# SIT215
# Computational Intelligence

Lecture

Week 1

: Introduction to Computational Intelligence, AI and Agents

*Unit Chair: Dr Glory Lee*

# Acknowledgement of Country

Deakin University acknowledges the Traditional Custodians of all the unceded lands, skies and waterways on which Deakin students, staff and communities come together.

As we learn and teach through virtually and physically constructed places across time, we pay our deep respect to the Ancestors and Elders of Wadawurrung Country, Eastern Maar Country and Wurundjeri Country, where our physical campuses are located.

We also acknowledge the many First Nations from where students join us online and make vital contributions to our learning communities.

# Learning Objectives

After this class, you will be able to

- Understand how this unit works

- Explain the relationship between AI and CI
- Understand the key philosophy for an intelligent system
  - ❑ explain how agents interact with environments
  - ❑ explore agent programs
- Describe key properties of an agent and environment,
  - ❑ including their applicable data structures (Focus in Practical session)

# UNIT OUTLINE

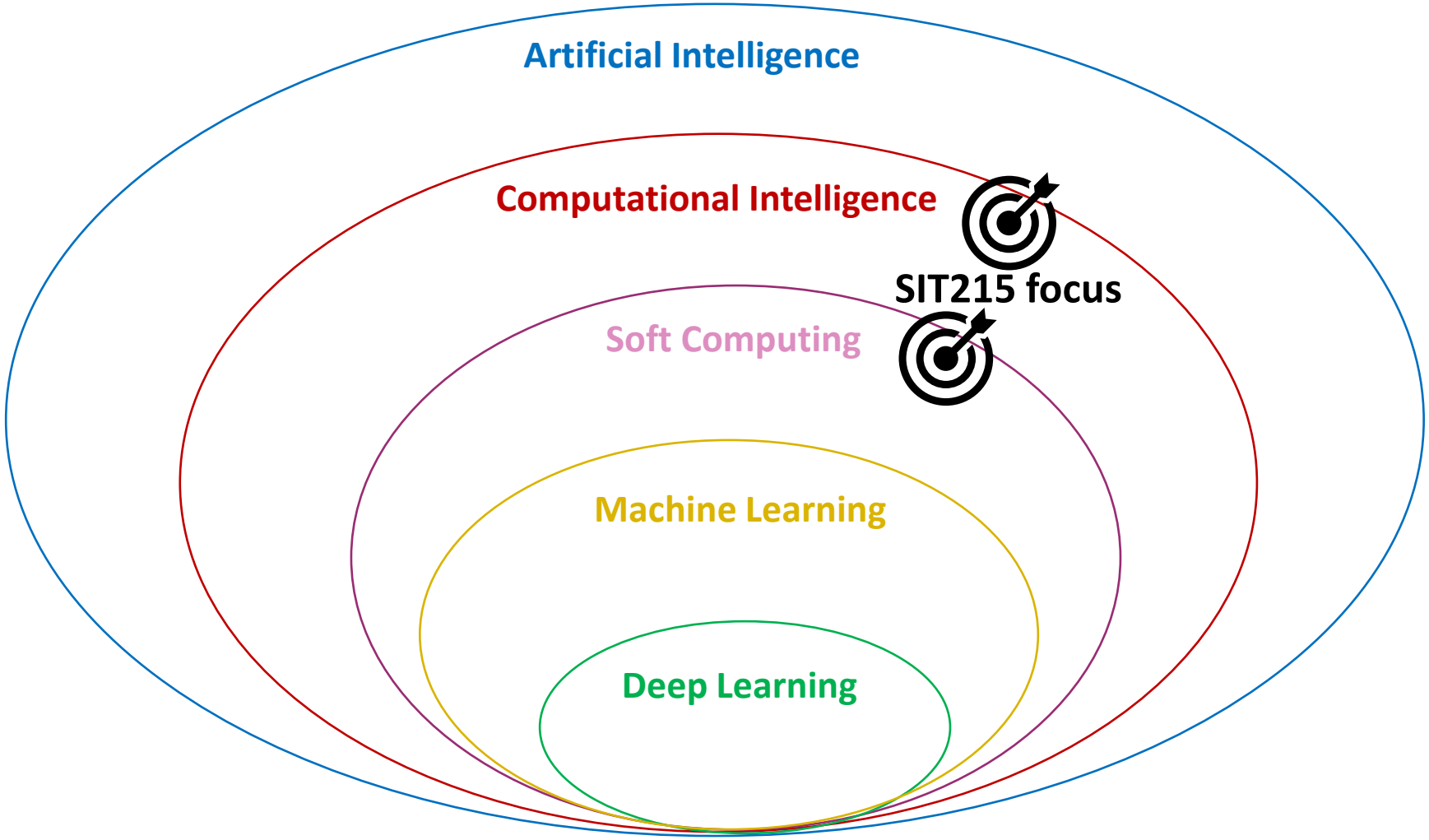
Introduction

Instruction to how this unit will work!

1

# Paradigm Relationship –

*Artificial Intelligence (AI), Computational Intelligence (CI)…Machine Learning (ML)*



# ULOs Alignment and Learning Achievements

| ULO | These are the Learning Outcomes (ULO) for this unit. At the completion of this unit, successful students can: | Deakin Graduate Learning Outcomes |
|---|---|---|
| ULO1 | Apply specific algorithms and data structures to model a range of problems arising in intelligent systems development. | GLO1: Discipline-specific knowledge and capabilities<br>GLO5: Problem solving |
| ULO2 | Design and implement software artefacts to demonstrate effectiveness and efficiency of solutions for intelligent systems development. | GLO1: Discipline-specific knowledge and capabilities<br>GLO4: Critical thinking<br>GLO7: Teamwork |
| ULO3 | Apply theoretical concepts and models to explain and communicate the design of intelligent systems. | GLO1: Discipline-specific knowledge and capabilities<br>GLO2: Communication<br>GLO7: Teamwork |

