

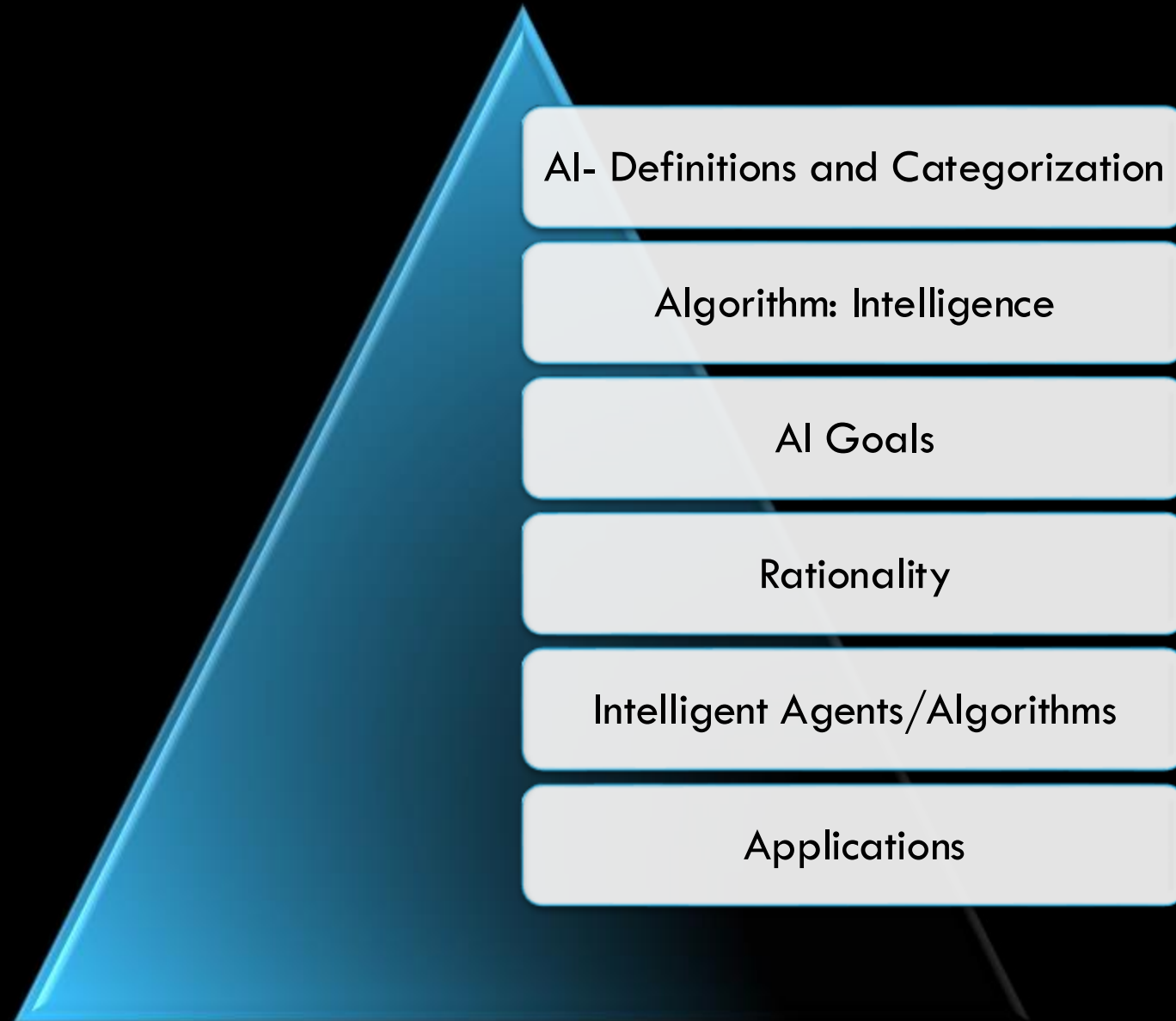


ECE 457A

ADAPTIVE COOPERATIVE ALGORITHMS

INTRODUCTION FUNDAMENTALS

TOPICS



ALGORITHM AND INTELLIGENCE



ALGORITHM

A list set of instructions/steps, used to solve problems or perform tasks, based on the understanding of available alternatives. **Simply: a set of steps used to complete a specific task.**



