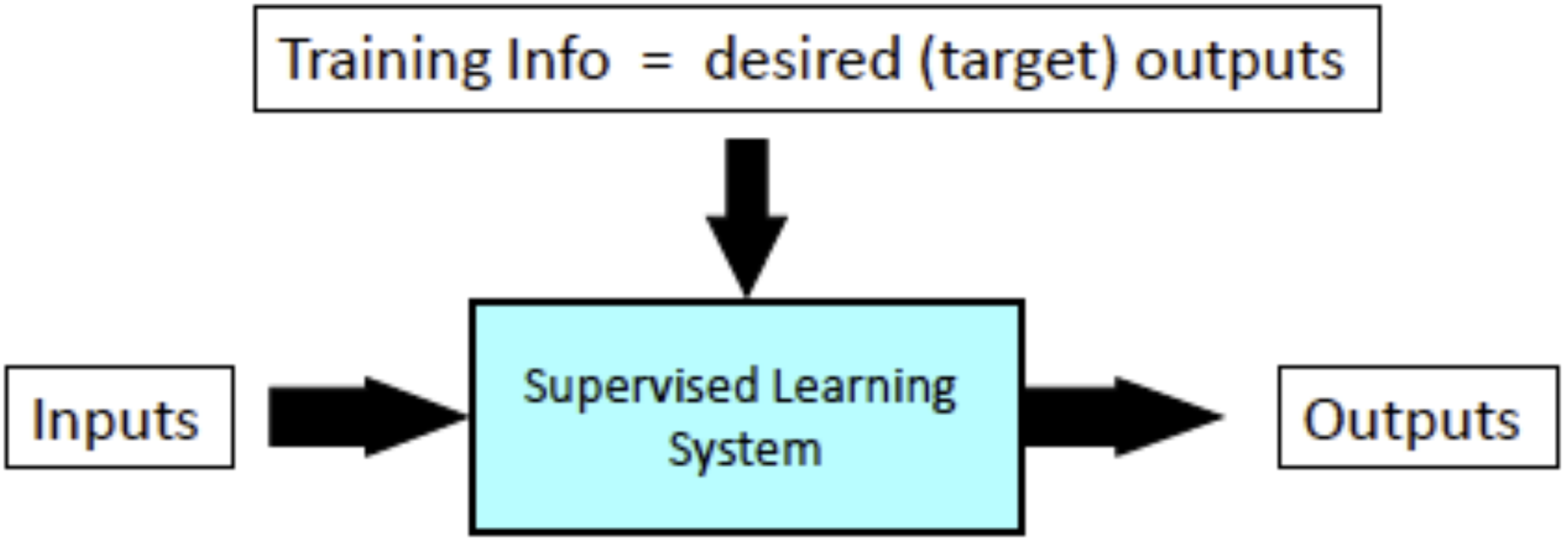
Data: (x, y)
x is data; y is label

Goal: Learn a function to map
$X \longrightarrow y$
$y = f(x)$

Examples: Classification, regression
decision trees, object detection, etc.