# Unit Outline

The topics you will investigate in this unit are:

| W # | Topic | Field |
|---|---|---|
| 1 | Introduction to CI, AI and Agents | Foundations of AI, CI, Intelligent agents |
| 2 | Problem Solving Part 1 | Environment, Intelligent (State Space) search approaches, Heuristics |
| 3 | Problem Solving Part 2 | Cost Functions, Systematic exploration of solution spaces |
| 4 | Solution Quality and Evaluation | Optimisation, Empirical measures of heuristic quality |
| 5 | Knowledge and Reasoning Part 1 | Knowledge representation, Fuzzy logic, Approximate reasoning |
| 6 | Knowledge and Reasoning Part 2 | First-Order Logic, Structuring knowledge for decision making, adaptive optimisation |
| 7 | Planning and Action Part 1 | Planning in real-world, PDDL, Action representation |
| 8 | Planning and Action Part 2 | Planning in dynamic environments, PDDL |
| 9 | Performance Evaluation | Metrics, Benchmarking, Ethical considerations |
| 10 | Learning Paradigms | Supervised, Unsupervised, and Reinforcement learning |
| 11 | Review and Conclusion | Overview, Current trends, Foresights |

# Resources

**Unit Site** > Unit Information , Unit Guide

- SIT215 Induction: How to succeed page

- Announcement
- Learning resources
- Assessment resources
- Reading List – recommended reading
- Discussion Forum is also a useful platform to resolve common doubts

**Unit MS Teams** > Mainly serve as a virtual meeting space at the scheduled class time

- Peer Support Channel

# SIT215 Assessment

**Assessment**

| Assessment Description | Student output | Grading and weighting (% total mark for unit) | Indicative due week |
|---|---|---|---|
| Assessment 1 Problem solving task | One problem solving task | 40% | Weeks 6 |
| Assessment 2 Quiz | Open book quiz | 20% | Week 9 |
| Assessment 3 Project | Software source code, resource files, recorded video presentation, and written report | 40% | Week 11 |

## Information @Unit Guide

When and how to submit your work

Due: Sunday 13 April 2025 by 8pm AEST (Week 6).
You must submit your solution files via the unit site.

The quiz will be undertaken through the unit site (Quiz tool).
The quiz will be available for student response in Week 7 and is due for submission no later than 8pm (AEST) Sunday 11 May 2025 (Week 9).

Submission is via the via the unit site and all submission components must be submitted no later than Sunday 25 May 2025, 8pm AEST (Week 11).

**There is no Examination for this unit in T1 2025**

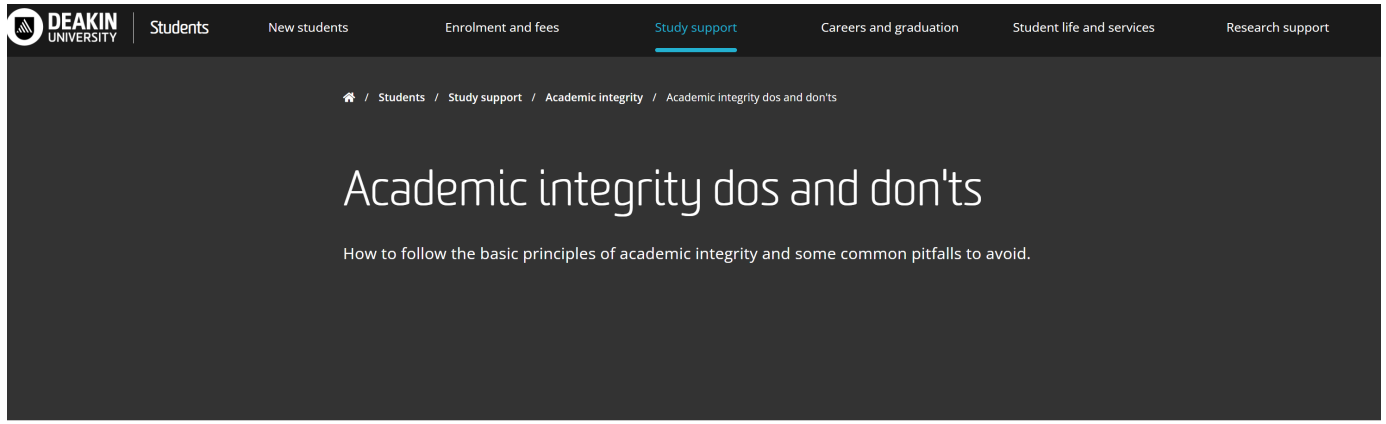
**For tasksheets, marking rubric, etc, please refer to Unit Site > Assessment Resources**