INTELLIGENCE

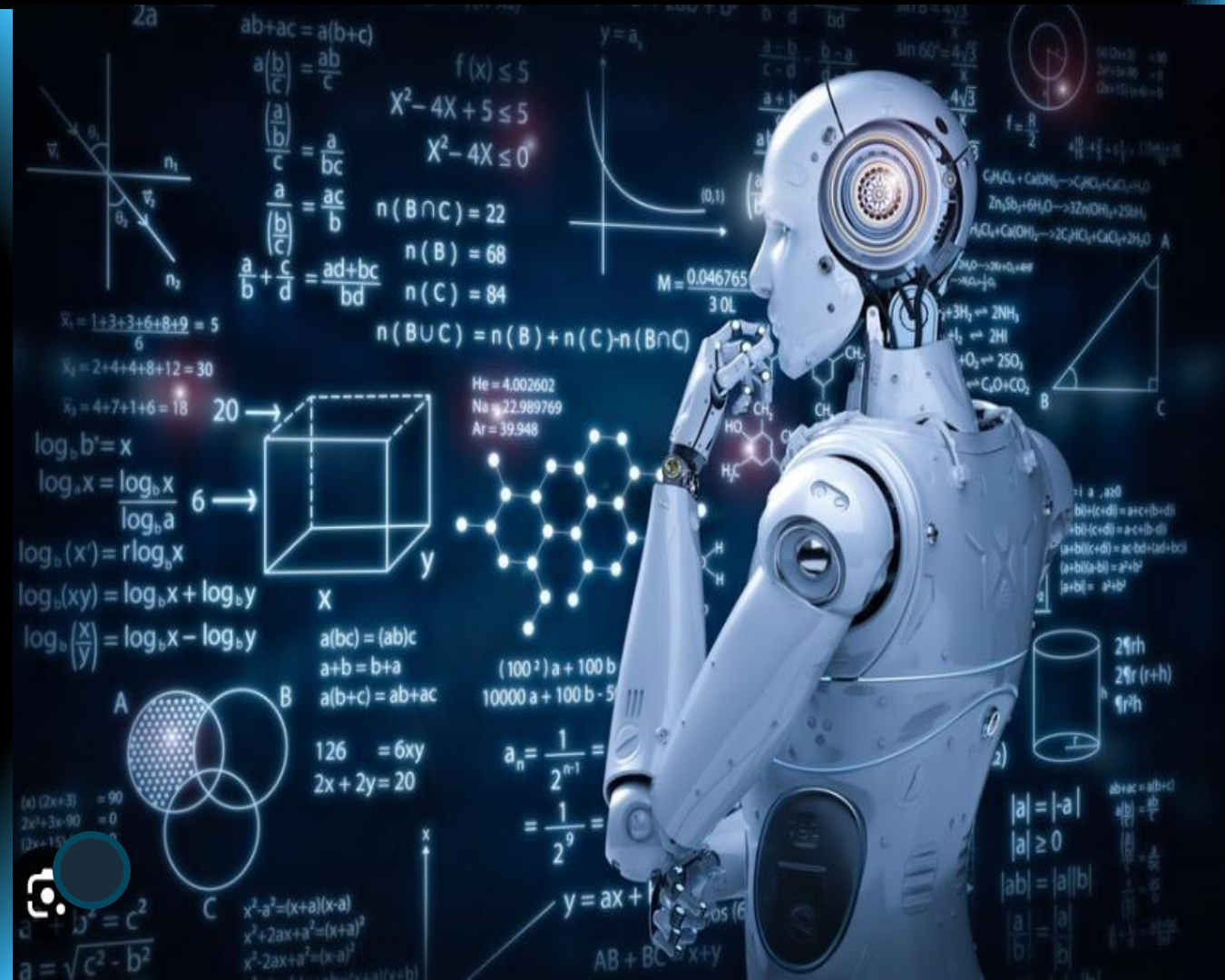
The ability to acquire and apply knowledge and skills.

ARTIFICIAL INTELLIGENCE (AI)

WHAT IS ARTIFICIAL INTELLIGENCE (AI)?

the science and engineering of making intelligent machines, especially intelligent computer programs. Such as

- ✓ Robots
- ✓ Visual perception,
- ✓ Speech recognition,
- ✓ Decision-making, and
- ✓ Translation between languages



AI GOALS

Scientific vs. Engineering

- Scientific goal for AI is to develop concepts and mechanisms to **understand** biological intelligent behavior.
- Engineering goal for AI is to develop concepts, theory and practice of **building** intelligent machines.

