LECTURER: TAI LE QUY

INTRODUCTION TO REINFORCEMENT LEARNING

Who am I?

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- PhD at L3S Research Center – Leibniz University Hannover
  - Topic: Fairness-aware machine learning in educational data mining
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Who are you?

- Name
- Employer
- Position/responsibilities
- Fun Fact
- Previous knowledge? Expectations?

UNIT 1

INTRODUCTION TO REINFORCEMENT LEARNING

STUDY GOALS

- Explain the basic principles of reinforcement learning
- Analyze the differences between supervised, unsupervised and reinforcement learning
- Identify key components of a reinforcement learning problem and apply them to solve complex tasks

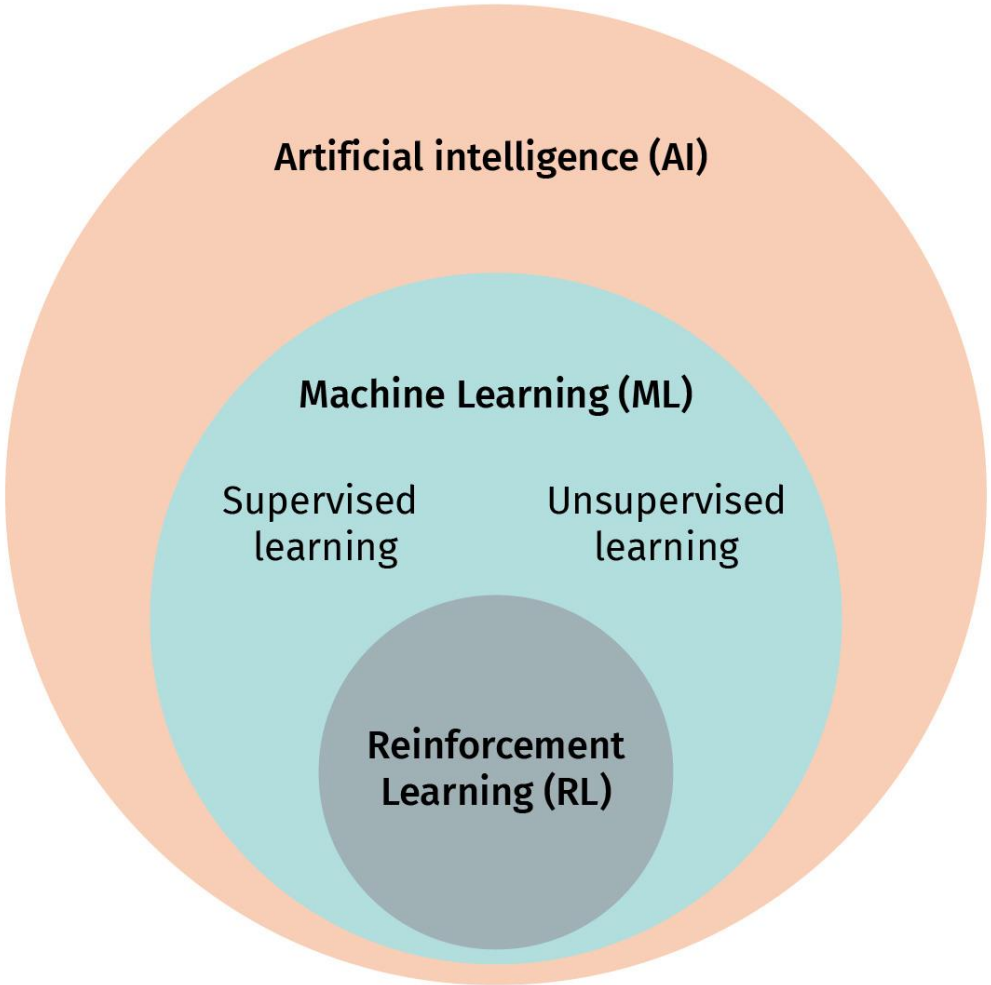
EXPLAIN SIMPLY

1. Explain the key principles behind reinforcement learning and how it differs from traditional software systems