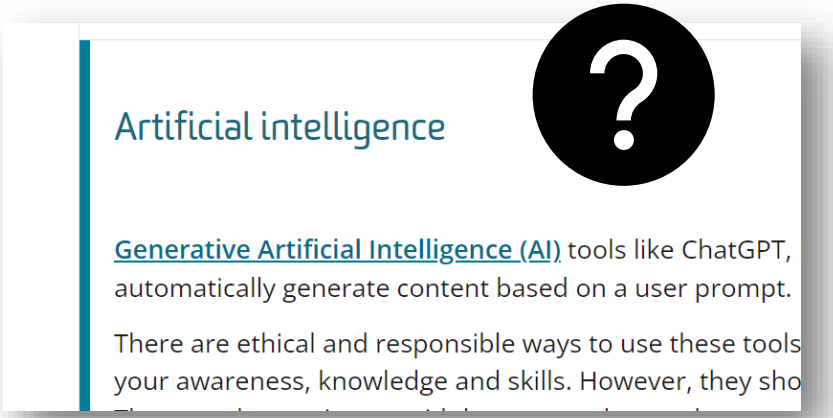
# Academic Integrity Notice

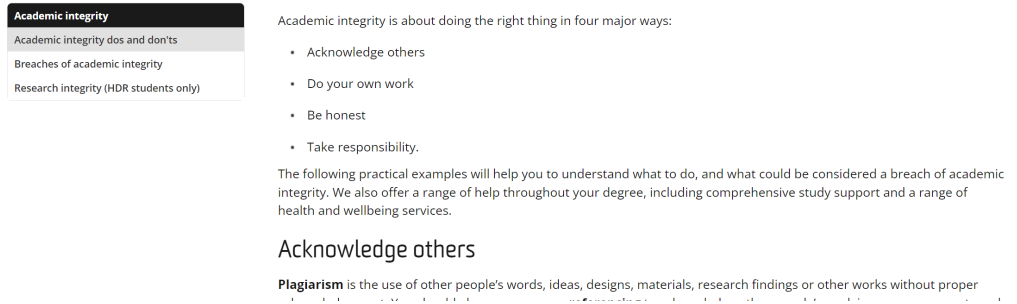
Plagiarism is the "wrongful appropriation" and "stealing and publication" of another author's "language, thoughts, ideas, or expressions" and the representation of them as one's own original work. (source: Wikipedia)

It is a serious academic offence and you might be expelled from the University!

https://www.deakin.edu.au/students/study-support/academic-integrity/responsibilities



