Artificial Intelligence

Lecture 01 - Introduction

Pacto Pedagógico

Pacto Pedagógico

1. Revisión del programa.

2. Cronograma de actividades.

3. Dinámica del curso.

4. Compromisos de los estudiantes.

5. Compromisos del profesor.

6. Expectativas mutuas.

7. Ambiente de respecto e inclusión.

Contenido

Module 01 – Foundations, search & Planning

- Week01- What is AI? The Intelligent-Agent Paradigm
- Week02- Problem formulation and uniformed search
- Week03- Heuristic search & Optimality
- Week04- Meta-heuristic Search: Genetic Algorithms

  for Planning & Scheduling
- Week05- Knowledge, CSPs & Classical Planning

Contenido

Module 02 – The Learning Lens

- Week06- Supervised ML pipeline fundamentals

- Week07- Trees & Ensembles; mini Kaggle contest

- Week08- Deep-Learning crash course (Keras, MNIST)

- Week09- Computer Vision in 180 min; fine-tune ResNEt

- Week10- NLP & Transformers; zero-shot demo

- Week11- Reinforcement Learning.

Contenido

Module 03 – Contemporary Practice

- Week12- Generative AI & Scaling Laws

- Week13- LLM-powered Agents (ReAct, tool use)

- Week14- Multi-Capability Prompting & Multimodality
  (CLIP, GPT-4V)

- Week15- AI Engineering: Reproducibility ➝
  Deployment & Responsible AI (MLflow + DVC, Docker
  + FastAPI, bias audits)

Contenido

Module 04 – Evaluation & Integration

- Week16- Ethics in AI
- Week16-Project showcase & peer review, Synthesis, futures, final quiz

Evaluación

Evaluación

MODULE	EVALUATION	%	Timeline	Date
Module 1 – Foundations, Search & Planning	Quiz	5	week 4	August 4 to 9
	Theoretical and practical report	20	week 5	August 11 to 16
Module 2 – The Learning Lens	Quiz	5	week8	September 1 to 6
	Theoretical and practical report	20	week 9	September 8 to 13
Module 3 – Contemporary Practice	Quiz	5	week 12	September 29 to Oct 4
	Theoretical and practical report	20	week 13	October 13 to 18
Module 4 – Evaluation & Integration	Final project and report (Agent)	25	week 16	November 3 to 8

Metodología

Metodología

- Clases magistrales (60 ~ 90 minutos).

- Parte práctica (60 ~ 90 minutos).

- Desarrollo de proyecto: Agente Inteligente.

- Informes.

Objetivos

Objetivos

- Comprender qué es la inteligencia artificial (IA) y sus principales definiciones.
- Conocer los campos de aplicación de la IA.
- Aplicar los conceptos base de la inteligencia artificial. Agentes y sus habilidades para:
    - Representación de conocimiento.
    - Razonamiento computacional.
    - Aprendizaje automático.
    - Resolución de problemas.
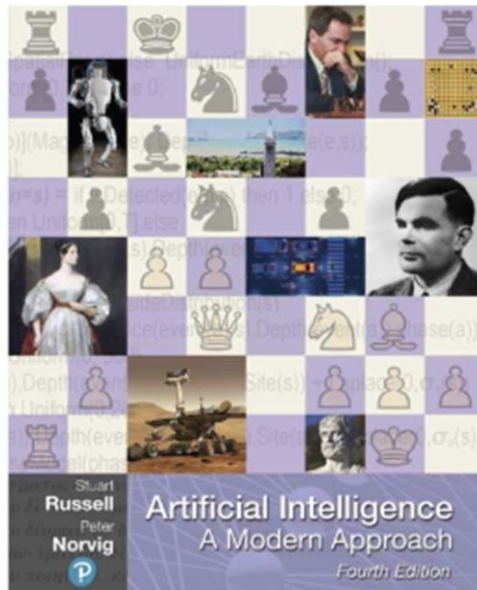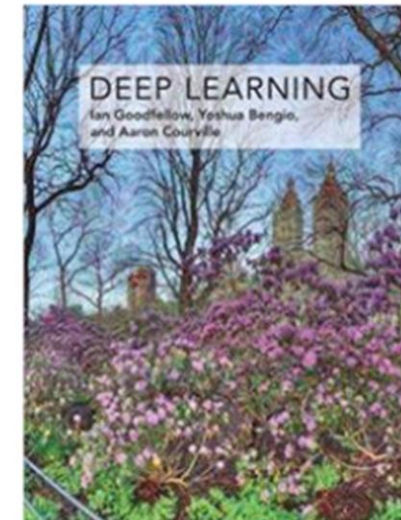   - Procesamiento del lenguaje natural.

