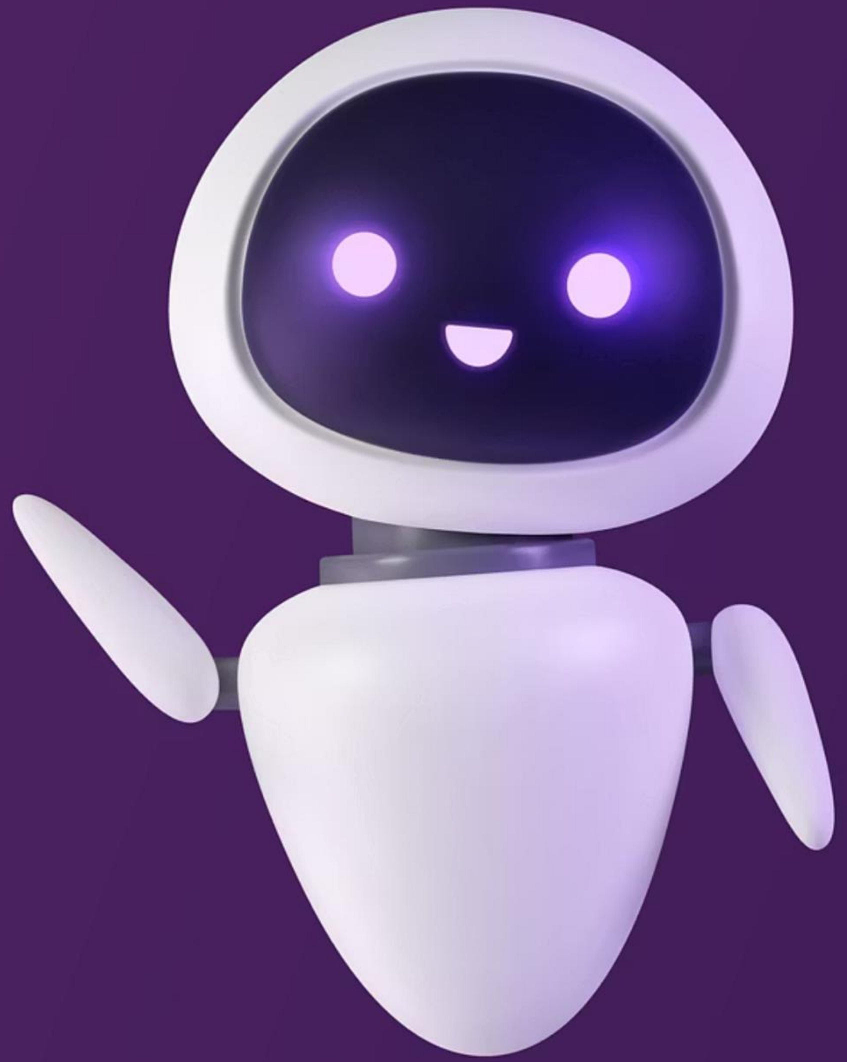


Agents

This presentation explores the fundamental concepts of agent, environment, perceptions, and actions within the context of artificial intelligence.

P **by Penousal Machado**

Artificial Intelligence

What is AI?

Artificial intelligence (AI) is the ability of a computer or machine to machine to perform tasks typically requiring human intelligence, intelligence, such as learning, problem-solving, and decision-making. decision-making.

Key Areas of AI

AI encompasses various subfields, including machine learning, deep learning, deep learning, natural language processing, and computer computer vision.

What is an Agent?

An agent is an entity that can perceive its environment, act upon it, and learn from its experiences. It's a software or hardware system designed to behave autonomously.

General vs. Narrow AI

General AI

Artificial General Intelligence (AGI) refers to a theoretical form of form of artificial intelligence that possesses the ability to understand, learn, and apply knowledge across a wide range of range of tasks, matching or surpassing human cognitive capabilities. capabilities.

There is no proof that Human Intelligence is General Intelligence

Narrow AI

Narrow AI focuses on developing systems that excel in a particular domain or task, like image recognition, natural language processing, or playing a specific game.

Key Characteristics of AGI:

Generalization

The ability to apply knowledge learned in learned in one context to different, unrelated situations

Autonomy

The capacity to operate independently, set goals, and make decisions without human intervention.

Self-improvement

The capability to learn from experiences experiences and enhance performance over performance over time.

Current Status and Challenges:

Complexity of Cognition

“In from three to eight years we will have a machine with the general intelligence of an average human being.”
Marvin Minsky, 1970

Ethical and Safety Concerns

Ensuring that AGI systems act in alignment with human values and do not pose unintended risks.

Technical Limitations

Current computational models and hardware may not yet support the development of AGI (e.g. Energy)

Strong vs Weak AI

Strong AI

AI that is not just capable of general intelligence but may also possess **consciousness, self-awareness, and sentience**.

Environment's Characteristics

Static vs. Dynamic

Deterministic vs. non-deterministic

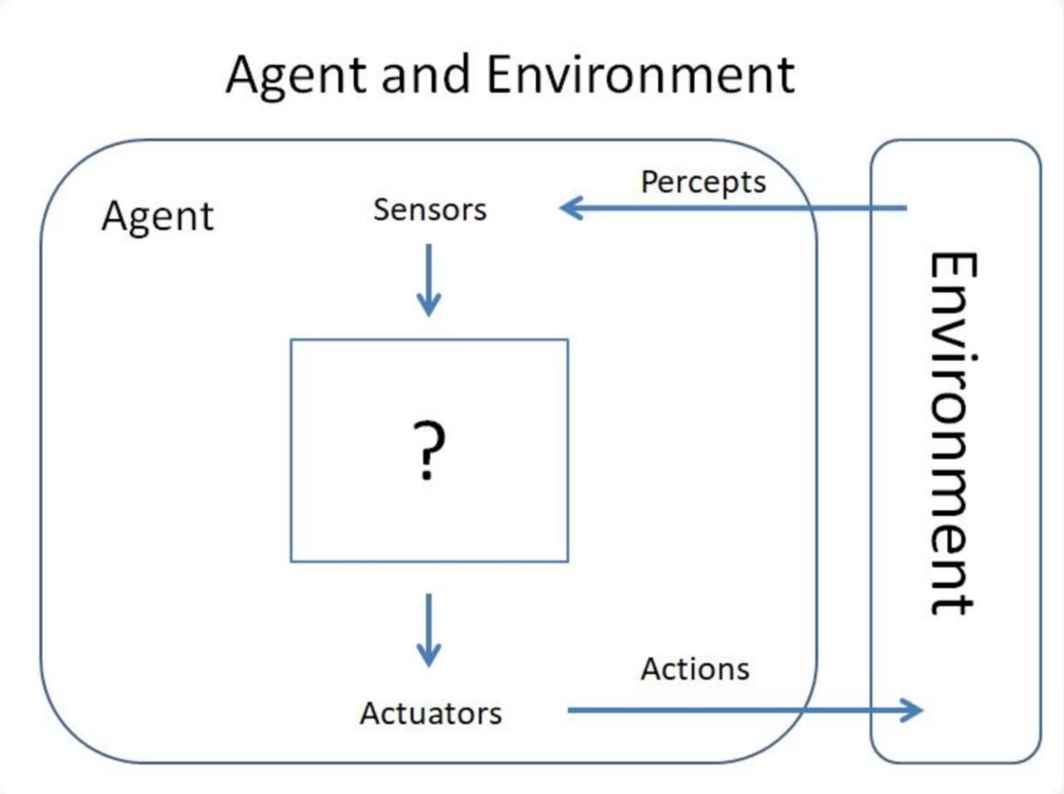
Accessible vs Inaccessible

Os Ambientes

Estáticos vs. Dinâmicos

Deterministas vs. Não Deterministas

Acessíveis vs. Inacessíveis



The Agent-Environment Interaction

1 **Perception**

Agents gather information about their environment through sensors.

2 **Internal Representation**

There is a diference between the sensorial stimuli and the perception of that stimuli.

3 **Controler**

The "brain" of the agent

4 **External Representation**

From brain to actuators

5 **Action**

Agents act on their environment using actuators, influencing its state.

A brain is not enough!

Two-Way Connection

The brain doesn't just control the body - our physical experiences actively shape how our brain thinks and learns. learns.

Embodied Cognition

Our understanding of concepts is grounded in physical physical experiences - we think about "grasping" an idea idea because we physically grasp objects.

Sensorimotor Loop

Every action creates new sensory feedback, forming a continuous loop where physical movements influence perception and learning.

Developmental Impact

Physical interaction with the environment is crucial for both both biological and artificial intelligence to develop sophisticated understanding.

Agents and Their Environments

Static vs. Dynamic

A static environment remains unchanged unchanged over time, while a dynamic dynamic environment is constantly evolving.

Deterministic vs. Non-Deterministic

In a deterministic environment, the outcome of an action is predictable, while while in a non-deterministic environment, environment, there's an element of randomness or uncertainty.

Accessible vs. Inaccessible

An accessible environment allows an agent agent to fully perceive its state, while an an inaccessible environment has

Real-World Environments

Agents interact with physical environments, like robots navigating navigating factories or self-driving cars on roads.

Virtual Environments

Agents can also exist in virtual environments, like game characters in video games or chatbots in online platforms.

Defining the Agent's Perceptions

Perception refers to the agent's ability to gather information about its environment. It involves the agent's senses and how it interprets the sensory data.

Agents perceive their environments through various sensors, which capture data capture data about the surroundings, such as light, sound, and physical contact. contact.

Sensors and Perception

1

Sensory Input

Sensors gather raw data from the environment.

2

Signal Processing

Raw data is preprocessed and filtered to remove noise.