SUPERVISED LEARNING



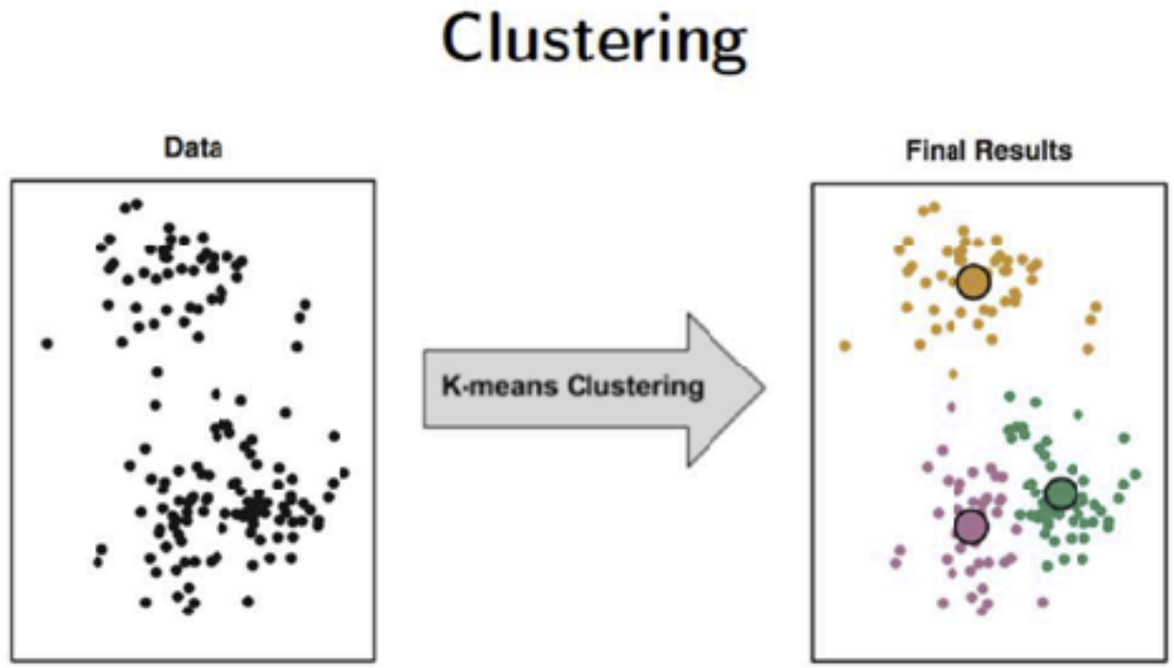
Error = (target output – actual output)

UNSUPERVISED LEARNING

Data: (x)
Just data, no labels

Goal: Learn some underlying hidden structure of the data

Examples: Clustering, dimensionality reduction, feature learning, anomaly detection, etc



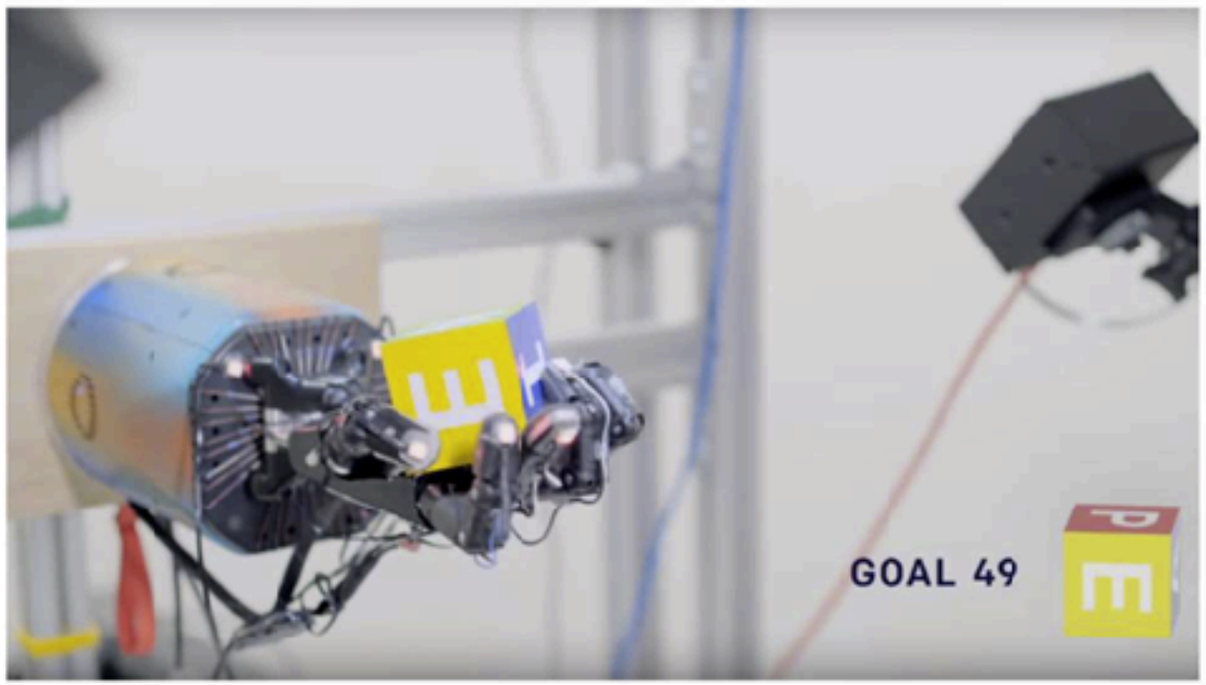
REINFORCEMENT LEARNING

Problems involving **an agent** interacting with **an environment**, which provides numeric reward signals.