Textbooks

Textbooks

Stuart Russell y Peter Norvig

Artificial Inelligence

A Modern Approach

Prateek Joshi

Artificial Intelligence with Python

Ian Goodfellow

Deep Learning

Introduction to AI

Definiciones – Qué significa Inteligencia?

Inteligencia: Capacidad de adquirir y usar conocimiento.

Inteligencia Artificial : Dar a las máquinas la capacidad de:

- Almacenar el conocimiento y usarlo para razonar.
- Buscar soluciones.
- Aprender individual y colectivamente.
- Comunicarse y percibir imitando a los humanos

Figura 1: Inteligencia vs Inteligencia Artificial

Definiciones – Qué significa IA (AI)?

- Campo de estudio de las ciencias de la computación: Crear sistemas capaces de realizar tareas que normalmente requieren inteligencia humana.

- Homo Sapiens "El hombre Sabio".

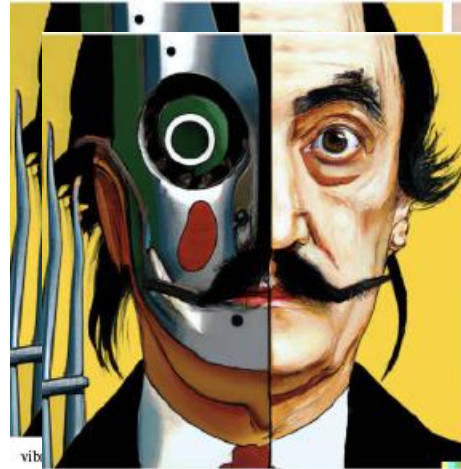- "El impacto de la IA será mayor que cualquier cosa en la historia de la humanidad" - Kai-Fu Lee.

AI is having real-world impact

- **Public Imagination**
  - Text assistants

AI is having real-world impact

- **Public Imagination**
  - Text assistants
  - Image Generation

AI is having real-world impact

- **Public Imagination**

- **Economy**

  - 454 billion USD

The global artificial intelligence (AI) market size was valued at USD 454.12 billion in 2022 and is expected to hit around USD 2,575.16 billion by 2032, progressing with a CAGR of 19% from 2023 to 2032. The North America artificial intelligence market was valued at USD 167.30 billion in 2022.

PRECEDENCE RESEARCH

ARTIFICIAL INTELLIGENCE (AI) MARKET SIZE, 2022 TO 2032 (USD BILLION)

Year	Value
2022	$ 454.12
2023	$ 538.13
2024	$ 638.23
2025	$ 757.58
2026	$ 900.00
2027	$ 1,070.10
2028	$ 1,273.42
2029	$ 1,516.64
2030	$ 1,807.84
2031	$ 2,156.75
2032	$ 2,575.16

Source: www.precedenceresearch.com

https://www.precedenceresearch.com/artificial-intelligence-market

AI is having real-world impact

- **Public Imagination**

- **Economy**

- **Politics**

AI is having real-world impact

- **Public Imagination**

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AI is having real-world impact

- **Public Imagination**

- **Economy**

- **Politics**

AI is having real-world impact

- **Public Imagination**
- **Economy**
- **Politics**
- **Law**

Aug. 18, 2023, 12:18 PM; Updated: Aug. 18, 2023, 12:48 PM

AI-Generated Art Lacks Copyright Protection, D.C. Court Says (1)

Riddhi Setty
Reporter

Isaiah Poritz
Legal Reporter

Bloomberg Law, 2023

8 Daily Newspapers Sue OpenAI and Microsoft Over A.I.

The suit, which accuses the tech companies of copyright infringement, adds to the fight over the online data used to power artificial intelligence.

New York Times, 2024

AI is having real-world impact

- **Public Imagination**

- **Economy**

- **Politics**

- **Law**

- **Labor**

Finance & economics | Free exchange

New research shows the robots are coming for jobs—but stealthily

Look beneath the aggregate economic numbers, and change is afoot

The Economist, 2021

The Optimist's Guide to Artificial Intelligence and Work

The focus of much discussion is on how it will replace jobs, but nothing is inevitable.