3

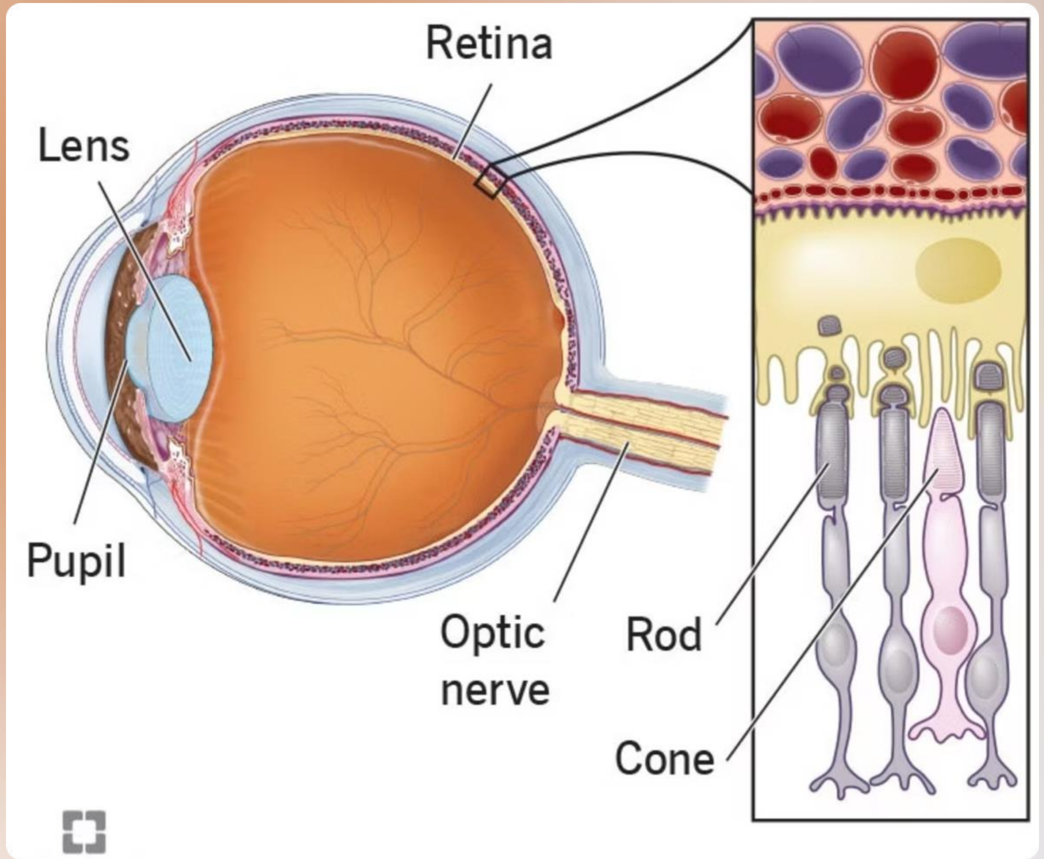
Feature Extraction

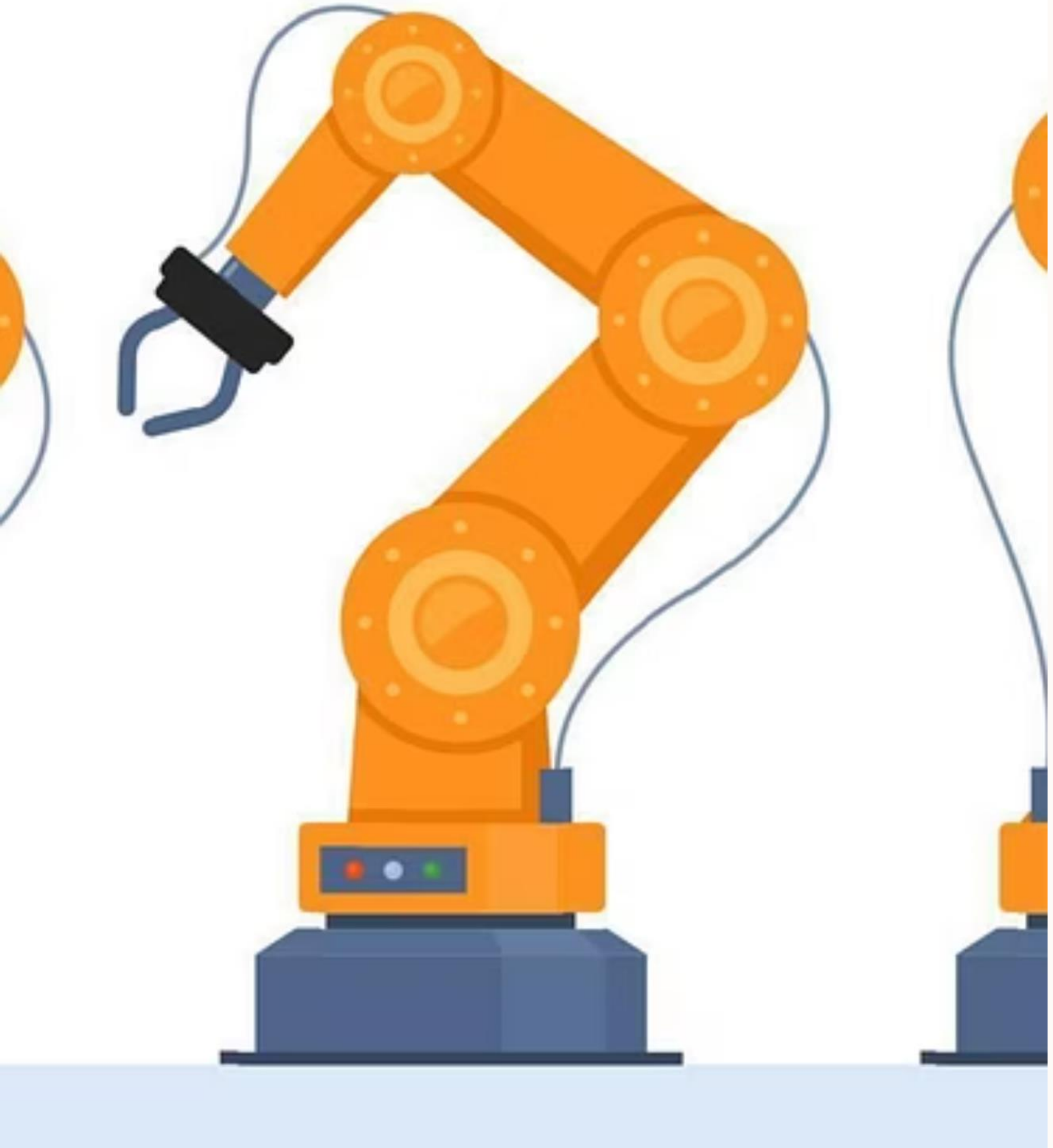
Meaningful features are extracted or created from the processed processed data.

4

Interpretation

The extracted features are interpreted to form a perception of the of the environment.





Executing Actions in the Environment

Actions are executed through actuators, which are the agent's physical components that interact with the environment, carrying out tasks based on the agent's decisions.

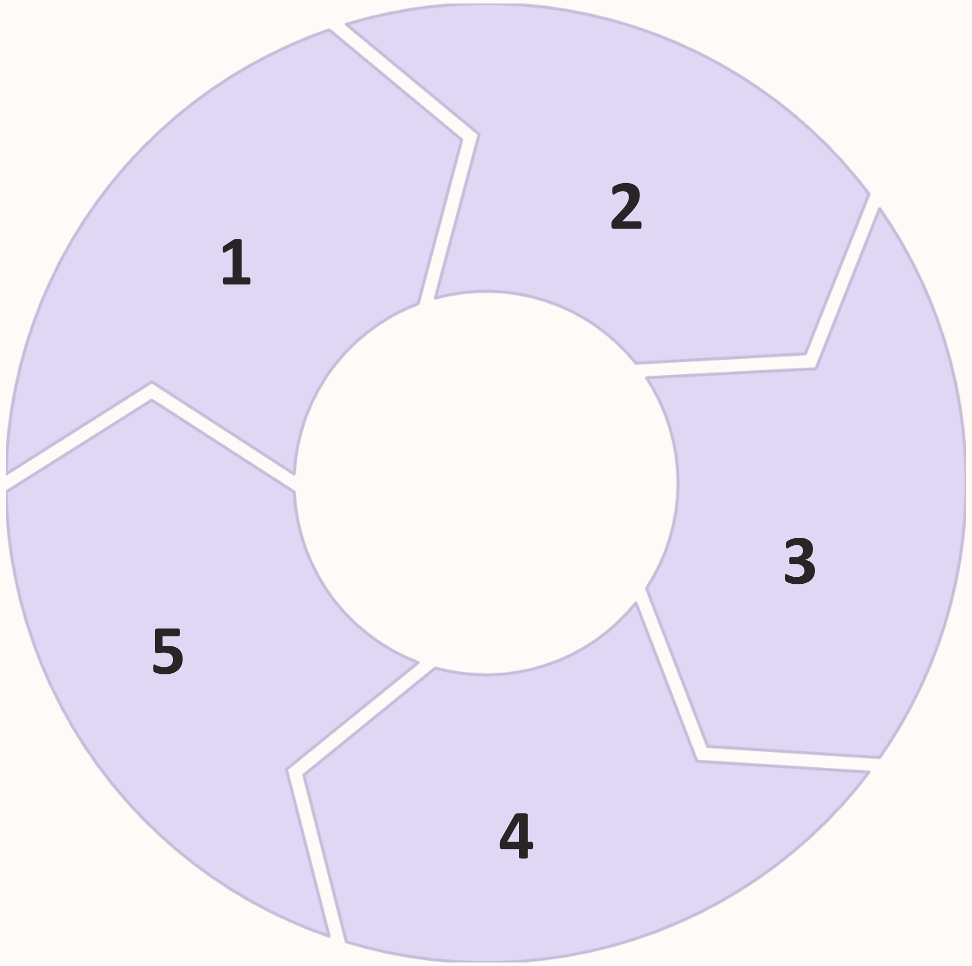
The Feedback Loop: Perception and Action

Perception

The agent perceives the environment.

Perception

The agent perceives the new state of the the environment.



Decision

The agent makes a decision.

Action

The agent takes action.

Environment

The environment changes based on the the action.

What about "Agentic AI"?

It is just a buzz word. Agents have been around for decades.

Evaluating Agent Performance

Task Completion
Completion

How effectively the agent completes its assigned tasks.