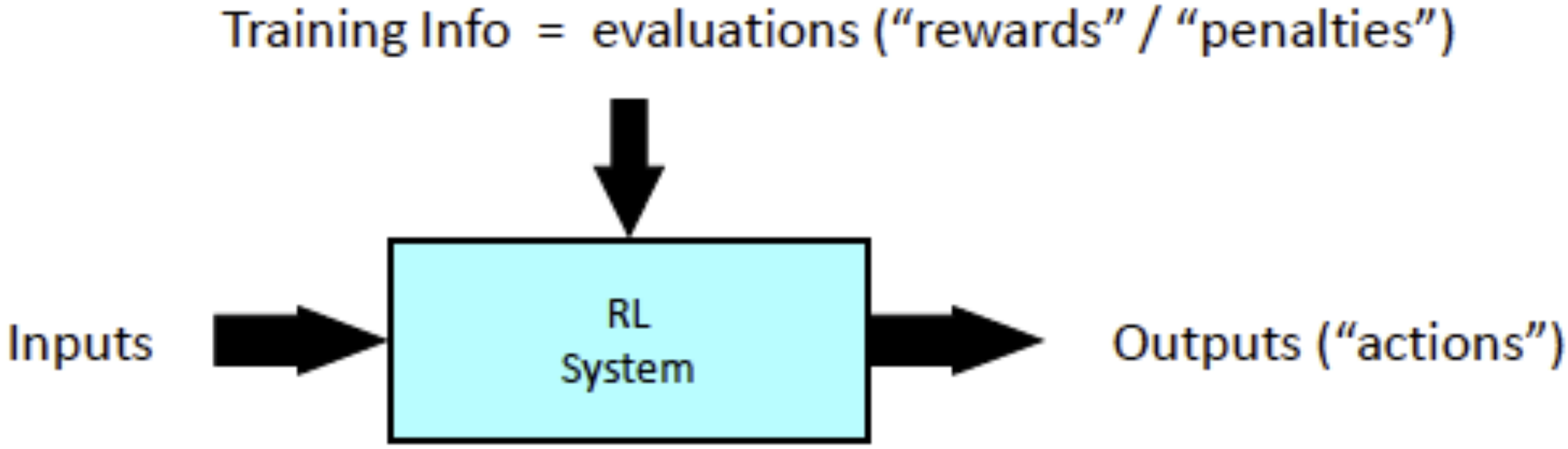
Goal: Learn how to take actions in order to maximize reward