New York Times, 2023

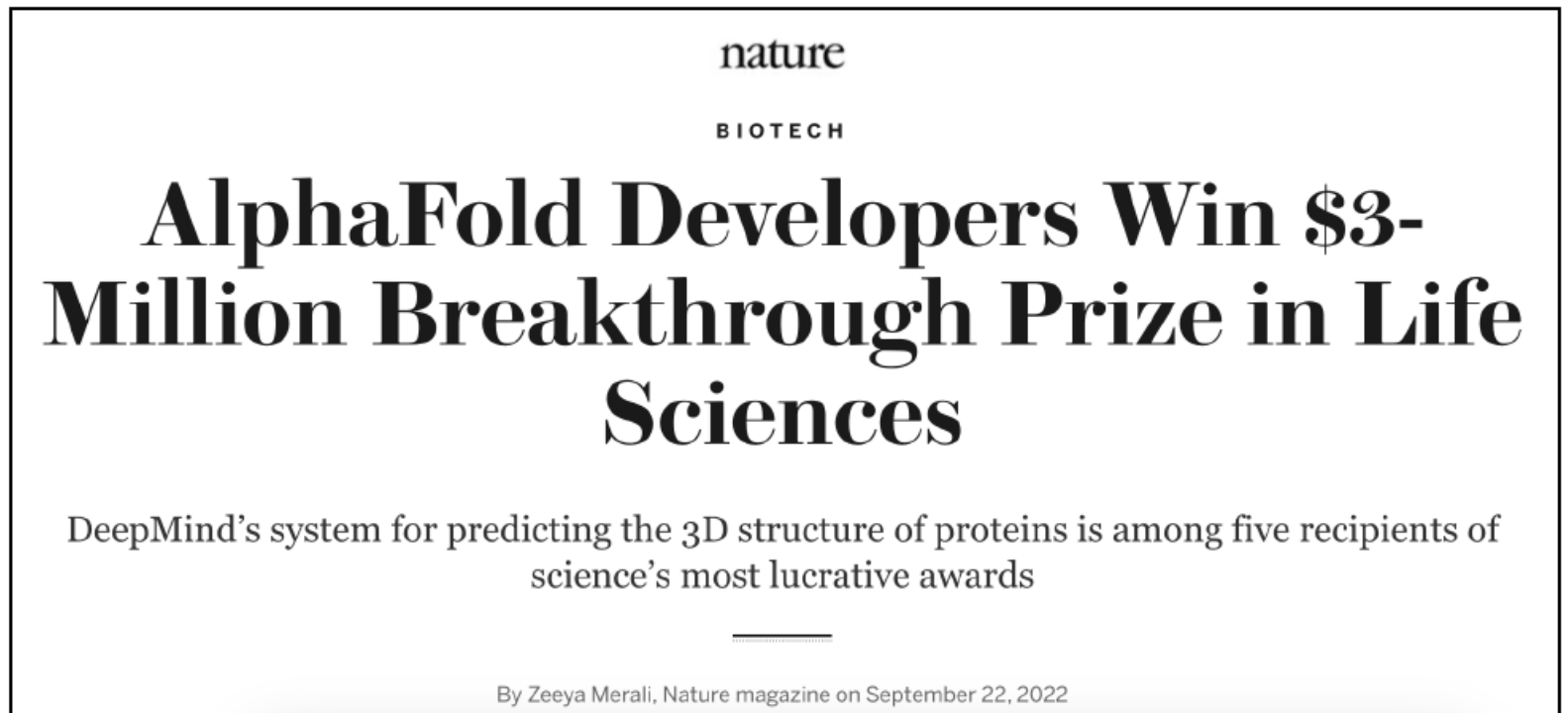## The human labor behind AI chatbots and other smart tools

Data labeling is an important step in developing artificial intelligence but also exposes the people doing the work to harmful content.