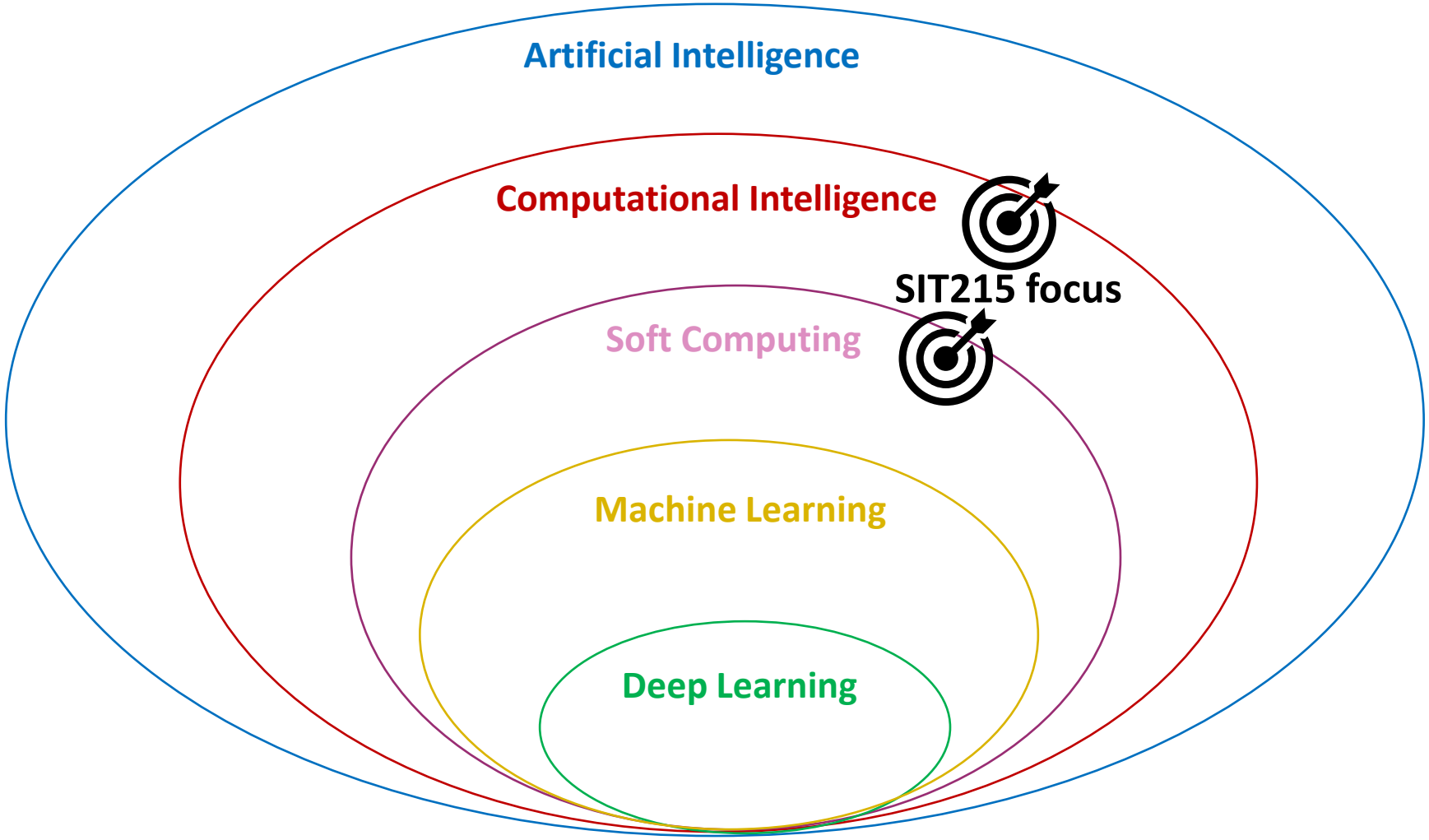



# AI and CI

# 2

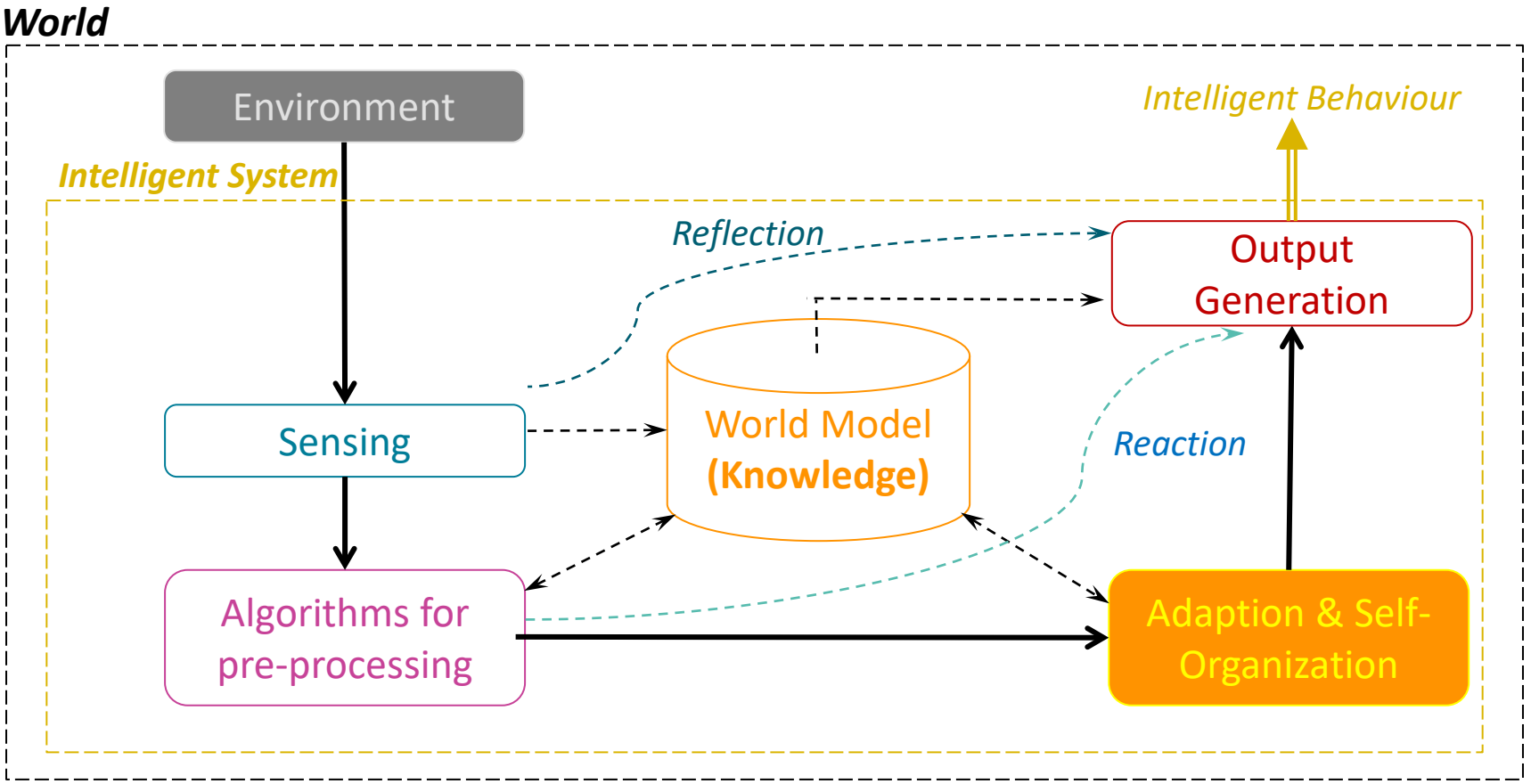
# Paradigm Relationship –

*Artificial Intelligence (AI), Computational Intelligence (CI)…Machine Learning (ML)*



# What forms a basic (AI) intelligent system?

AI-system comprises the following components:



# What is Computational Intelligence?

- A field of computer science studies focusing on a computers ability to learn, adapt and/or evolve a solution to a given task, usually from data or observation
- Computational Intelligence (CI) is a sub-branch of Artificial Intelligence (AI)
- CI is concentrated in the study of **adaptive mechanisms** to **enable or facilitate intelligent behaviour in complex and changing environments**. (Engelbrecht, 2007).

***CI Systems***

*Do not use knowledge in the AI sense, are frequently linked to (or inspired by) solutions from nature*

# AI vs CI

| | Artificial Intelligence (AI) | Computational Intelligence (CI) |
|---|---|---|
| ***Definition*** | AI is the study of **intelligent behaviour** performed by machines as opposed to the human intelligence | CI is the study of **adaptive mechanisms** to enable or facilitate intelligent behaviour in complex and immersive environments |
| ***Nature*** | Is Deterministic. Require exact input | Is Stochastic. Can deal with ambiguous, inexact, incomplete, and noisy data |
| | Produce precise answer (Deterministic results) | Produce approximate answers (Probabilistic results) |
| ***Aims*** | Aims at **emulating human intelligence on machines** to make them think, learn, and behave like human beings. | To understand computational paradigms that **make intelligent behaviour possible for an agent** |
| ***Applications*** | Common Applications of AI are speech/face recognition, object detection, machine vision, natural language processing, big data solutions, etc. | Common applications of CI include, diagnosis, predictive and optimization applications in different areas. |

# Start the CI journey

3

“A computer would deserve to be called intelligent if it could deceive a human into believing that it was human.”

~Alan Turing

# The foundation of AI - Philosophy

Can formal rules be used to draw valid conclusions?

How does the mind arise from a physical brain?

Where does knowledge come from?

How does knowledge lead to action?

# Intelligence formulation in different disciplines

## Probability, computable, algorithm

**Mathematics**

- What are the formal rules to draw valid conclusions?
- What can be computed?
- How do we reason with uncertain information?