2. Describe the components of a reinforcement learning system and their role in intelligent decision-making

3. Compare and contrast reinforcement learning, supervised learning, and unsupervised learning

ARTIFICIAL INTELLIGENCE, MACHINE LEARNING, AND REINFORCEMENT LEARNING

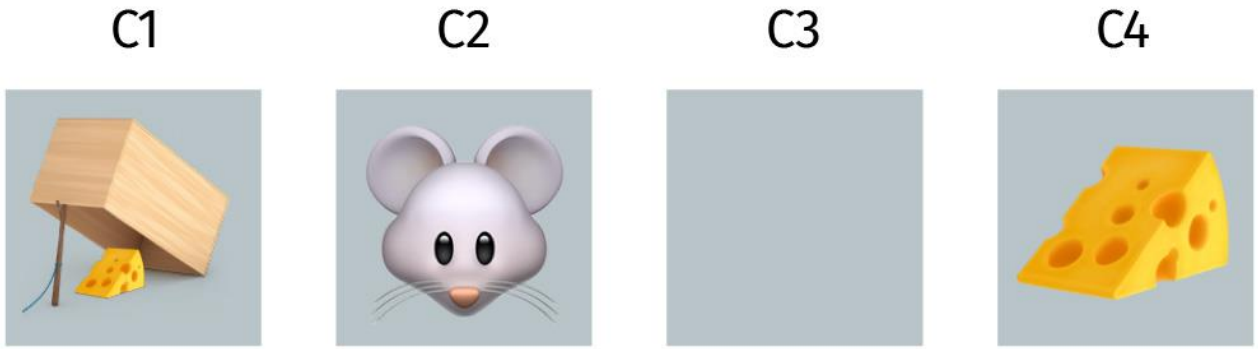


Source: Saasha Nair (2023)

WHY REINFORCEMENT LEARNING

OBJECTIVES OF REINFORCEMENT LEARNING

Teaching computer systems to make optimal decisions

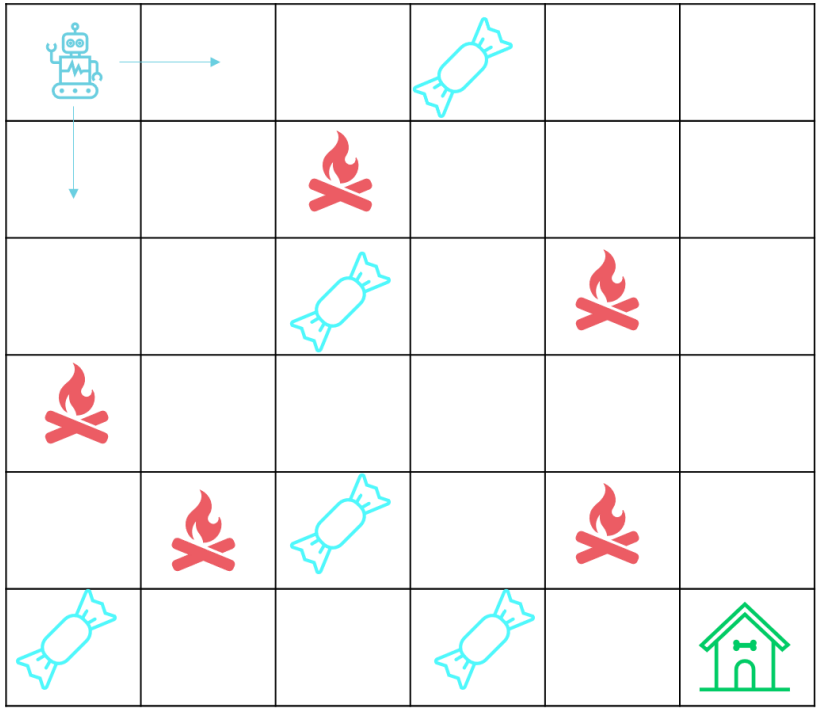


- Trial and error strategy to act under uncertainty
- Use experience to improve over time

Source of the image: Nair, 2023.

Reinforcement learning is goal-oriented

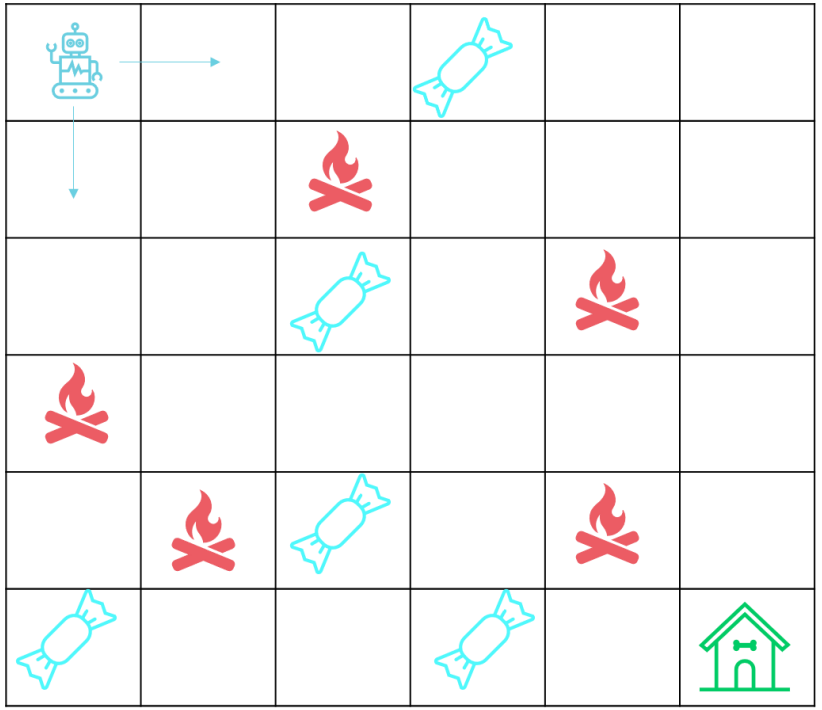
- Train through trial and error
- Reward desired behavior
- Punish undesired behavior



Source of the image: Plaku, 2023.