MarketWatch, 2023

AI is having real-world impact

- **Public Imagination**

- **Economy**
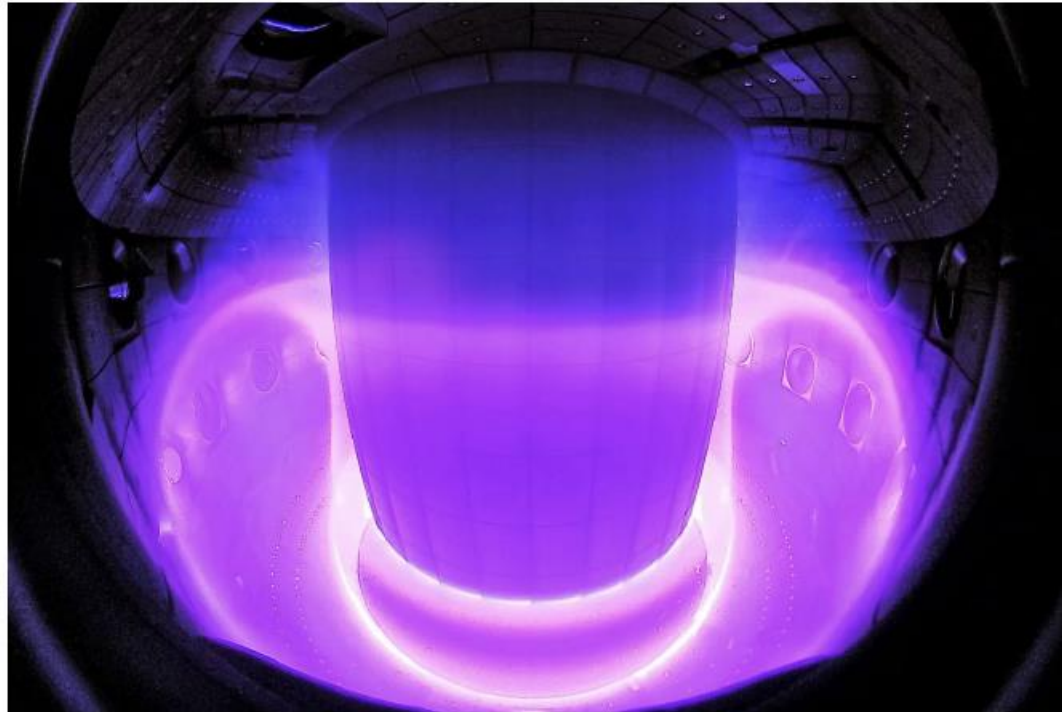
- **Politics**

- **Law**

- **Labor**

- **Sciences**

nature

BIOTECH

AlphaFold Developers Win $3-Million Breakthrough Prize in Life Sciences

DeepMind's system for predicting the 3D structure of proteins is among five recipients of science's most lucrative awards

By Zeeya Merali, Nature magazine on September 22, 2022

Nature, 2022

AI is having real-world impact

- **Public Imagination**

- **Economy**

- **Politics**

- **Law**

- **Labor**

- **Sciences**

AMIT KATWALA   SCIENCE   FEB 16, 2022 11:00 AM

DeepMind Has Trained an AI to Control Nuclear Fusion

The Google-backed firm taught a reinforcement learning algorithm to control the fiery plasma inside a tokamak nuclear fusion reactor.

PHOTOGRAPH:CURDIN WÜTHRICH, SPC/EPFL

Wired, 2022

AI is having real-world impact

- **Public Imagination**
- **Economy**
- **Politics**
- **Law**
- **Labor**
- **Sciences**
- **Education**

BREAKING

ChatGPT In Schools: Here's Where It's Banned—And How It Could Potentially Help Students

Arianna Johnson Forbes Staff

I cover the latest trends in science, tech and healthcare.

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💬 2

Jan 18, 2023, 02:31pm EST
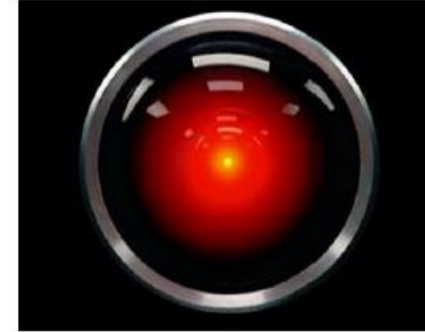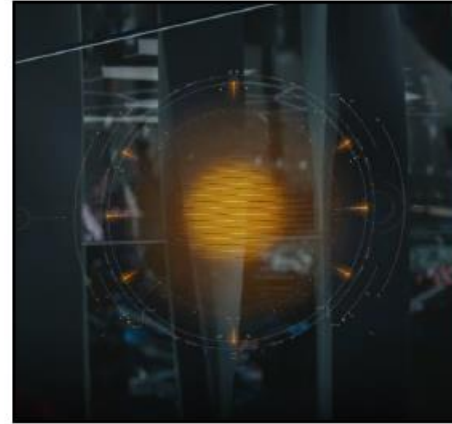
Forbes, 2023

What does AI do?

Science fiction AI

Qué significa IA (AI)?