## Knowledge representation

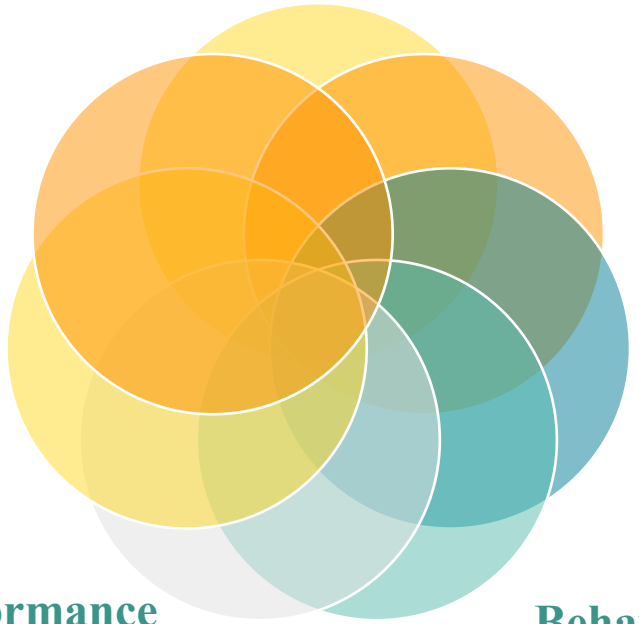
**Linguistics**

- How does language relate to thought?

## Decision theory, Markov decision processes

**Economics**

- How should we make decisions for maximising payoff?
- How should we do this when others may not go along?
- How should we do this when the payoff may be far in the future?



## Objective function

**Control theory and cybernetics**

- How can artifacts operate under their own control?

## Neurons

**Neuroscience**

- How do brains process information?

## Computational Performance

**Computer engineering**

- How can we build an efficient computer?

## Behaviourism

**Psychology**

- How do humans and animals think and act?

# We comment on AI is

Wonderful

Powerful

Exciting

- How do we measure / evaluate a successful AI (system)?

# Approaching AI

- Are you concerned with thinking or behaviour?

| Acting Humanly | Thinking Humanly |
| --- | --- |
| **Acting Rationally** | **Thinking Rationally** |

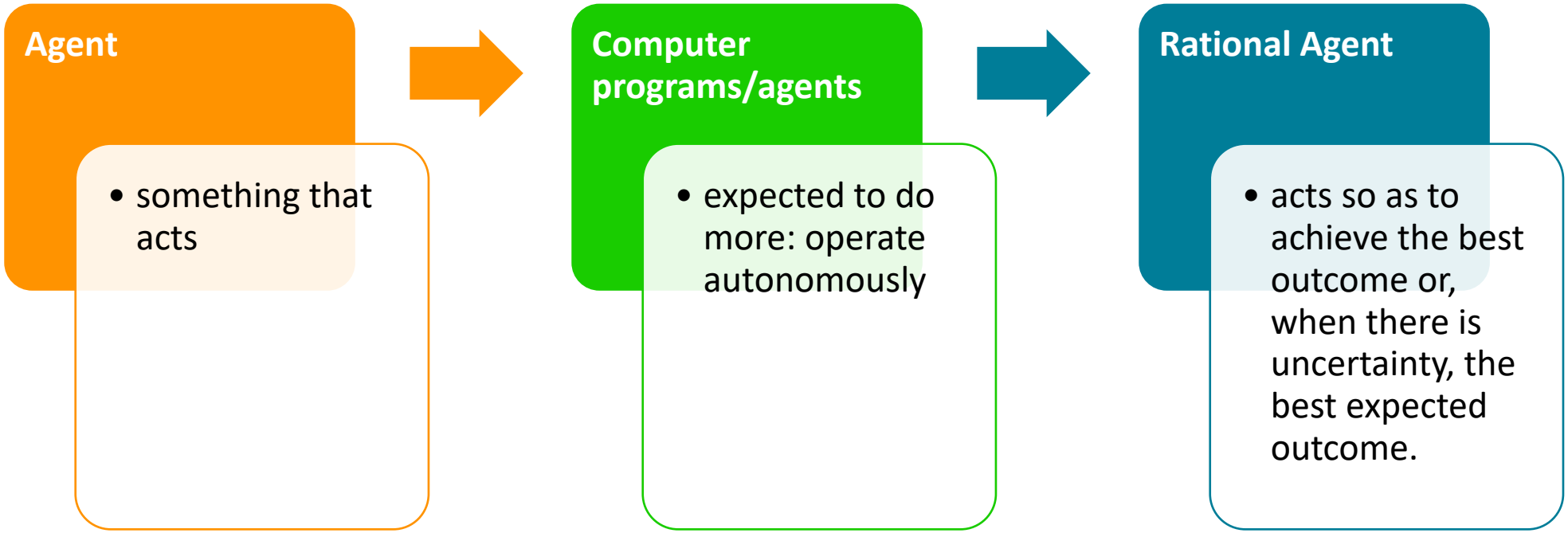
- Do you want to *model humans* or work from *an ideal standard*?

# The Role and Core Pillars of CI

- Knowledge Representation
- Reasoning
- Learning

- **Agents**
- **Environments**
- **Sensors**
- **Actuators**
- **Agent functions**

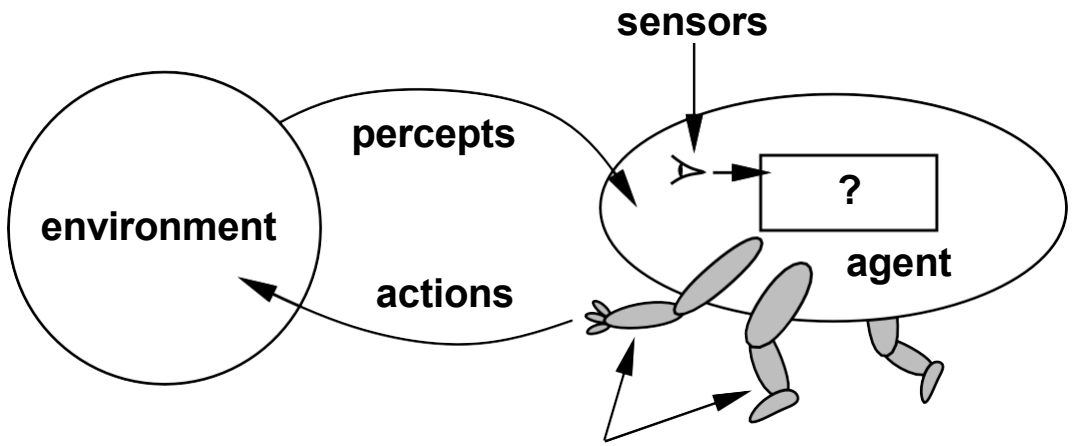
# Rationality




What is rational at any given time depends on four things:

- The **performance measure** that defines the criterion of success.
- The agent's prior **knowledge** of the environment.
- The **actions** that the agent can perform.
- The agent's **percept sequence to date**.