Viewed differently, our goals might include:

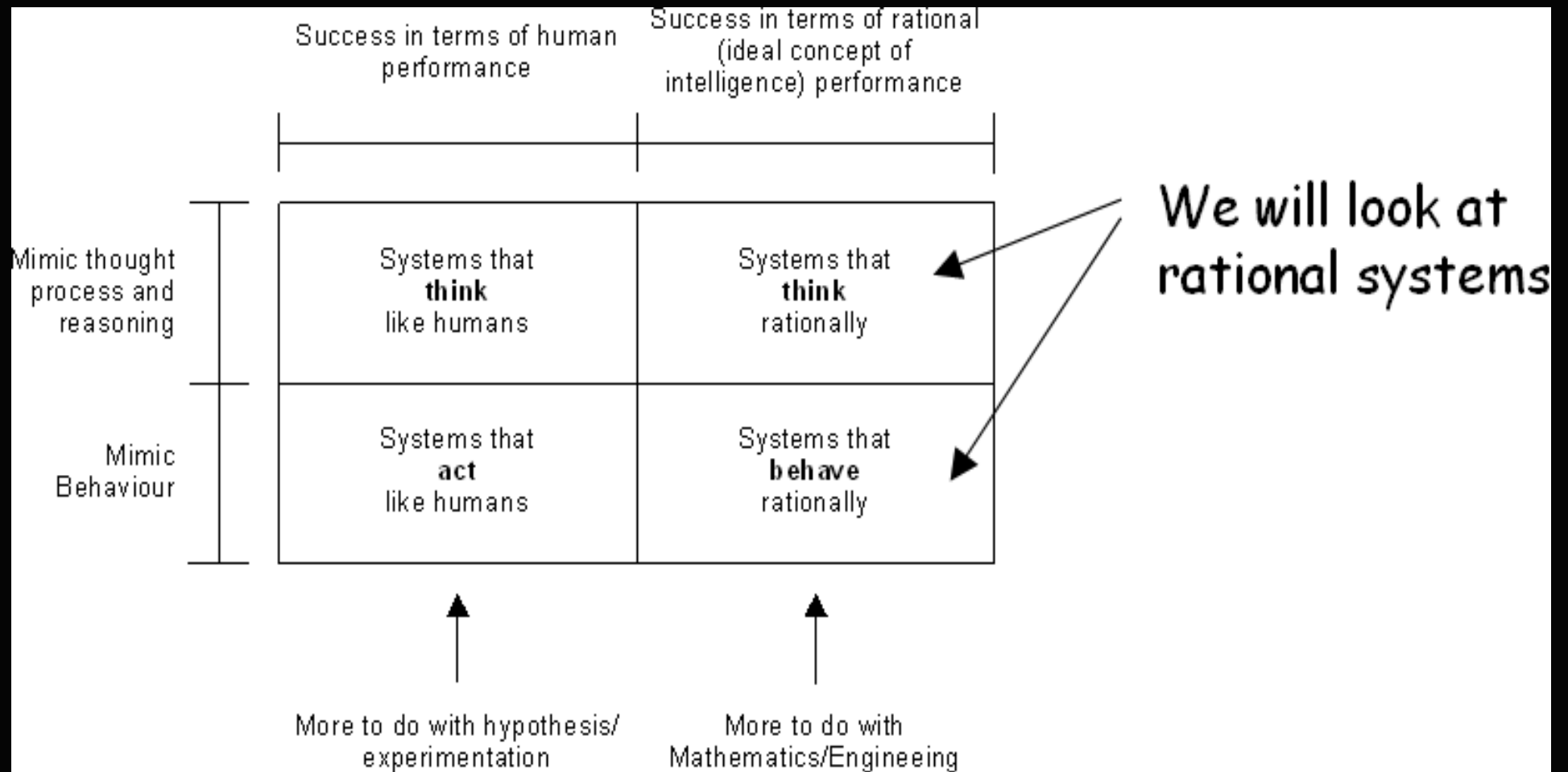
- Replicate human intelligence and reasoning.
- Solve hard and knowledge intensive problems.
- Develop a connection between perceptions and actions.
- Enhance human-human and human-machine interactions.
- And so forth...

AI, MACHINE LEARNING, DEEP LEARNING, DATA SCIENCE



CATEGORIZATION

Can organize it into two categories based on goals and methodologies:



RATIONAL SYSTEMS

Mentioned that in engineering, we are interested in **rational** systems.