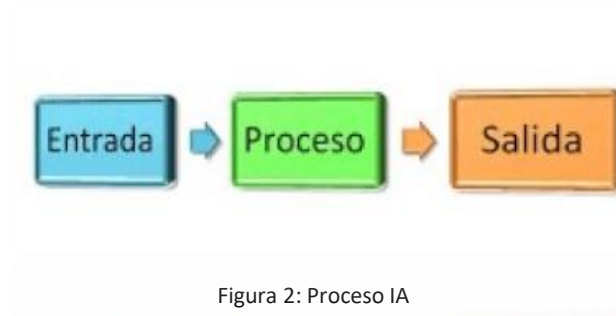La IA se puede definir desde varias perspectivas:

- Sistemas que piensan como humanos: **Modelo cognitivo.**

- Sistemas que actúan como humanos: **Test de Turing.**

- Sistemas que piensan racionalmente: **Lógica y probabilidad.**

- Sistemas que actúan racionalmente: **Agentes racionales.**

Características clave de la IA

- **Percepción**: Captar información del entorno.

- **Razonamiento**: Tomar decisiones lógicas.

- **Aprendizaje**: Adaptarse a nuevos datos.

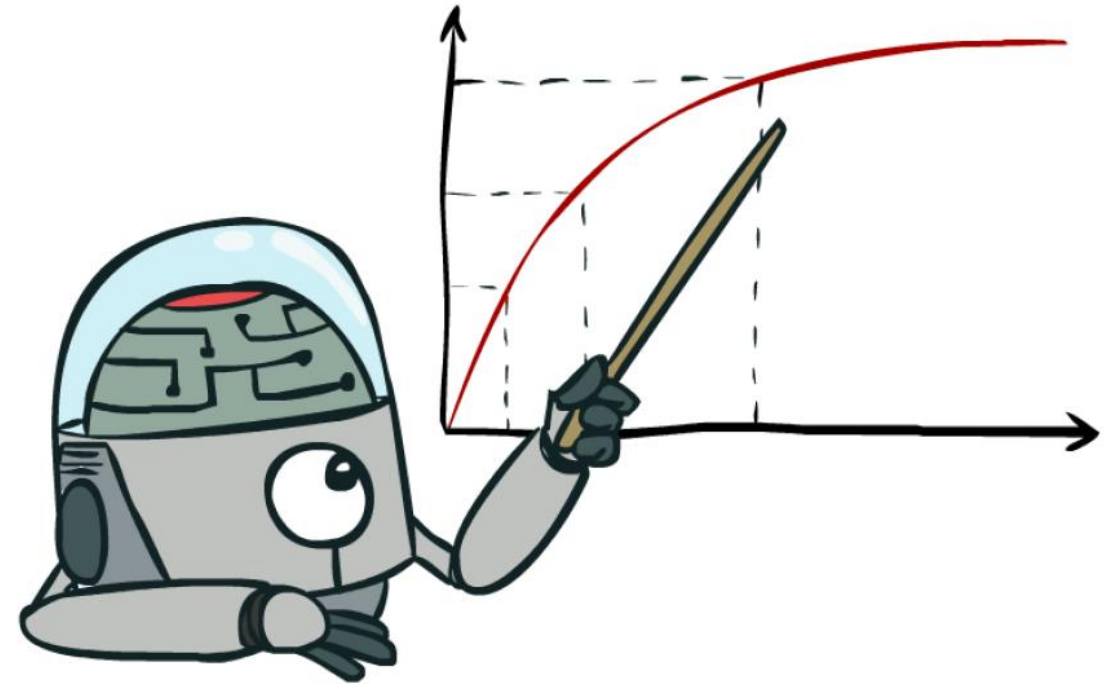- **Actuación**: Realizar acciones basadas en el razonamiento.