Efficiency

How efficiently the agent uses resources and time.

Robustness

How well the agent handles unexpected events or errors.

Designing Agents: The PEAS Framework

Performance

What is the performance measure?

Environment

Modelling the environment, environment, the world the the agent operates in.

Actuators

Define the actuators, i.e. the the agent's tools for taking taking actions in the environment.

Sensors

Define the sensors, i.e. agent's ability to perceive perceive the environment. environment.

Designing Agents: A Gradual Approach

Reactive Agents

Start with basic agents that that react to their environment.

Search Agents

Agents that search for solutions before acting.

Learning and Adaptive Agents

Agents that can learn and and adapt based on experience.

Agent Societies

Sophisticated agents with with advanced capabilities. capabilities.

Our Approach

Study and construction of artificial entities [**agents**] situated in an **environment**, with which they **interact** autonomously, seeking to achieve [internal, external] **objectives** with maximum **performance**.

The Three Methaphors

Metaphors for AI

Symbolic AI

This approach uses symbols and rules to represent knowledge and reason about the world.

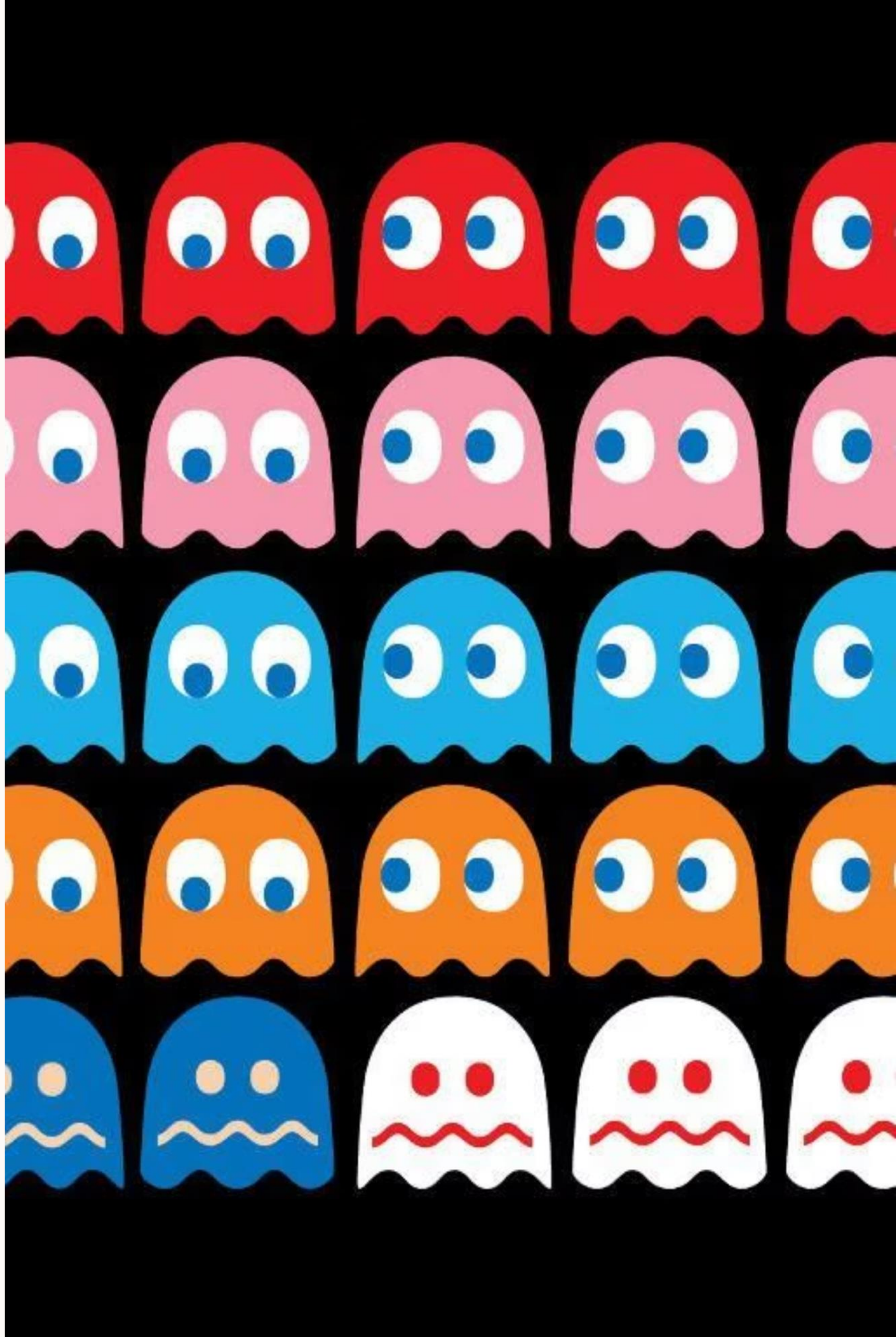
Connectionist AI

Neural networks. Inspired in biological brains

Nature inspired AI

Inspired in nature it mimics the complex workings of biological systems or other natural phenomena

Reactive Agents

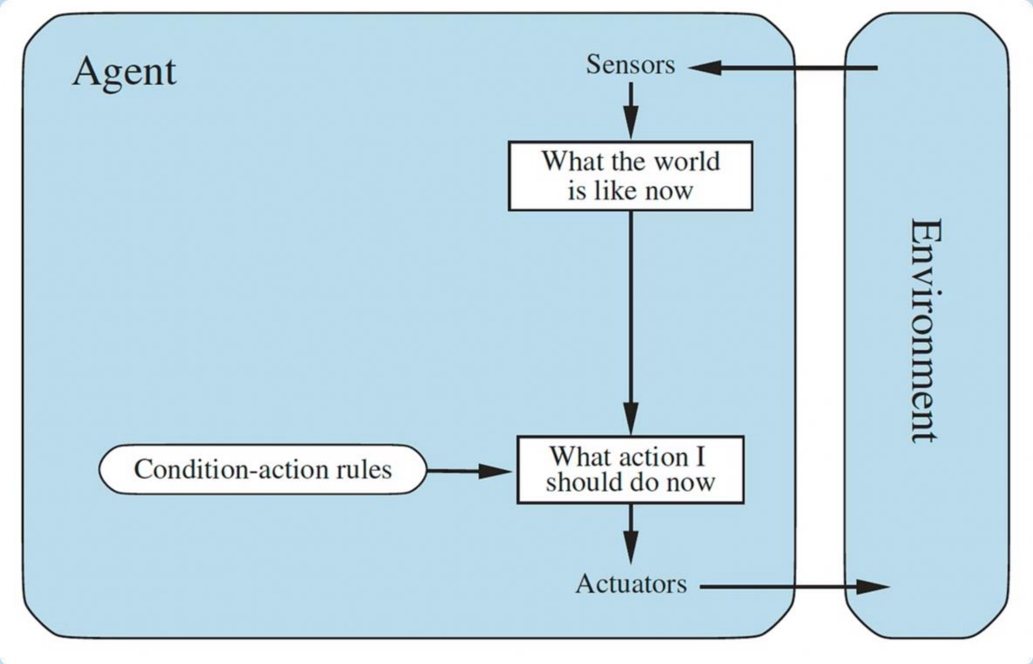


Reactive Agents

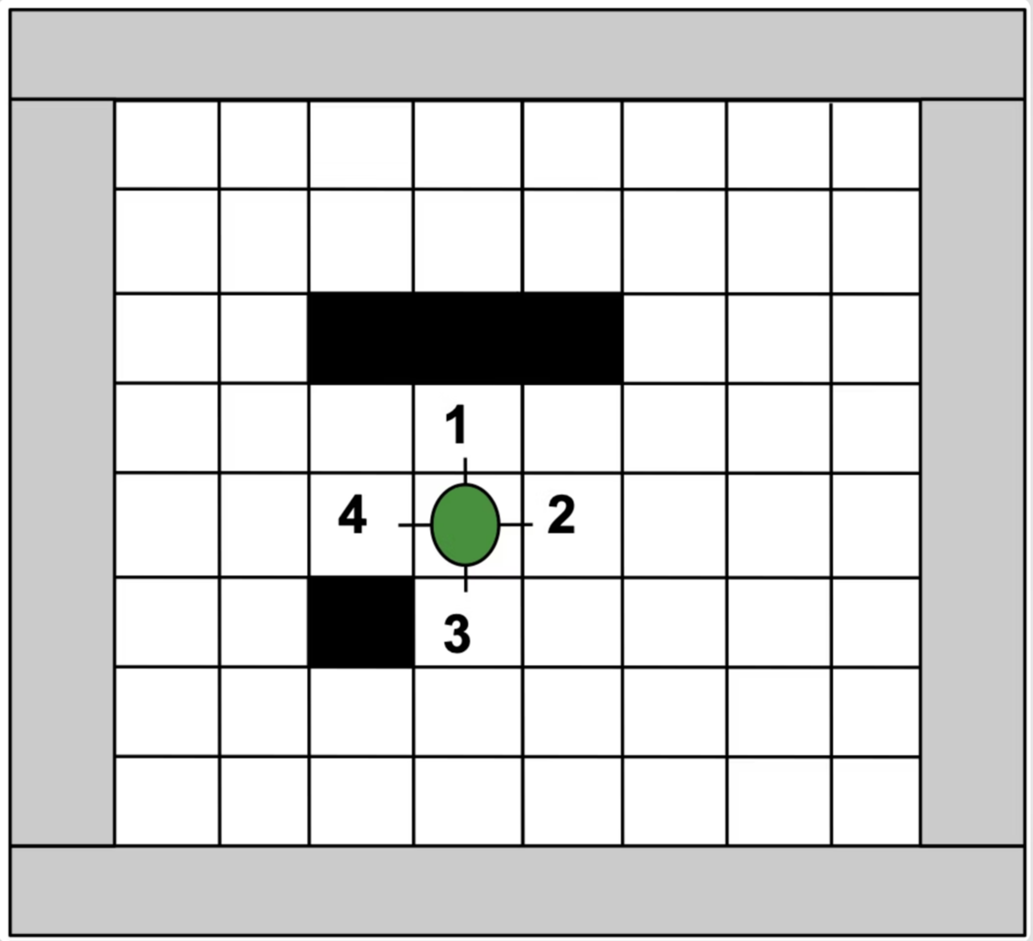
1. Make a direct mapping between perceptions and actions