Examples: Learning tasks, navigation, etc

Manipulating physical objects



REINFORCEMENT LEARNING

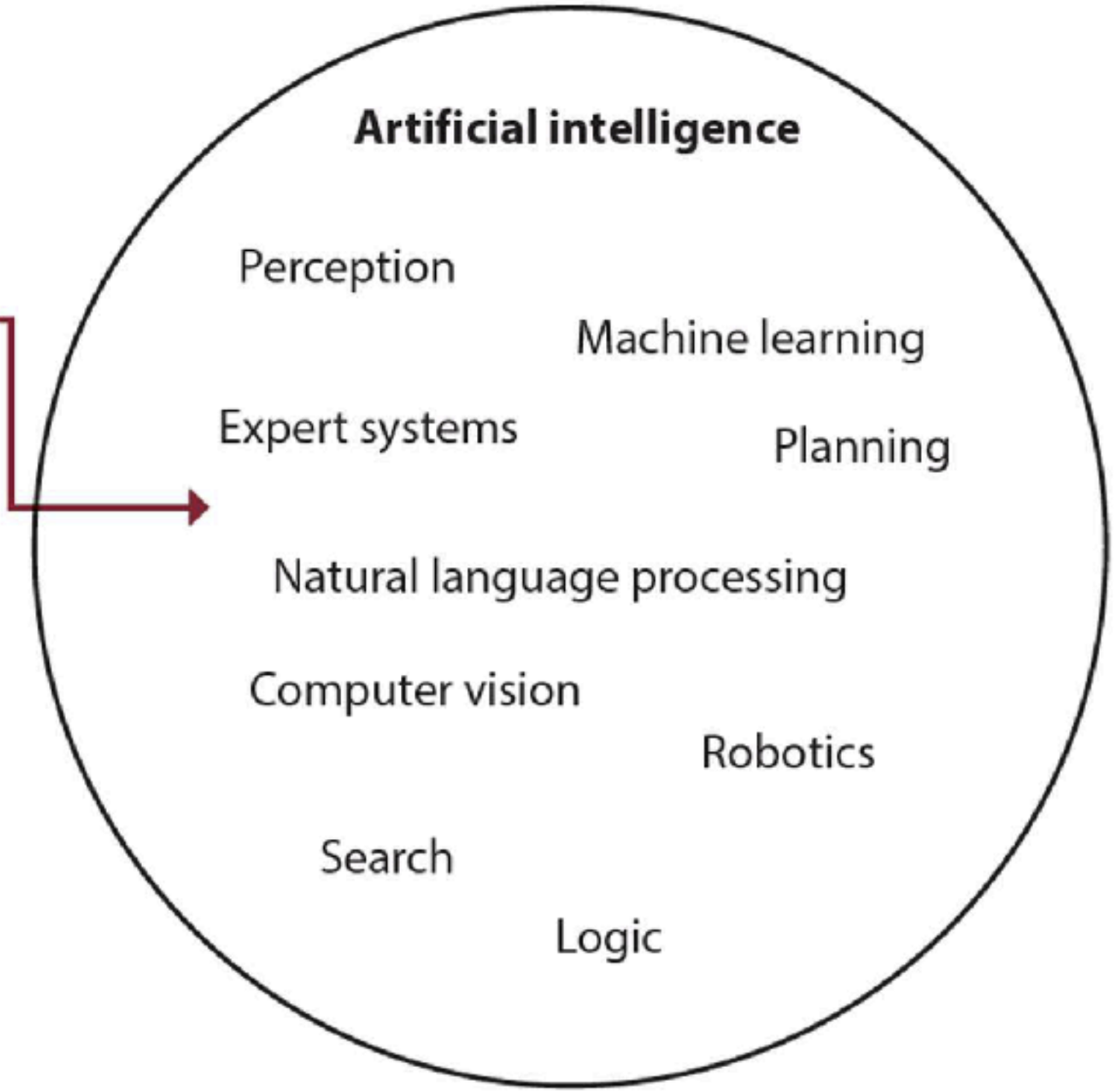


Objective: get as much reward as possible

ARTIFICIAL INTELLIGENCE

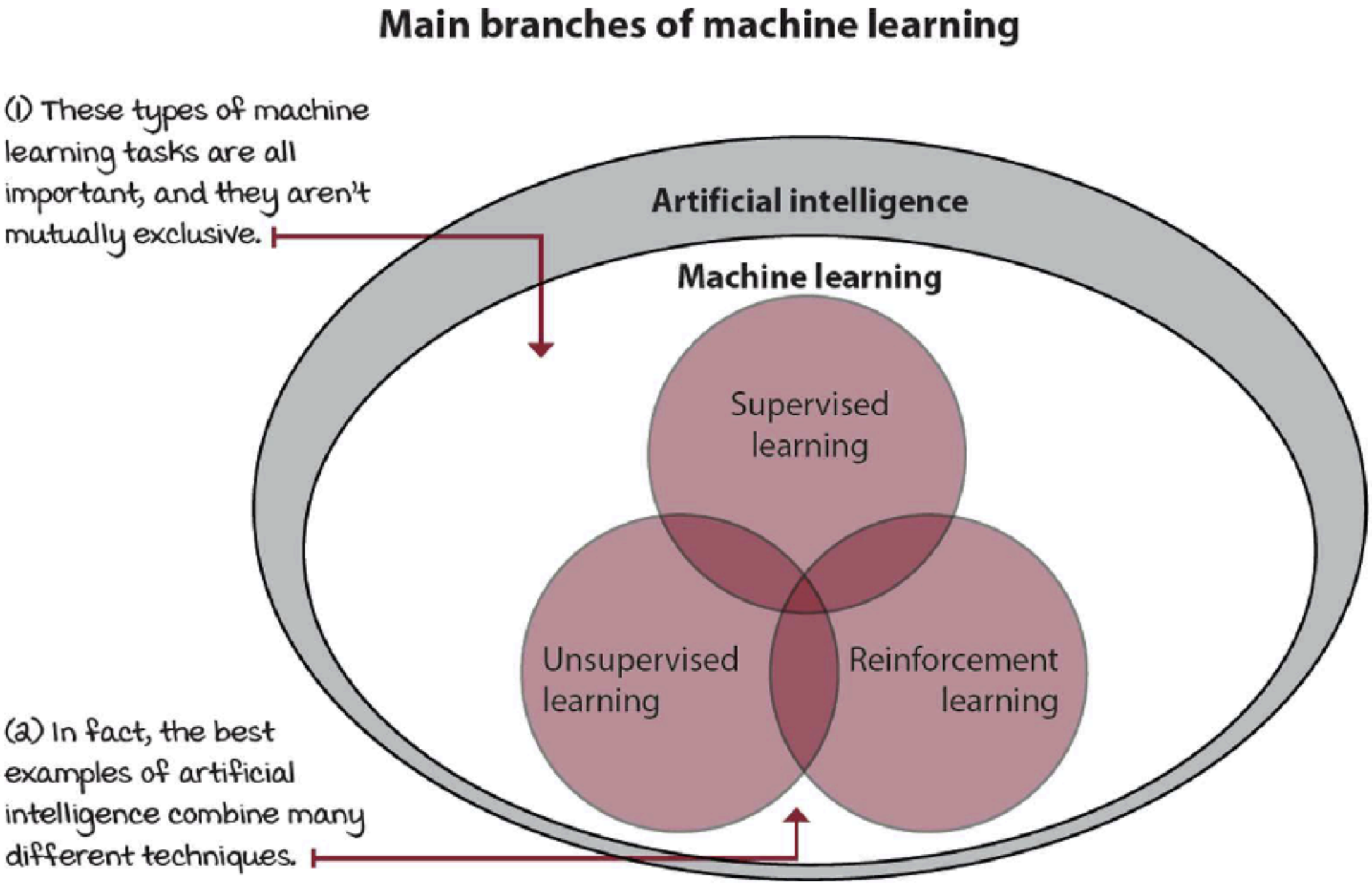
Subfields of artificial intelligence

(1) Some of the most important areas of study under the field of artificial intelligence.



All computer programs that display intelligence are considered AI,
But not all examples of AI can learn