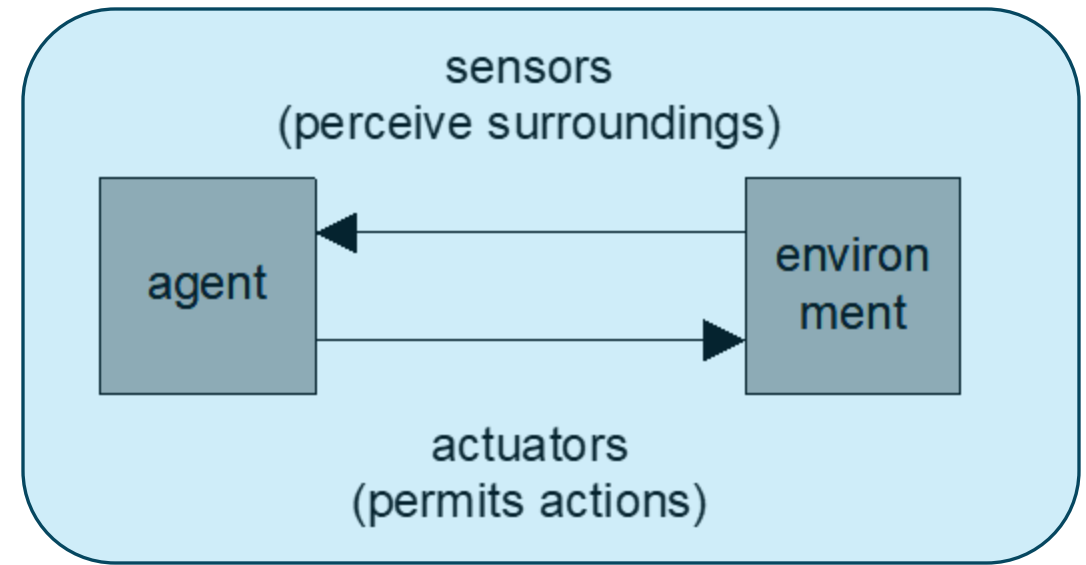
Thinking rationally means using logic to achieve goals via logical inferencing.

- Hard to represent informal knowledge
- Not all problems solvable in this manner (e.g., uncertainty).

Behaving rationally means perceiving the “world” and acting to achieve some goals given a set of beliefs.

- Amenable to computation.
- More general than inferencing (but can use inferencing).
- Actions taken to achieve a goal are not necessarily “correct”, but accomplish task at hand.

INTELLIGENT AGENTS/ALGORITHMS



agent

An agent is something that **senses** its environment and **acts** on it.

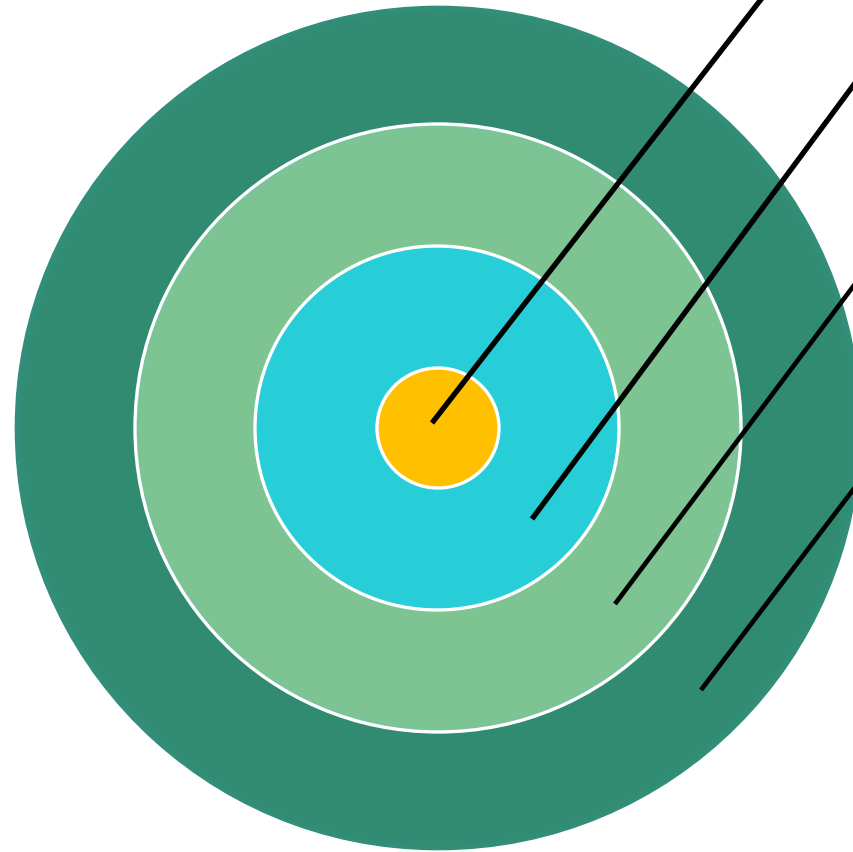
Rational

We would like to design **rational agents**.