2. Have a local view of of the environment

3. May have memory (typically small)

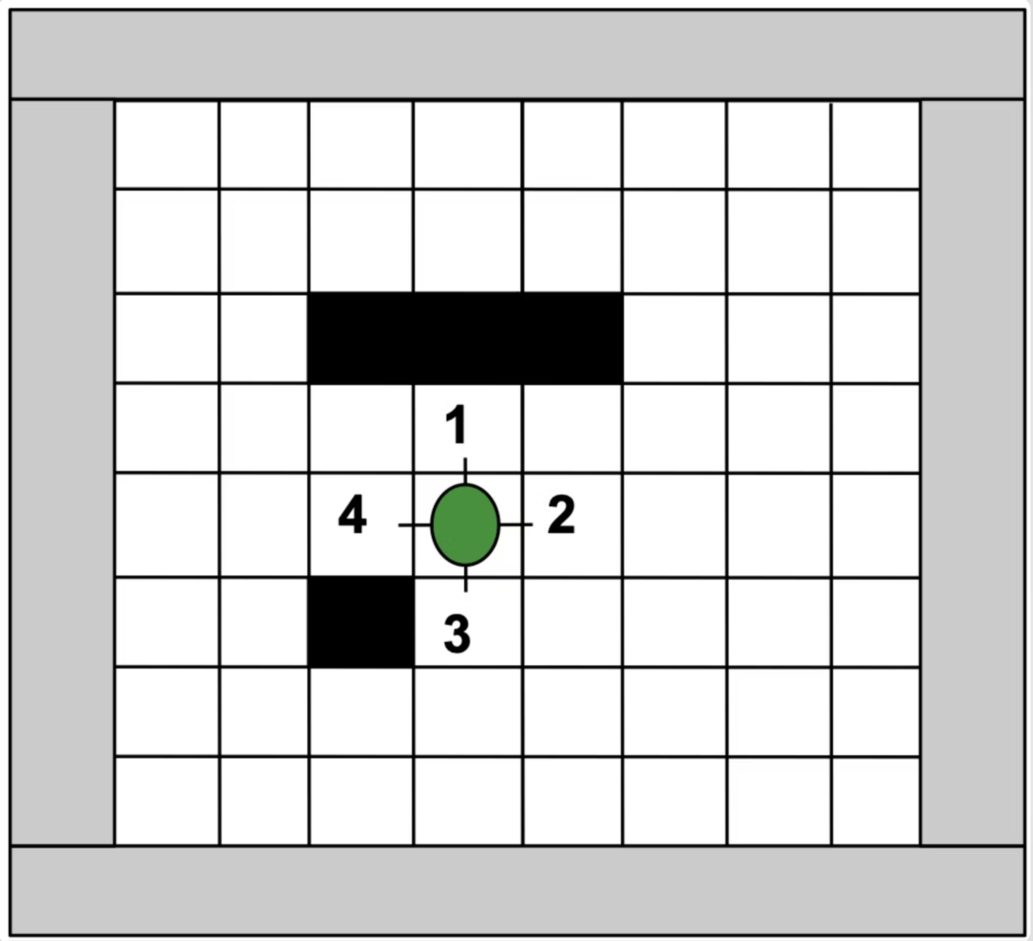


Designing Agents



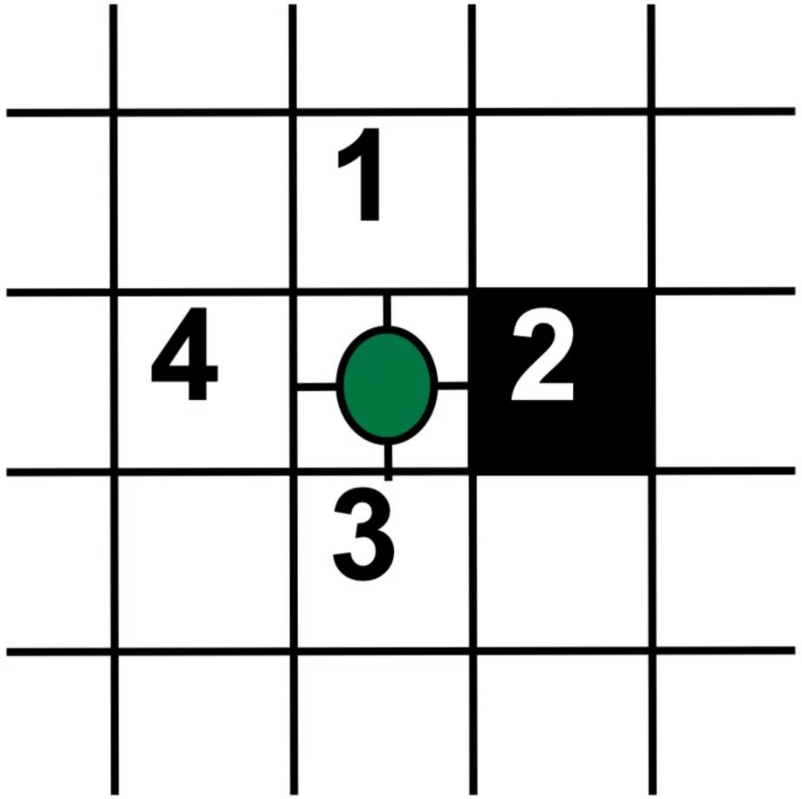
Describe the world

- 2D
- Discrete
- Closed
- Objects
- Agents



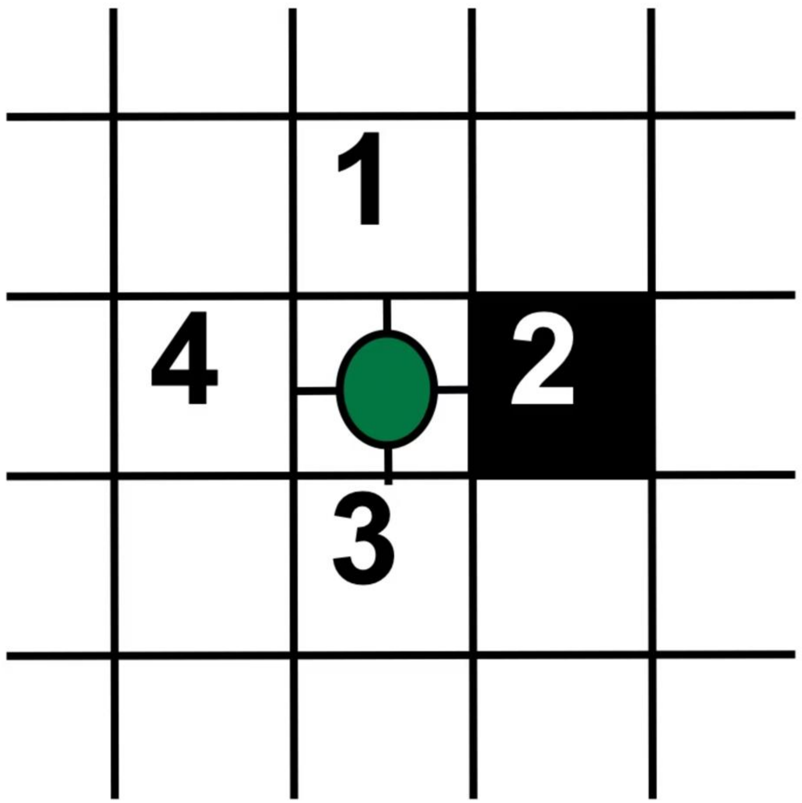
Describe the Agents

- Sensors
- Neighbourhood
- Actuators
- Memory
- Brain



Actions

- Move
  - North
  - South
  - East
  - Weast



Memory

- None

Brain

Symbolic AI

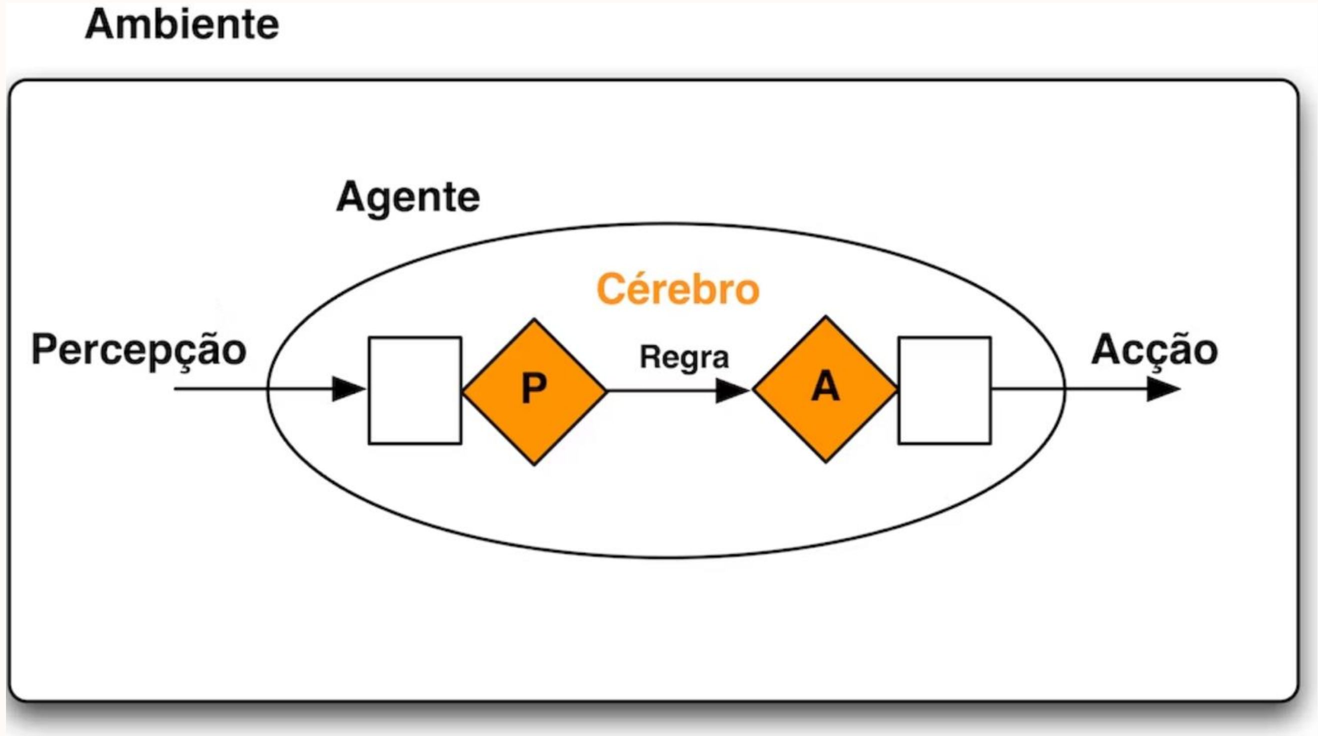
Production System.