# Agent and Environment




Agents include humans, robots, softbots, thermostats, etc.

An agent can be anything that can be viewed as perceiving its environment

through sensors and acting upon that environment through actuators

The agent function maps from percept histories to actions:

$$f : \mathrm{P}^* \rightarrow \mathrm{A}$$

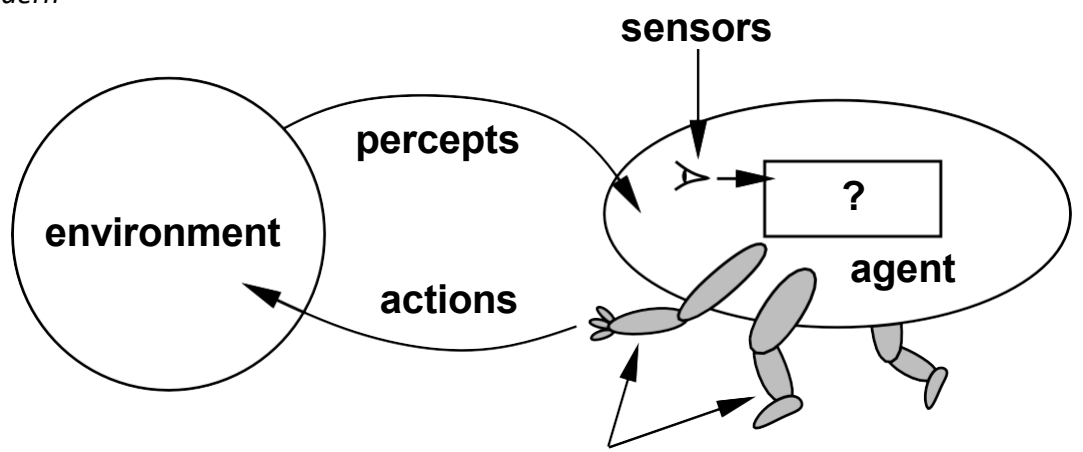
The agent program runs on the physical architecture to produce $f$

# Agent Types -

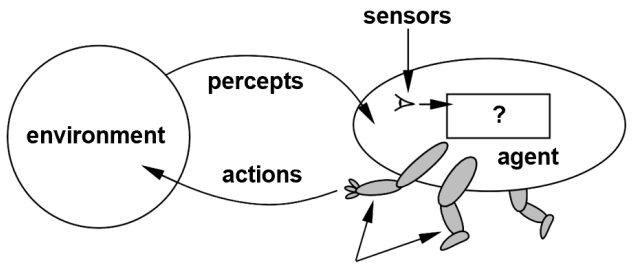
Examples from Educational Resources Pack from Russell, S. J., & Norvig, P. (2022). *Artificial Intelligence: A Modern Approach*. Pearson Education Ltd.

Four basic types

A. Simple reflex agents
B. Reflex agents with state
C. Goal-based agents
D. Utility-based agents

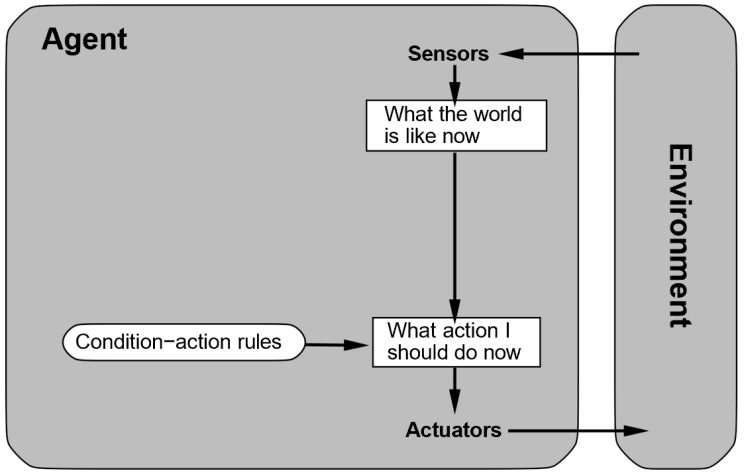


# Agent Types - Four basic types

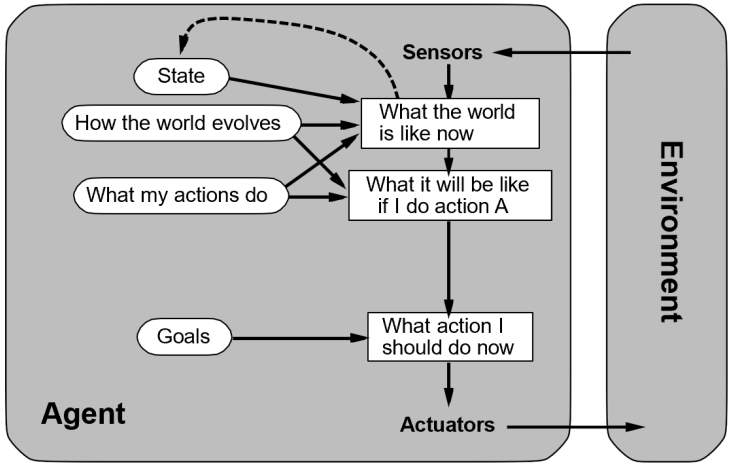



Examples from Educational Resources Pack from Russell, S. J., & Norvig, P. (2022). *Artificial Intelligence: A Modern Approach*. Pearson Education Ltd.