Figura 2: Proceso IA

UNIVERSIDAD
EAFIT
VIGILADA MINEDUCACIÓN

Escuela de
Ciencias Aplicadas
e Ingeniería

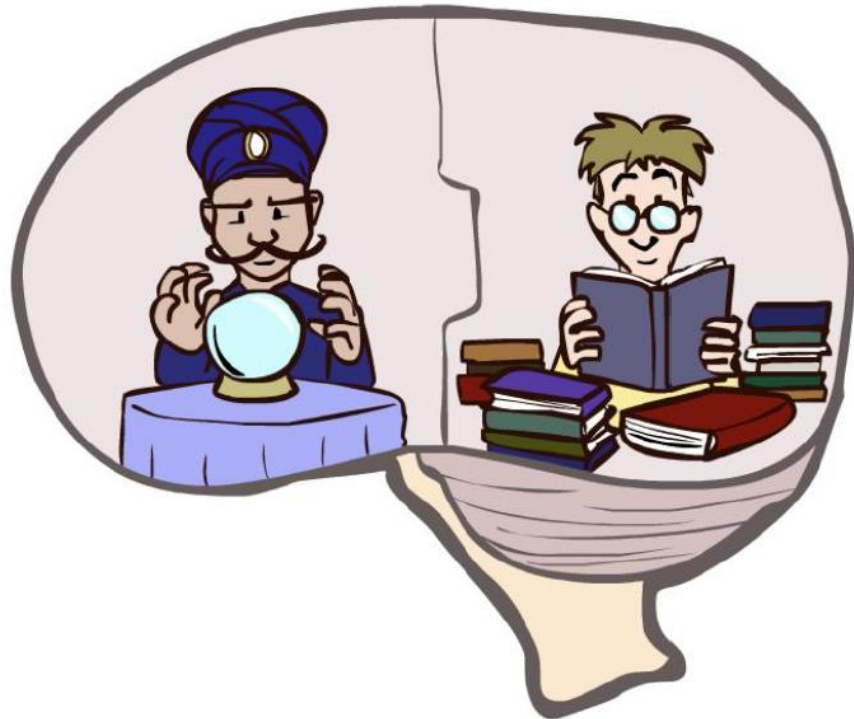# What is AI?

Rational decisions

We'll use the term rational in a very specific, technical way:

- Rational: maximally achieving pre-defined goals
- Goals are expressed in terms of the utility of outcomes
- World is uncertain, so we'll use expected utility

- Being rational means acting to maximize your expected utility

Rational decisions

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- A better title for this course would be: **Computational Rationality**
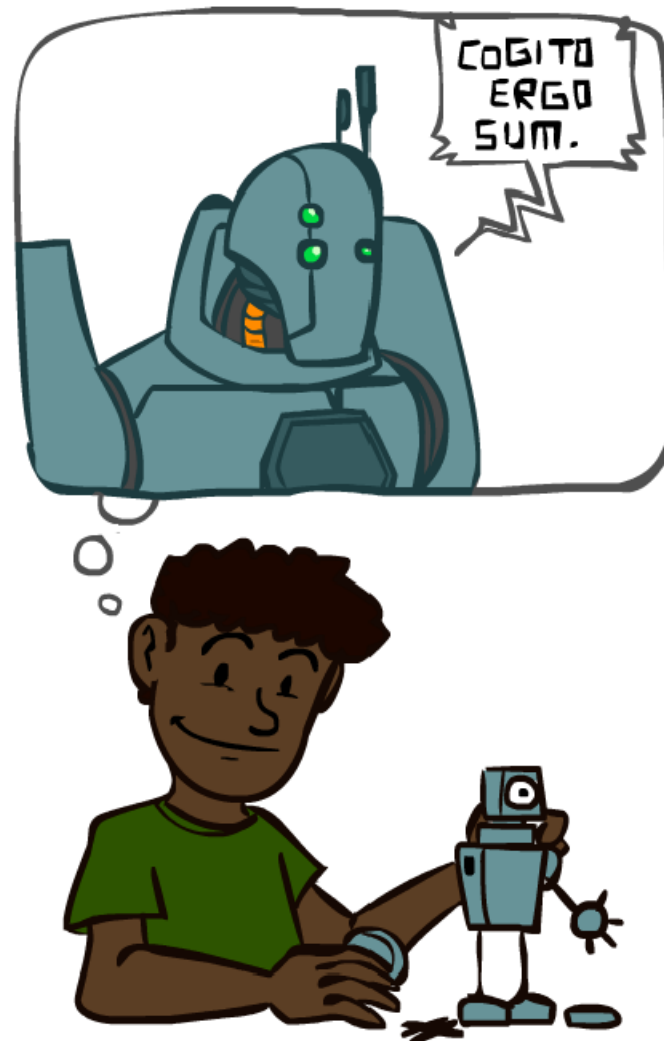
What about the brain

- Brains (human minds) are very good at making rational decisions, but not perfect
- Brains aren't as modular as software, so hard to reverse engineer!
- AI may be better than brains at some tasks
- *"Brains are to intelligence as wings are to flight"*
- We can't yet build AI on the scale of the brain
  ~100T synapses in the human brain vs ~500B
  weights in artificial neural networks
- Still, the brain can be a great inspiration for AI!

A(short)History of AI

Historia de la IA

- **Años 1940-50:** Fundamentos teóricos (Alan Turing) y primeras computadoras.

- **1956:** Conferencia de Dartmouth: Nacimiento formal de la IA.

- Años **1970-80:** Invierno de la IA (expectativas no cumplidas).

- Años **1980:** Auge de los sistemas expertos.

- Años **1990** en adelante: Aprendizaje automático, Deep Blue, y crecimiento exponencial.