Connectionist AI

Linear threshold units

Nature inspired AI

Subordination architecture



Symbolic approach

- Rules map perceptions in actions
- May or not have memory

Production system

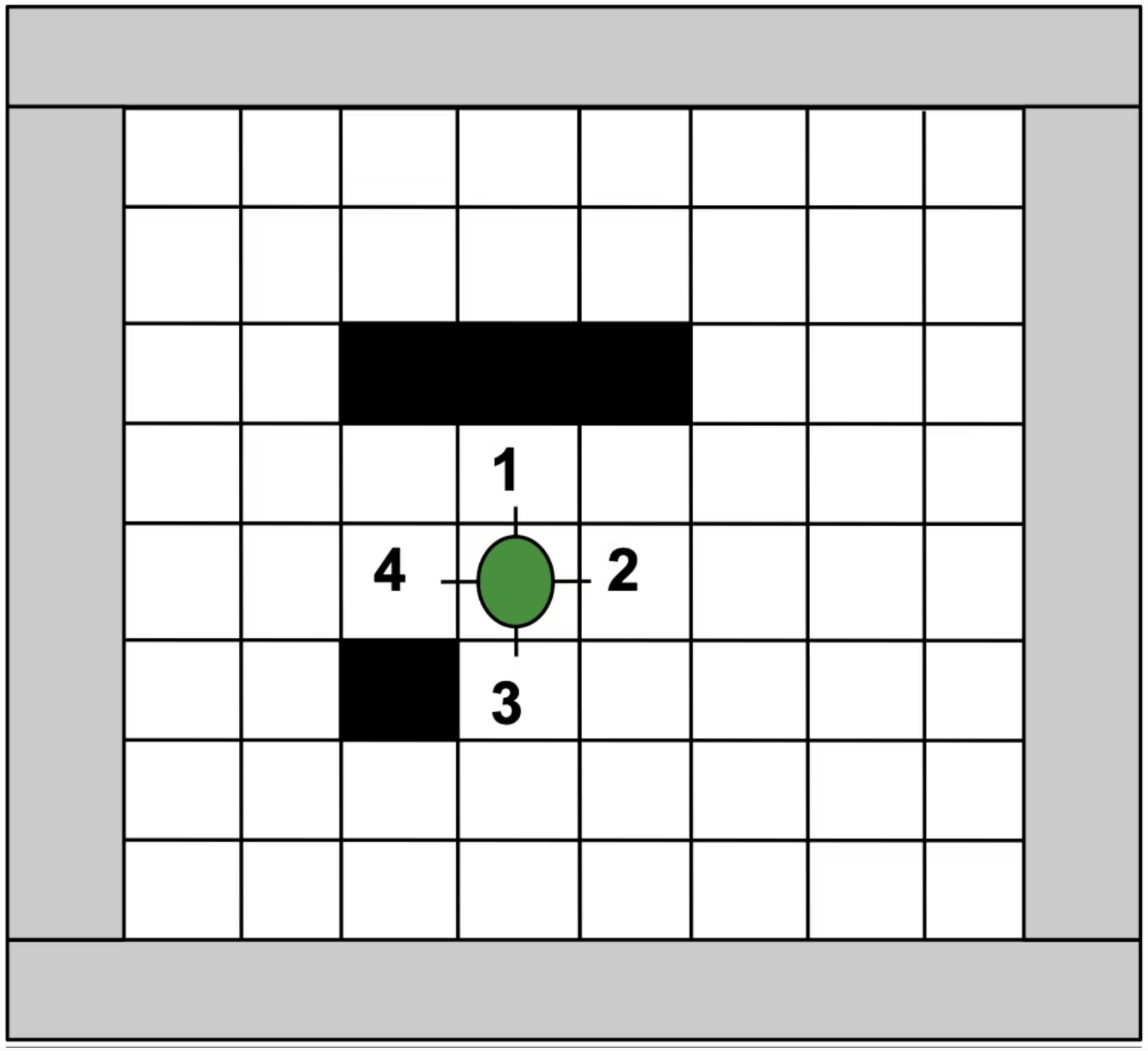
¬O1 → N

¬O2 → E

¬O3 → S

¬O4 → O

What is the emergent behaviour?



Trying to avoid loops

Let's try to avoid loops by changing the environment

¬O1, ¬P1 → N, Paint

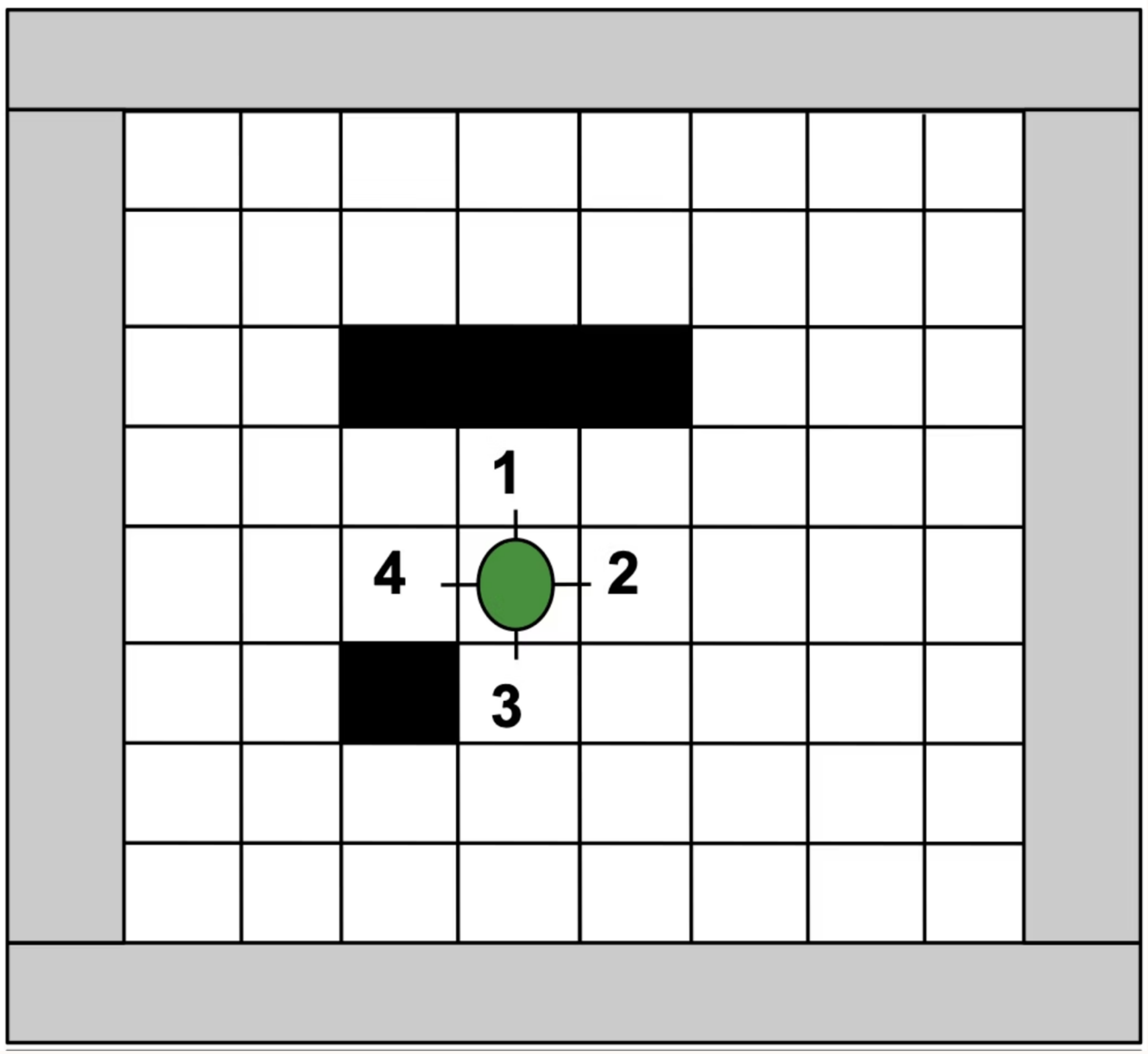
¬O2, ¬P2 → E, Paint

¬O3 , ¬P3 → S, Paint

¬O4, ¬P4 → O, Paint

T → NIL

What is the emergent behaviour?