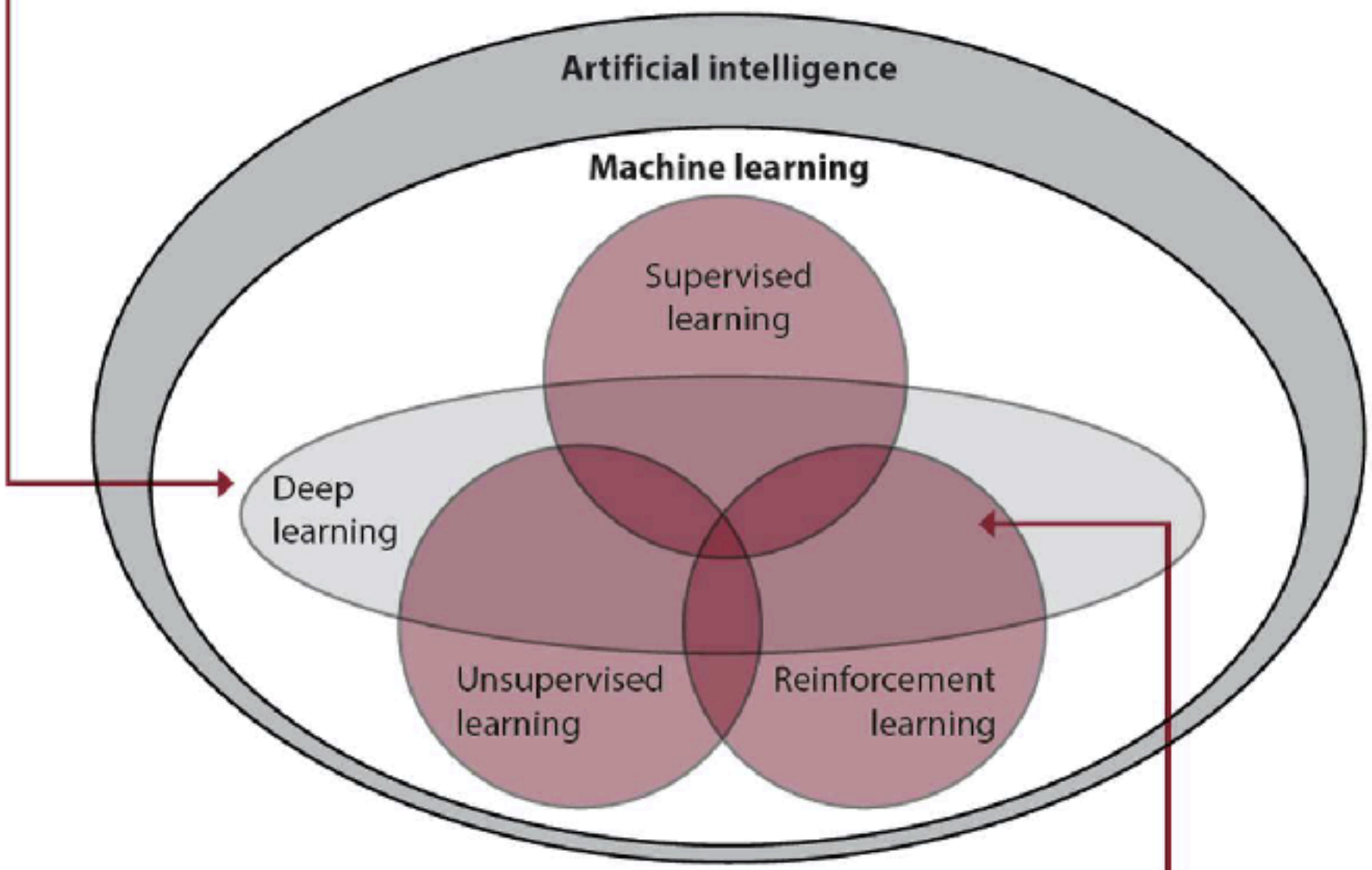
ARTIFICIAL INTELLIGENCE



ARTIFICIAL INTELLIGENCE

Deep learning is a powerful toolbox

(1) The important thing here is deep learning is a toolbox, and any advancement in the field of deep learning is felt in all of machine learning.



(2) Deep reinforcement learning is the intersection of reinforcement learning and deep learning.

INTERESTING APPLICATION

- https://www.youtube.com/watch?v=kopoLzvh5jY

Here in this video, we can observe agents discovering progressively more complex tool use while playing a simple game of hide-and-seek.

Through training in the new simulated hide-and-seek environment, agents build a series of six distinct strategies and counterstrategies, some of which we did not know our environment supported.

The self-supervised emergent complexity in this simple environment further suggests that multi-agent coadaptation may one day produce extremely complex and intelligent behavior.

INTERESTING APPLICATION

- https://www.youtube.com/watch?v=2tamH76Tjvw
- AI Teaches Itself How to Escape!
- In this video an AI named Albert learns how to escape 7 rooms designed. The AI was trained using Deep Reinforcement Learning, a method of Machine Learning which involves rewarding the agent for doing something correctly and punishing it for doing anything incorrectly. Albert's actions are controlled by a Neural Network that's updated after each attempt in order to try to give Albert more rewards and less punishments over time. Everything in this video (except for the music) was created entirely using Unity.

THANK YOU !!!