- **Siglo XXI:** IA en la vida diaria: redes neuronales, aprendizaje profundo.

Historia de la IA

- Marvin Minsky y John McCarthy (1969-71): Fundamentos del campo.

- Ed Feigenbaum y Raj Reddy (1994): Sistemas expertos.

- Judea Pearl (2011): Razonamiento probabilístico.

- Yoshua Bengio, Geoffrey Hinton, Yann LeCun (2019): Aprendizaje profundo.

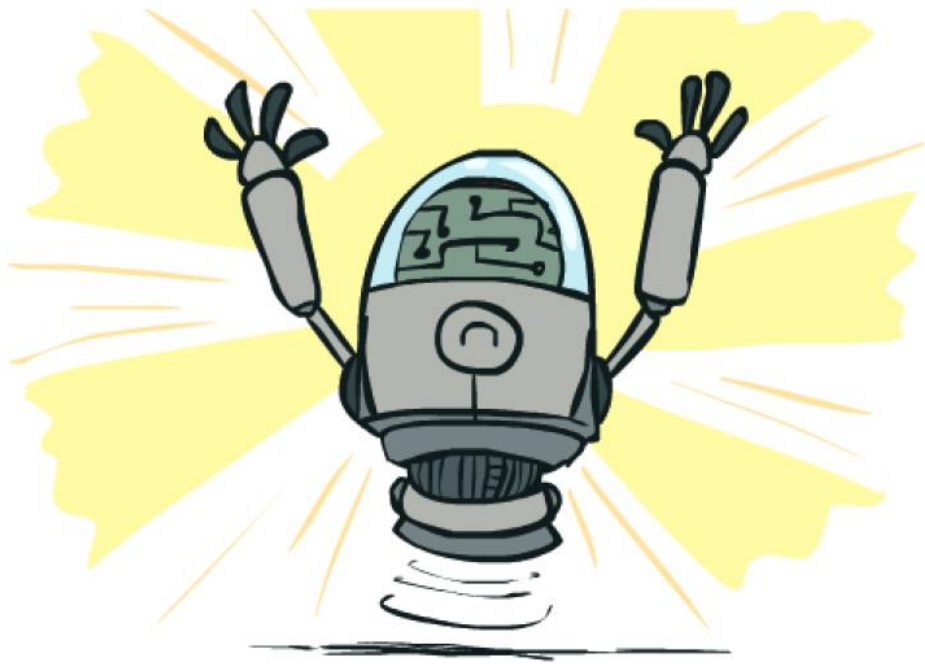Figura 4: Inteligencia vs Inteligencia Artificial

What can AI do?

What about the brain

Quiz: Which of the following can be done at present?

Win against any human at chess?
Win against the best humans at Go?
Play a decent game of table tennis?
Unload any dishwasher in any home?
Drive safely along the highway?
Drive safely along streets of San Francisco?
Buy a week's worth of groceries on the web?
Buy a week's worth of groceries at Berkeley Bowl?
Discover and prove a new mathematical theorem?
Perform a surgical operation?
Translate spoken Chinese into spoken English in real time?
Win an art competition?
Write an intentionally funny story?
Construct a building?

What about the brain

Google's AlphaGo beats Lee Sedol at Go in 2016

But … a plot twist in 2023!

DEEP BLUE WAS JUST THE START—
Man beats machine at *Go* in human victory over AI
Amateur exploited weakness in systems that have otherwise dominated grandmasters.
RICHARD WATERS, FINANCIAL TIMES - 2/19/2023, 4:51 AM

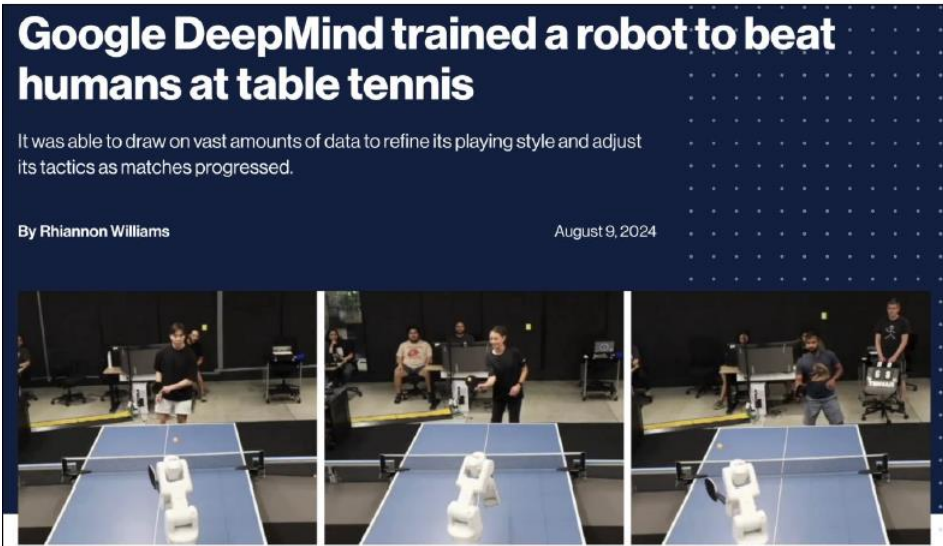**Quiz:** Which of the following can be done at present?