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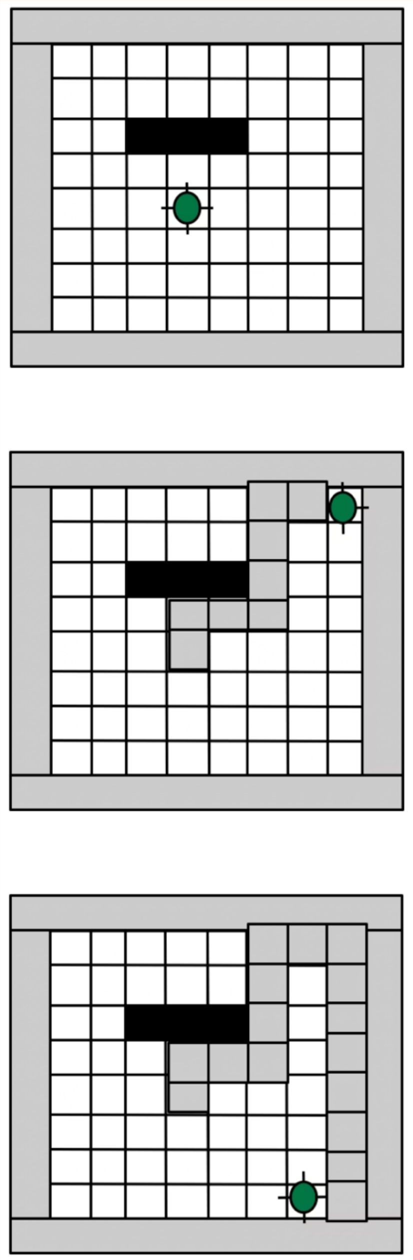
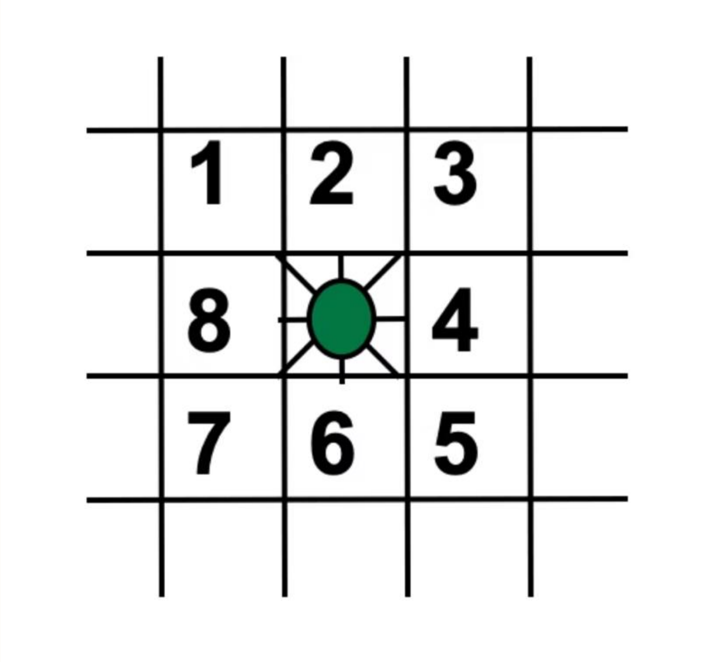
What is the emergent behaviour?

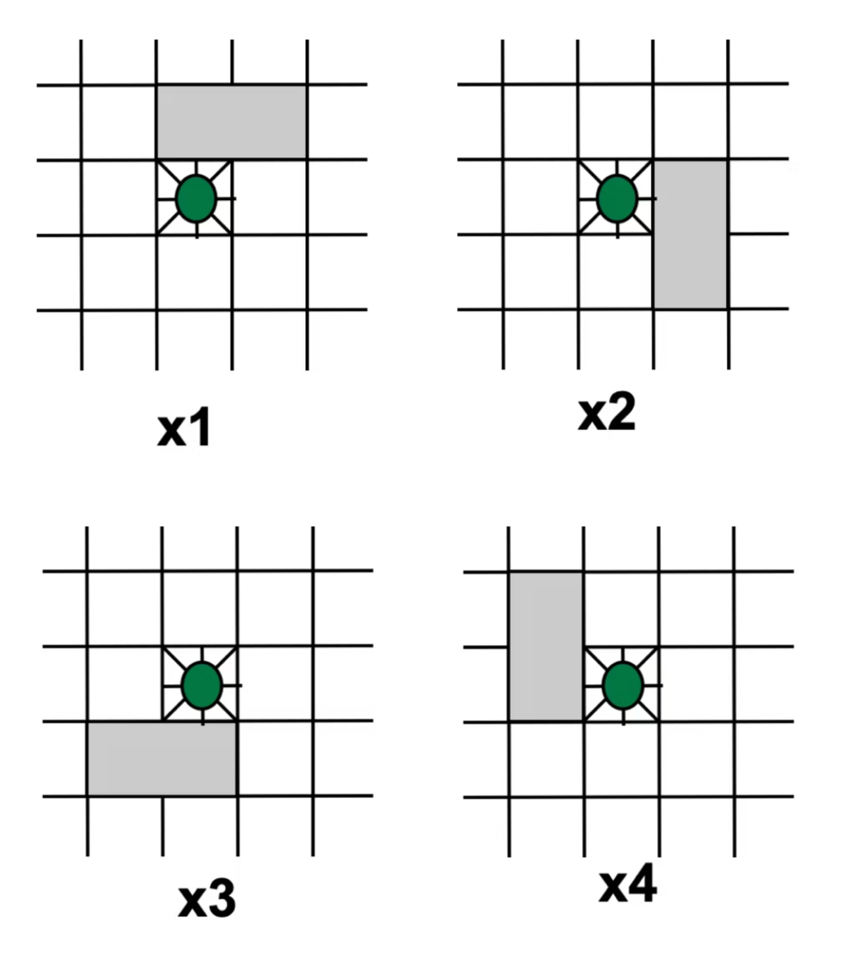


Different Skills

Sensors



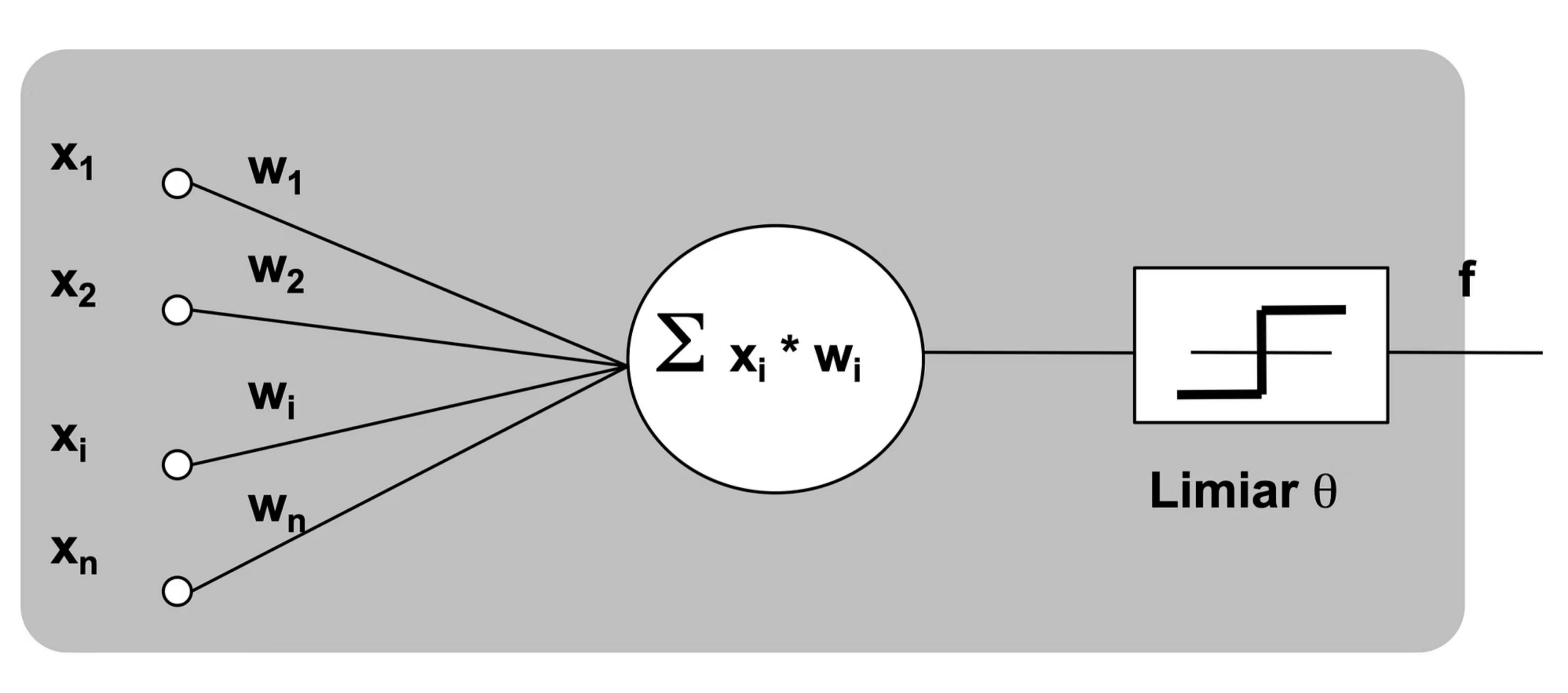
Perceptions



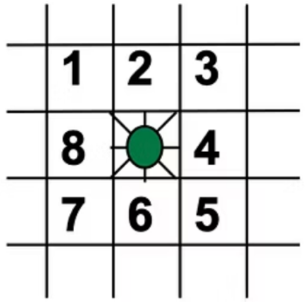
Production system system

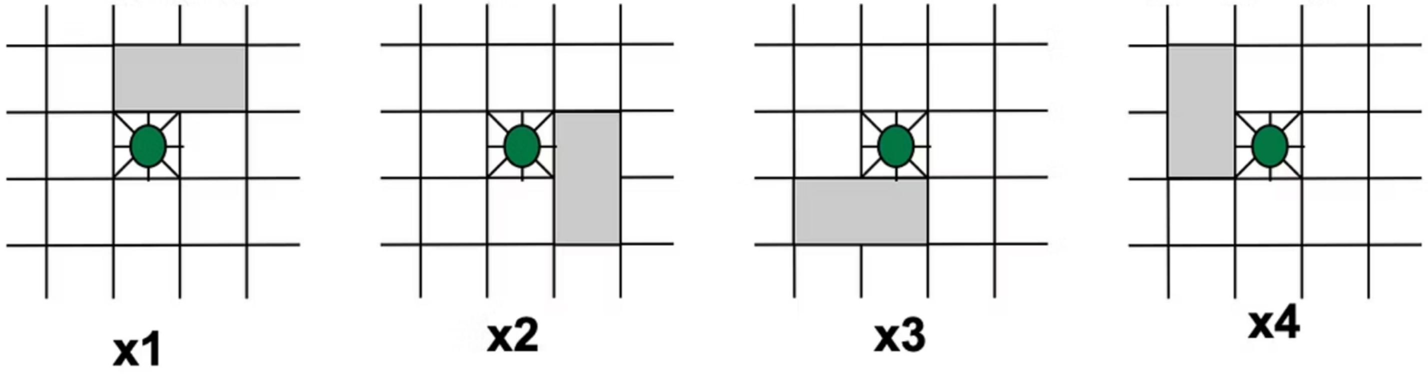
$$
\begin{array}{lcl}
x_4 \neg x_1 & \rightarrow & norte \\
x_3 \neg x_4 & \rightarrow & oeste \\
x_2 \neg x_3 & \rightarrow & sul \\
x_1 \neg x_2 & \rightarrow & este
\end{array}
$$