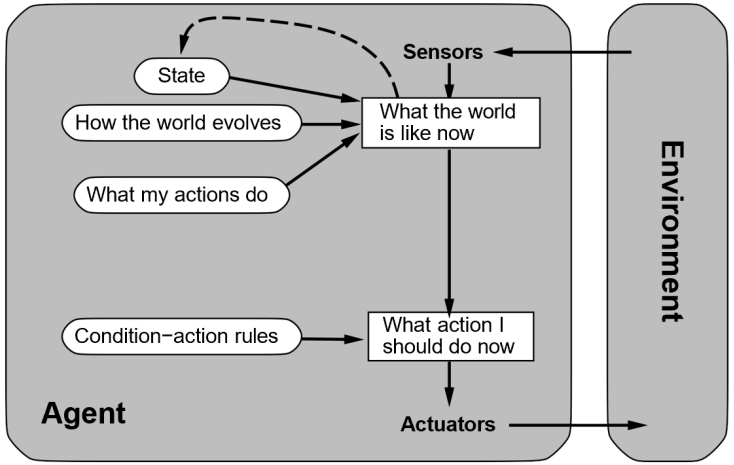
## A. Simple reflex agents



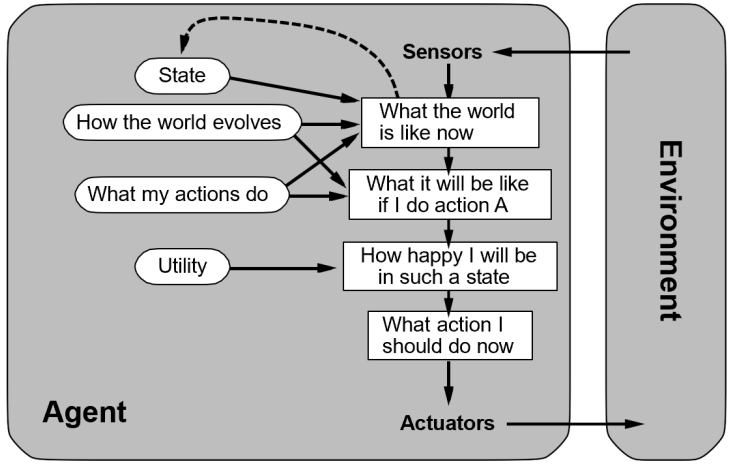

## C. Goal-based agents




## B. Reflex agents with state




## D. Utility-based agents



# Intelligent Agents and Systems

Basic kinds of agent programs that embody the principles underlying almost all intelligent systems:

- **Simple reflex agents – condition–action rule**
- **Model-based** reflex agents – internal state from percept history and reflects "how the world works" for the current state – including **ALL possible states**
- **Goal-based agents – Goal, Search, Planning**
- Utility-based agents **–** Binary distinction between "happy" and "unhappy" states, internalization of the performance measure.

# Generality

Examples from Educational Resources Pack from Russell, S. J., & Norvig, P. (2022). *Artificial Intelligence: A Modern Approach*. Pearson Education Ltd.

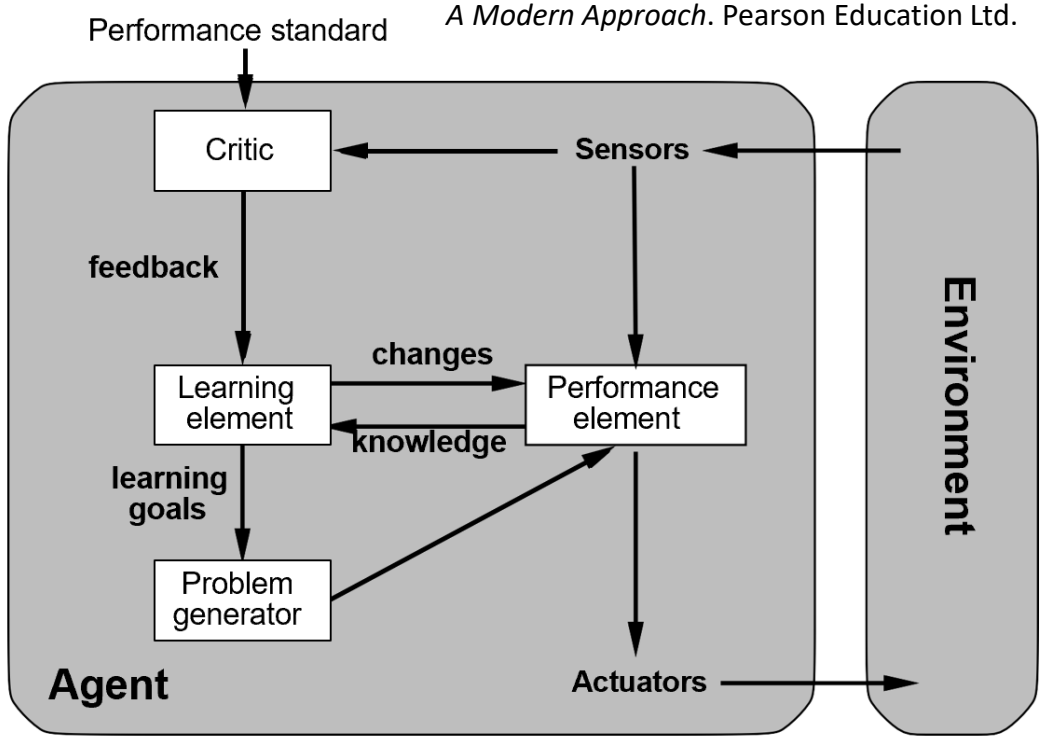
The four basic types **in order of increasing generality**:

A. Simple reflex agents
B. Reflex agents with state
C. Goal-based agents
D. Utility-based agents (Most general)

# General Computational Architecture

- Scalable design
  - Class – ***Environment*** and Methods
  - Class – ***Agent*** and Methods
  - Problem Formation
  - Performance Evaluation
  - Learning Ability can be added
  - *etc…*

Examples from Educational Resources Pack from Russell, S. J., & Norvig, P. (2022). *Artificial Intelligence: A Modern Approach*. Pearson Education Ltd.