Task: learn state to action mapping

- State: current condition of the world
- Action: allowed moves in each state
- Policy: state to action mapping

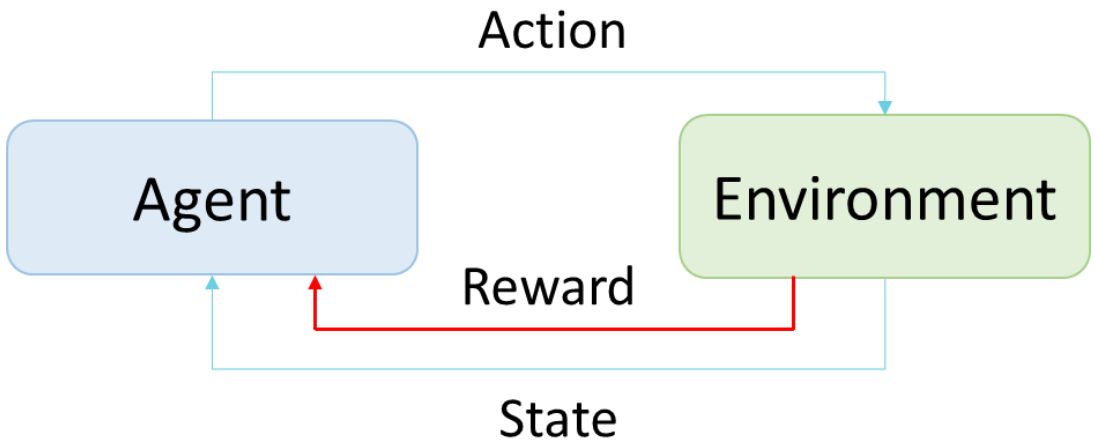


Source of the image: Plaku, 2023.

COMPONENTS OF REINFORCEMENT LEARNING SYSTEMS

Agent is guided by a goal as it operates in an environment

- Agent: the learning entity
- Environment: external context
- Objective: maximize long-term reward

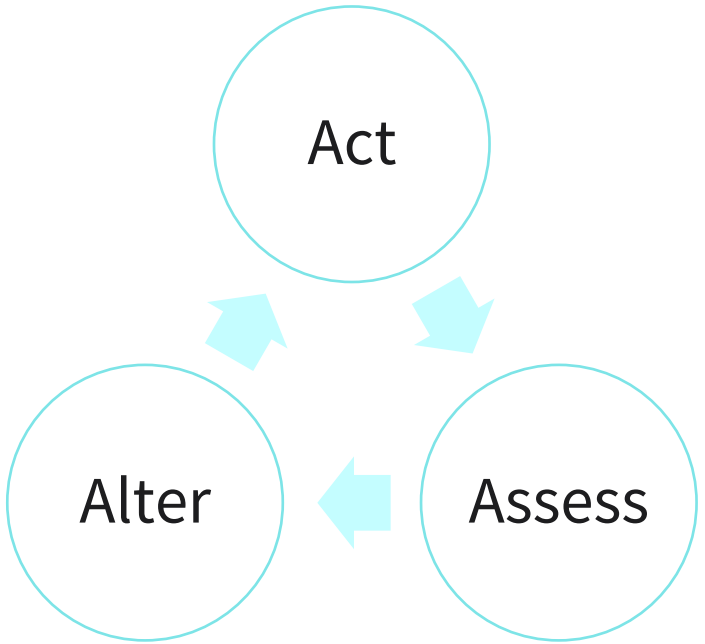


Source of the image: Plaku, 2023.