Implementation with Linear Threshold Units

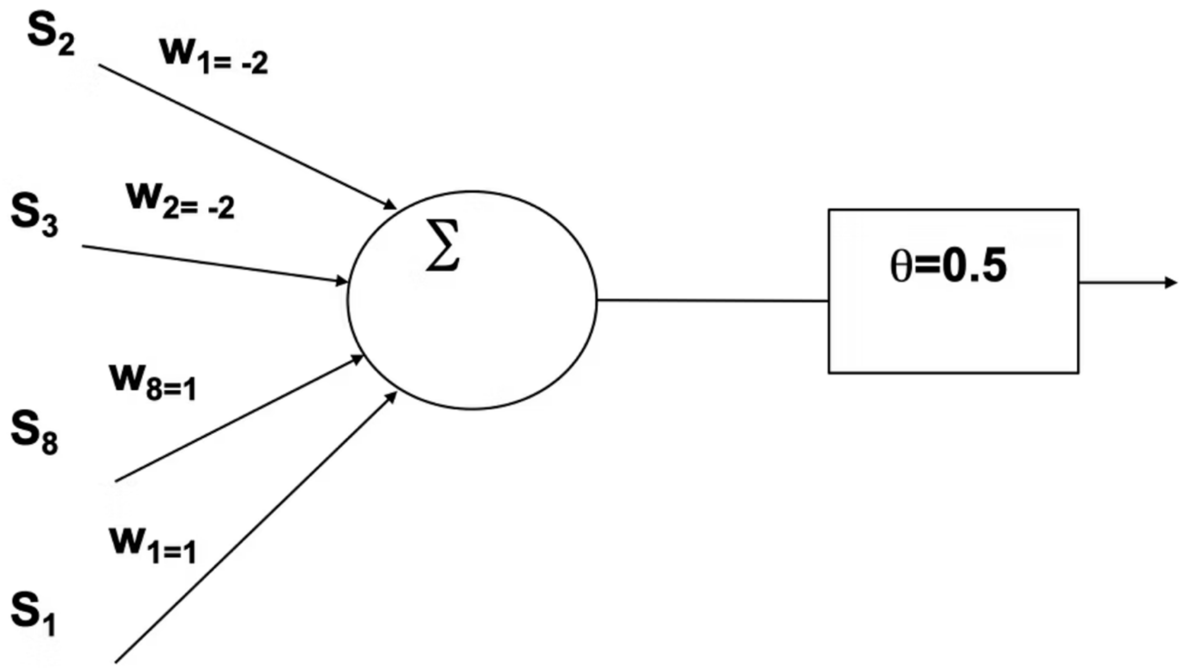


Implementation with Linear Threshold Units

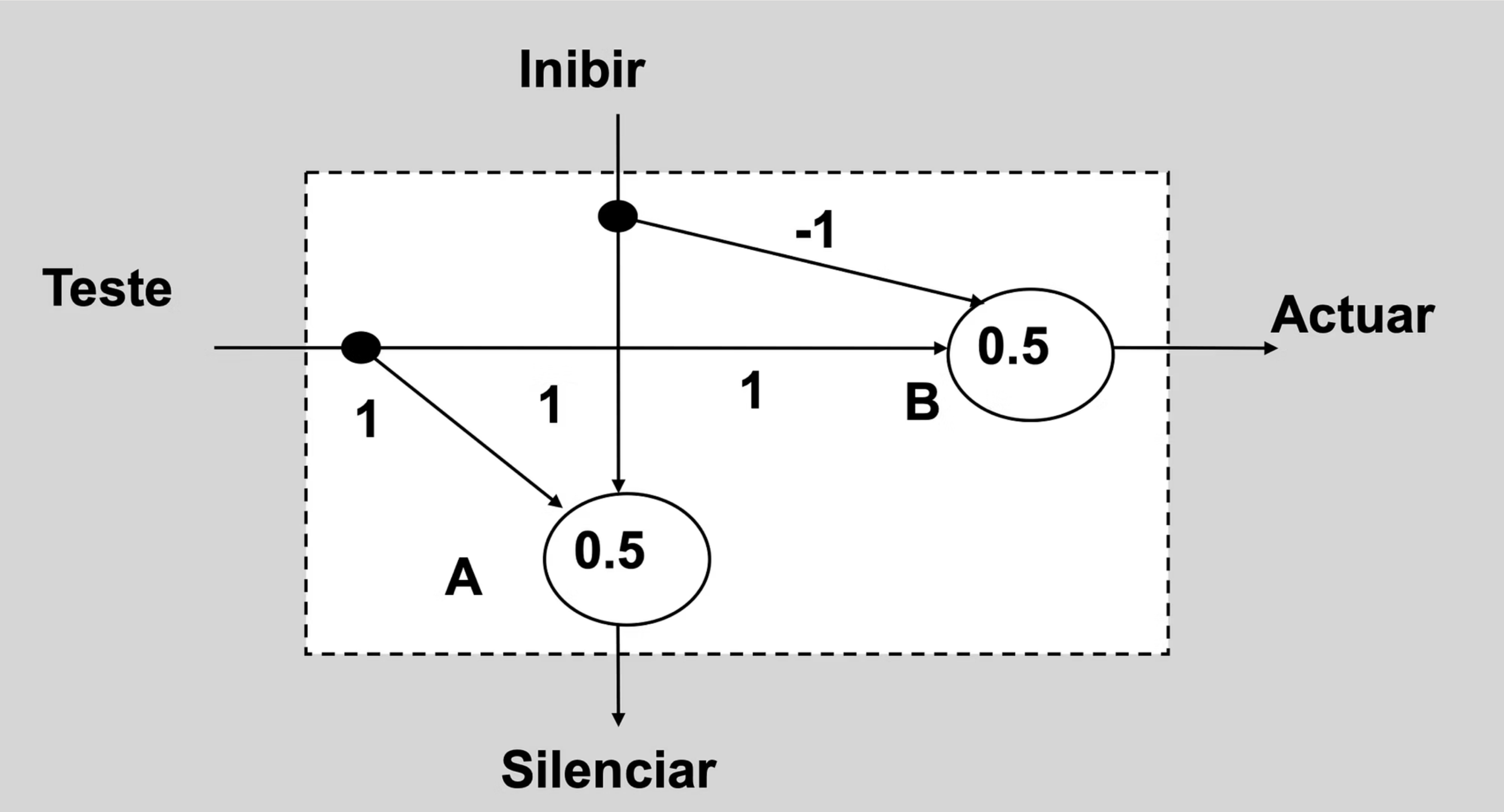




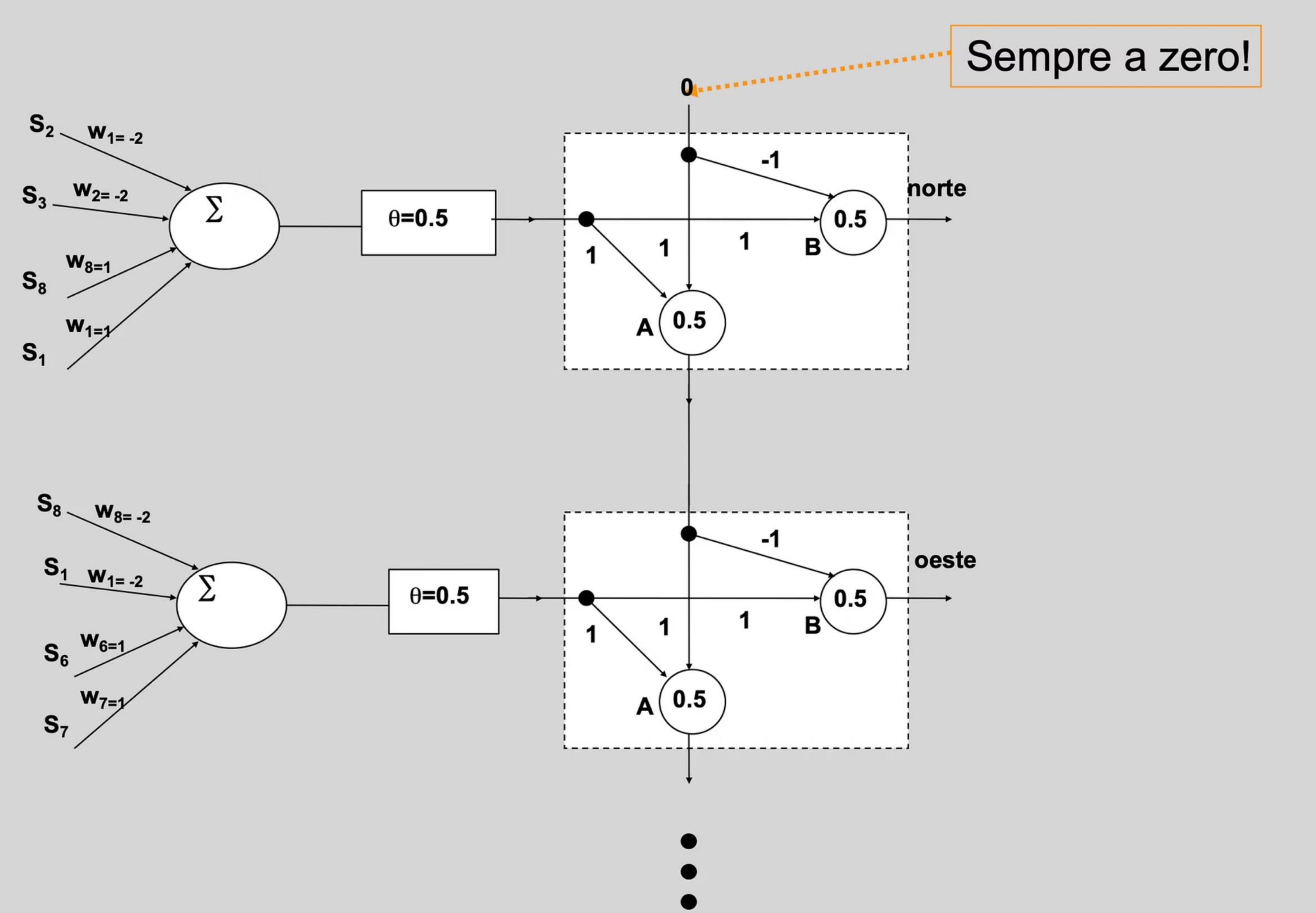
$$x_4 \neg x_1 \quad \rightarrow \quad norte$$