# Problem-based Discussions

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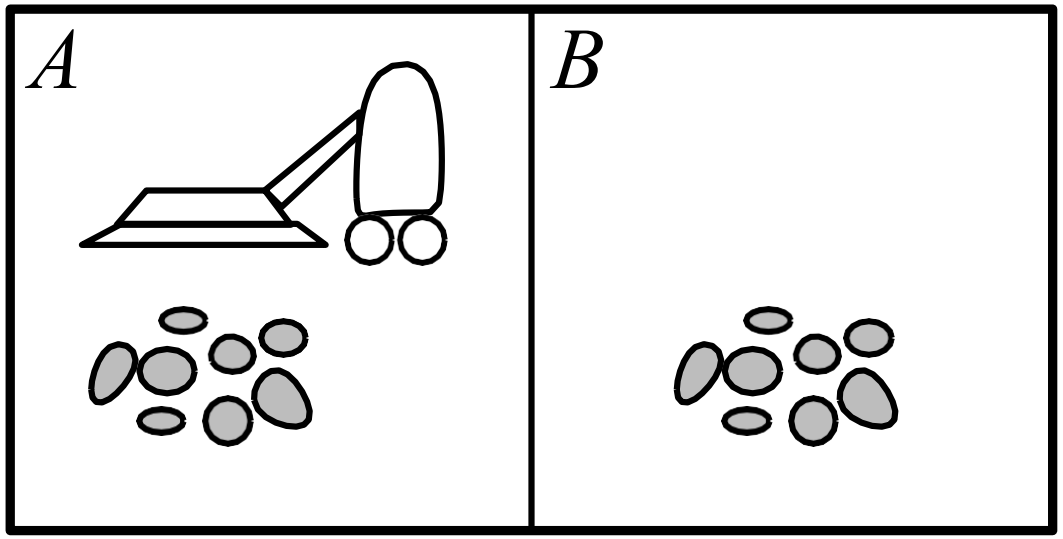
# Problem: Vacuum-cleaner world

Examples from Educational Resources Pack from Russell, S. J., & Norvig, P. (2022). *Artificial Intelligence: A Modern Approach*. Pearson Education Ltd.

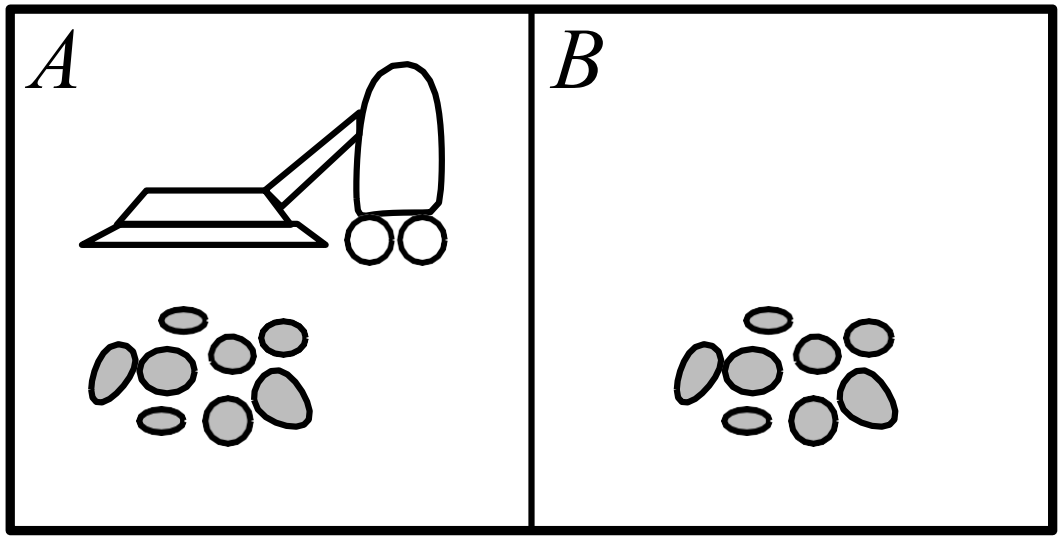



**Percepts**: location and contents, e.g., [$A$, $Dirty$]

**Actions**: $Left$, $Right$, $Suck$, $NoOp$

# Agent and Environment - Vacuum-cleaner agent

Examples from Educational Resources Pack from Russell, S. J., & Norvig, P. (2022). *Artificial Intelligence: A Modern Approach*. Pearson Education Ltd.




Percepts: location and contents, e.g., [$A$, $Dirty$]

Actions: $Left$, $Right$, $Suck$, $NoOp$

# Agent Programs

**AI-Computation-focused:** is to design an **agent program** that implements the **agent function** —the mapping from *percepts* to *actions*.

Assume this **program** will run on some sort of computing device with physical *sensors* and *actuators*—we call this the **architecture**

***agent = architecture + program .***

# Agent, Environment, and Function

| Percept sequence | Action |
|---|---|
| [*A*, *Clean*] | *Right* |
| [*A*, *Dirty*] | *Suck* |
| [*B*, *Clean*] | *Left* |
| [*B*, *Dirty*] | *Suck* |
| [*A*, *Clean*], [*A*, *Clean*] | *Right* |
| [*A*, *Clean*], [*A*, *Dirty*] | *Suck* |
| . | . |

```
function Reflex-Vacuum-Agent( [location,status]) returns an action
    if status = Dirty then return Suck
    else if location = A then return Right
    else if location = B then return Left
```

# Summary of Key Takeaways

- Agents can interact with environments
- The agent function enables an agent to perform “proper” actions in all circumstances
- A perfectly rational agent maximises expected performance Agent programs implement (some) agent functions