Agents are powered by the **act-assess-alter** cycle

Agent

- perceives environment & acts
- asseses the outcome
- alters behavior to optimize results



MACHINE LEARNING CATEGORIES

Supervised learning

- Learn with a teacher
- Train using input-ouput pairs
- Goal: generalization

Unsupervised learning

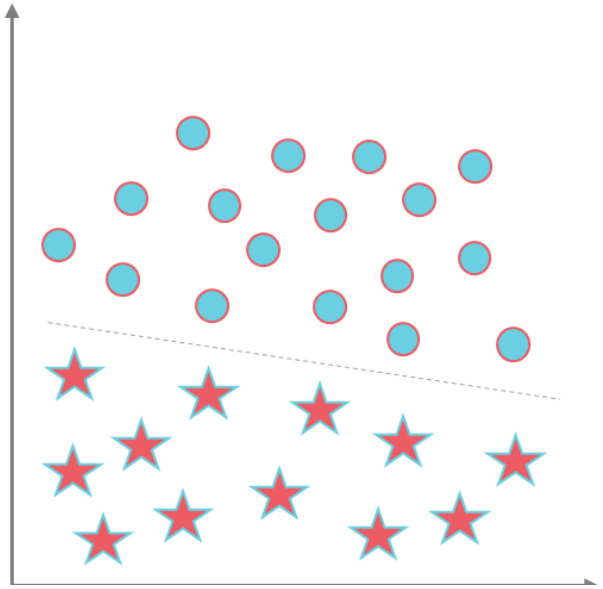
- Find patterns in data
- No labeled data, only features
- Goal: compression

Reinforcement learning

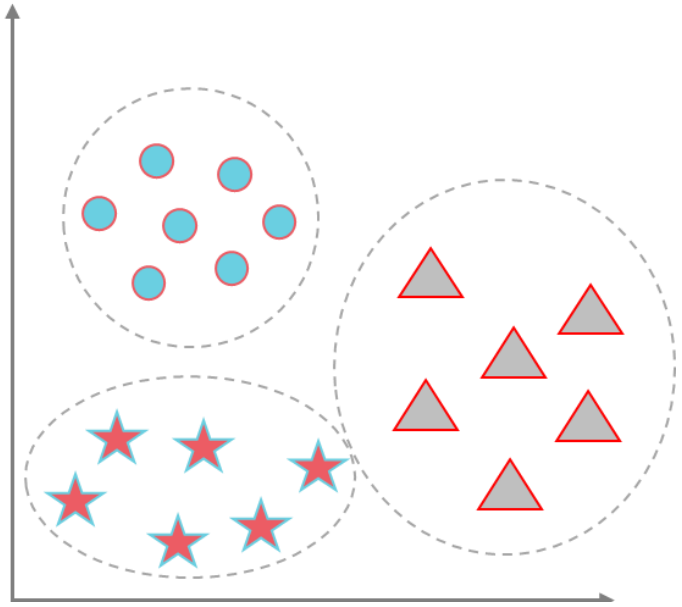
- Trial and error
- Agents acts in environment
- Goal: learn to act

MACHINE LEARNING CATEGORIES

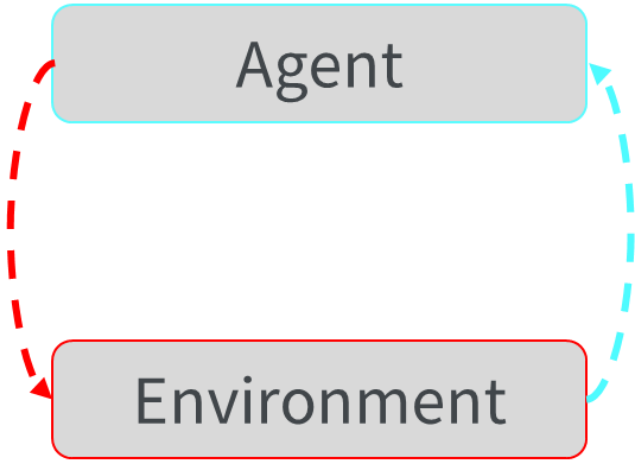
Supervised learning



Unsupervised learning



Reinforcement learning



Source of the image: Plaku, 2023.

REVIEW STUDY GOALS

- Explain the basic principles of reinforcement learning
- Analyze the differences between supervised, unsupervised and reinforcement learning
- Identify the various components in a reinforcement learning problem and apply it to solve complex tasks

SESSION 1

TRANSFER TASK

Case study

A self-driving car company wants to improve its vehicle's ability to navigate complex intersections. The task involves detecting and interpreting road signs, traffic lights, pedestrian crossings, and movement of other vehicles.

Task

Discuss how this task can be modeled as a reinforcement learning problem. What would the key components?

TRANSFER TASK
PRESENTATION OF THE RESULTS

Please present your results.

The results will be discussed in plenary.

1. The goal of reinforcement learning is…
   a) Learn to generalize
   b) Learn to specialize
   c) Learn to act
   d) Learn to compress

2. The agent is internally powered by…
   a) Act-assess-alter loop
   b) State-action-reward loop
   c) Sense-act loop
   d) Transition functions

3. The broad categories of machine learning are…
   a) Artificial intelligence, unsupervised learning, supervised learning
   b) Supervised learning, unsupervised learning, reinforcement learning
   c) Reinforcement learning, planning, search
   d) State space, action space, return

LIST OF SOURCES

Images

Nair, 2023.
Plaku, 2023.