Chaining Rules



Chaining Rules



Subsumption Architecture

It emphasizes a **decentralized** and **hierarchical design**, enabling complex behavior to **emerge** from simple components without relying on a centralized controller or extensive symbolic reasoning.

Layered Design

The system is composed of layers, each responsible for a specific behavior or task Higher layers can "subsume" the functionality of lower layers, overriding or modifying their output when needed.

Behavior-Based Approach

Each layer corresponds to a specific behavior, such behavior, such as obstacle avoidance, path following, or goal seeking

Behaviors operate independently and in parallel, parallel, with simpler behaviors typically handled handled by lower layers.

Reactive and Bottom-Up

Focuses on direct interaction with the environment through sensors and actuators. Avoids reliance on high-level symbolic reasoning or internal world models.

Decentralization:

No central controller manages the entire system; behaviors are modular and modular and self-contained

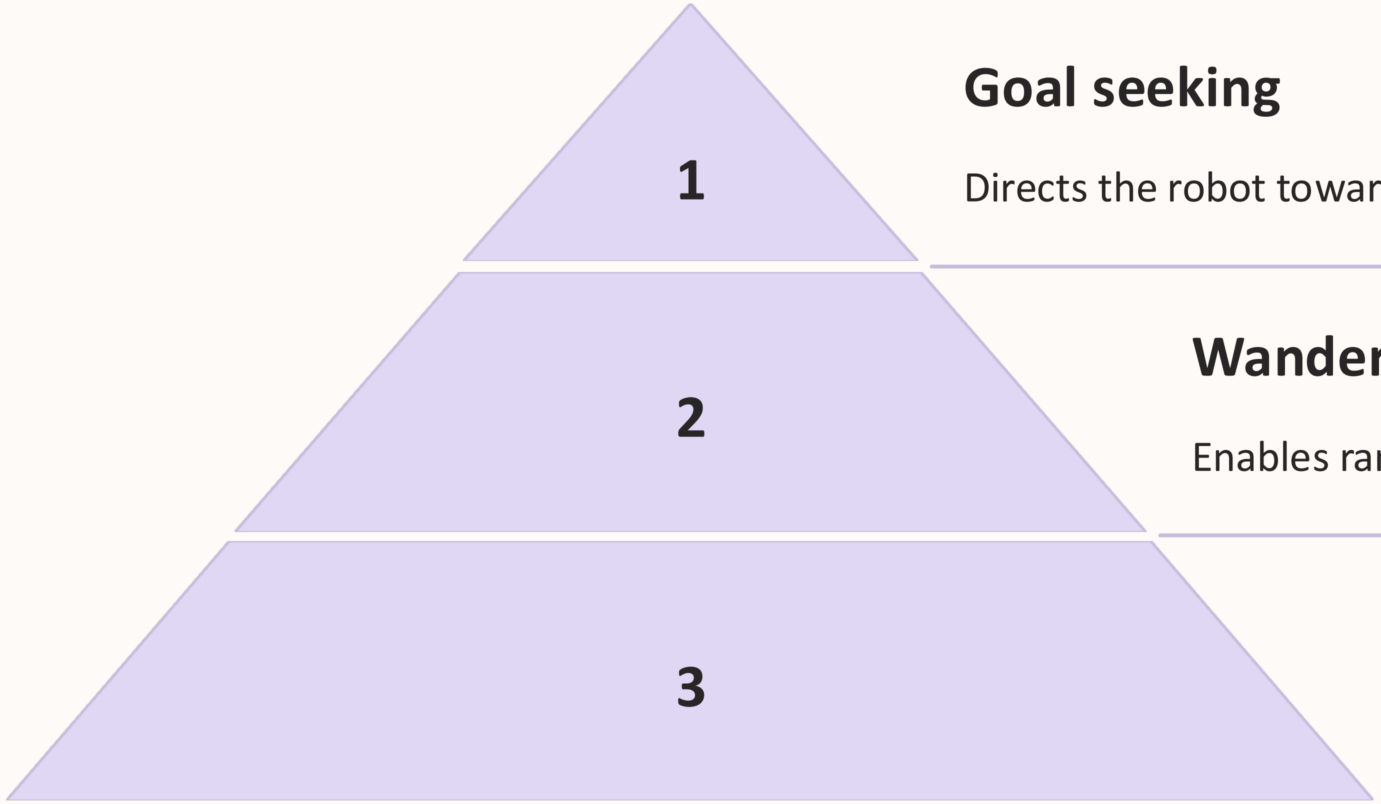
Emergent Behavior

Complex and intelligent actions emerge from the interaction of simple behaviors simple behaviors and the environment.

The sum is greater than the parts.

Example

Consider a robot navigating a room:



Goal seeking

Directs the robot toward a specific target

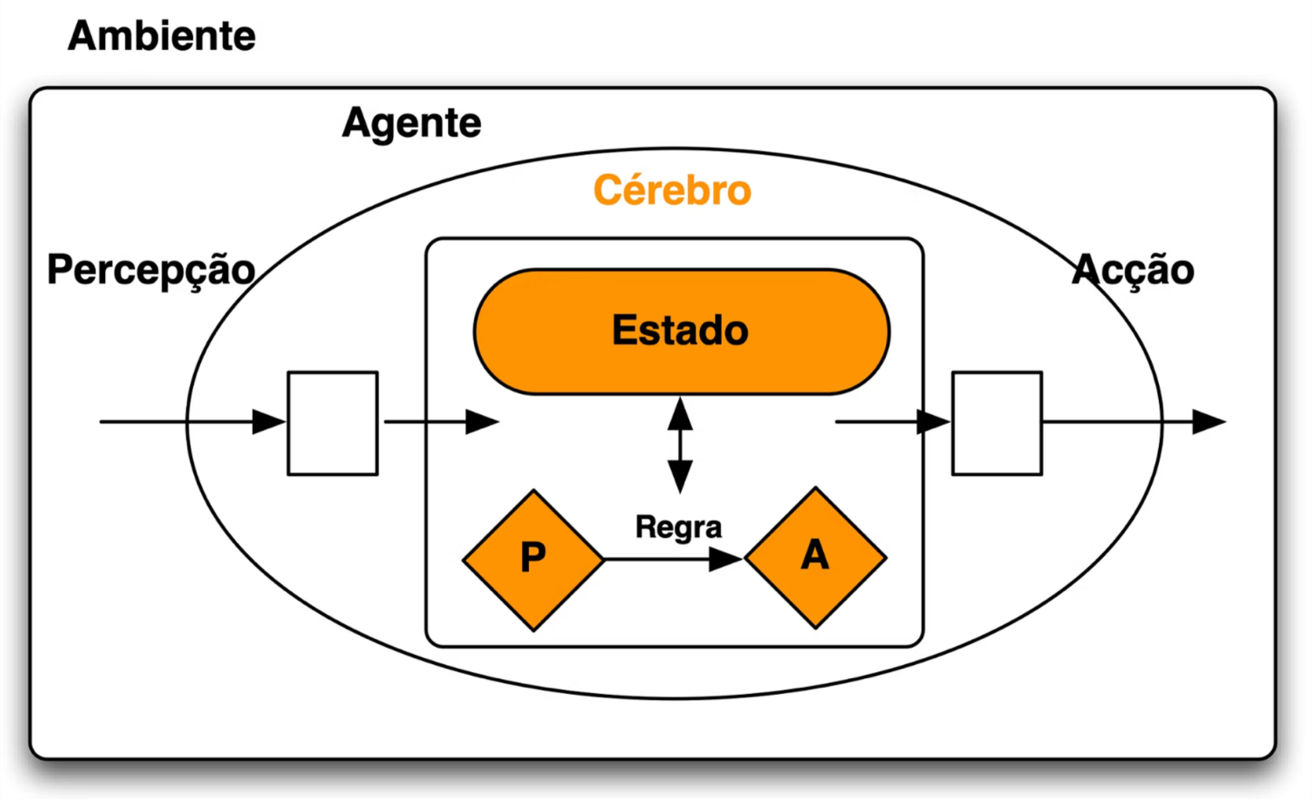
Wander behavior

Enables random movement when no obstacles are detected

Obstacle avoidance

Uses sensors to prevent collisions

If an obstacle is detected, the obstacle avoidance layer overrides (or subsumes) the higher-level behaviors (wandering or goal seeking), ensuring safe ensuring safe operation.



Reactive agents with Memory

- Map perceptions and memory into actions

An example: following a trail

Off,F → A,Off

Off, ¬F → E,On

On,F → A,Off

On, ¬F → D, D, On