- A **rational agent** is one that for each perceived sequence of events, it does what is expected to maximize performance on the basis of perceptual history and built-in knowledge (leads to concept of **autonomy**).



TIC-TAC-TOE



Think about the tic-tac-toe game:

1- what happens when two rational agents play against each other?

2- what happens when one rational agent plays against an irrational?

3- what happens when two irrational agents play against each other?

ENVIRONMENTS

Agents work within an **environment** with certain characteristics.

It's useful to identify and understand a small number of possible dimensions for an environment that can influence the design of an agent (as previously mentioned).



Environment

- **Fully Observable vs. Partially Observable**
- **Deterministic vs. Stochastic**
- **Episodic vs. Sequential**
- **Static vs. Dynamic**
- **Discrete vs. Continuous**
- **Competitive vs. Co-operative**

ENVIRONMENTS

Fully observable vs. partially observable

- An environment is effectively fully observable if the sensors detect all aspects that are relevant to the choice of action.
- An environment might be partially observable because of noisy and inaccurate sensors or because parts of the state are simply missing from the sensor data.

Deterministic vs. stochastic.

- If the next state of the environment is completely determined by the current state and the action executed by the agent, then we say the environment is deterministic;
- otherwise, it is stochastic.

ENVIRONMENTS

In episodic environments, the choice of action in each episode depends only on the episode itself, e.g., spotting defective parts on an assembly line.

EPISODIC

In sequential environments, the current decision could affect all future decision, e.g.. Chess. Episodic environments are much simpler than sequential environments because the agent does not need to think ahead

SEQUENTIAL

ENVIRONMENTS

**Static
vs.
dynamic**

If the environment can change while an agent is deliberating, then we say the environment is dynamic for that agent; otherwise, it is static.

**Discrete
vs.
Continuous**

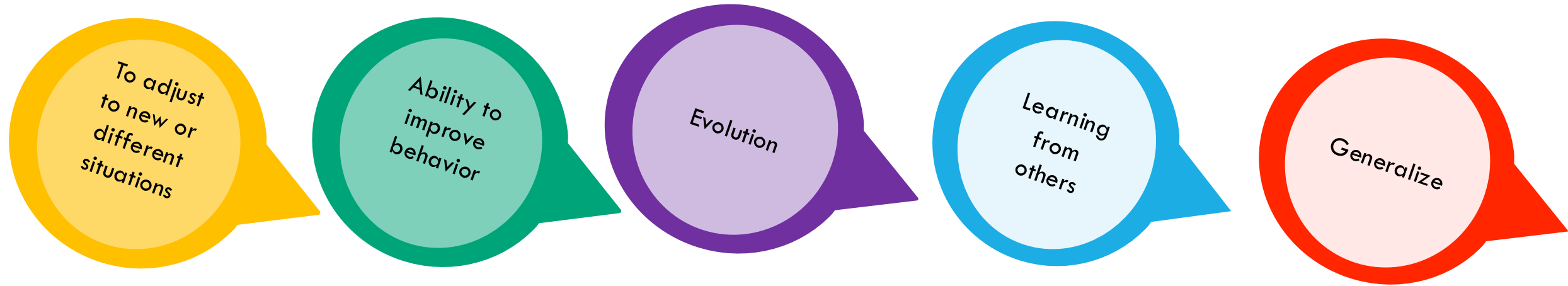
The discrete/continuous distinction can be applied to the state of the environment, to the way time is handled, and to the percepts and actions of the agent.

**Single
vs.
Multi**

The distinction between single-agent and multi-agent environments may seem simple enough.



ADAPTATION



COOPERATION



A group to solve a joint problem or perform (a) common task(s) based on sharing the responsibility for reaching the goal.

Direct cooperation

Indirect cooperation

Independent actions

COOPERATION

Cooperation is the practice of hardware and/or software entities working together in order to achieve certain objective.



• This objective can be, but not limited to,

- Achieving Individual or Common Goal
- Division of Labor
- Collective Autonomy
- Achieving Collective Intelligence
- Conflict Avoidance
- Achieving Maximum Reward
- Maintaining System Functionality
- Knowledge and Information Acquisition and/or Sharing