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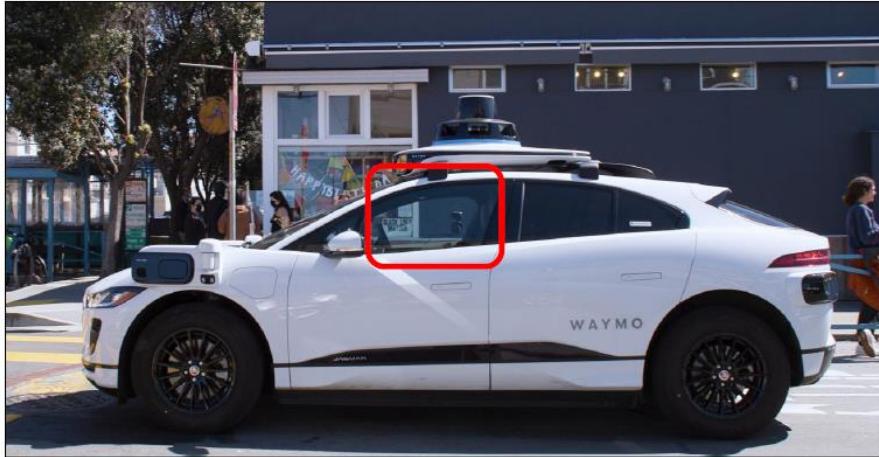
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Google DeepMind trained a robot to beat humans at table tennis

It was able to draw on vast amounts of data to refine its playing style and adjust its tactics as matches progressed.

By Rhiannon Williams   August 9, 2024

What about the brain

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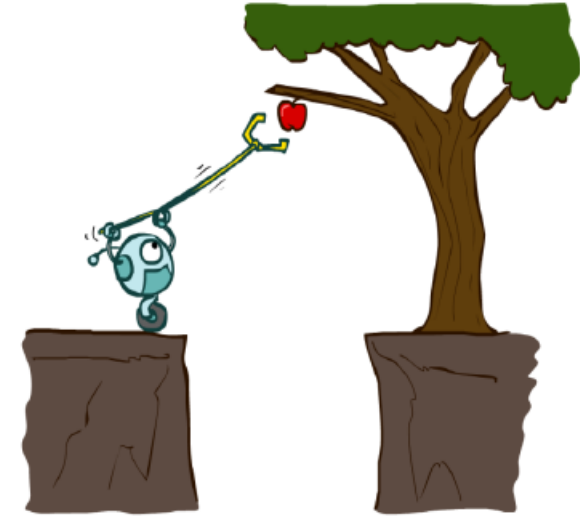
This course: Designing rational agents
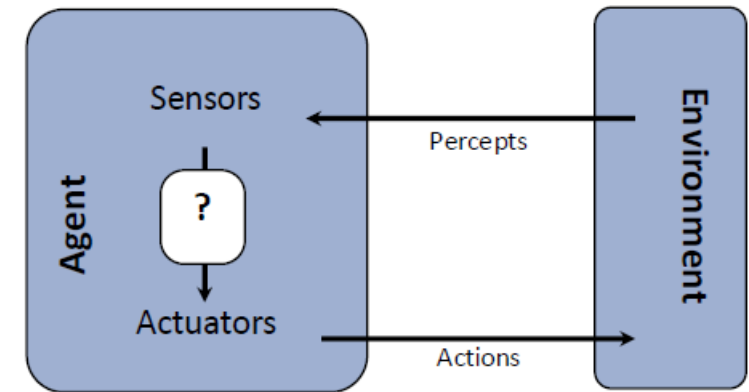
This course: Rational Agents

An agent is an entity that perceives and acts.

- A **rational agent** selects actions that maximize
its (expected) **utility**.
- Characteristics of the **percepts**, **environment**,
and **action space** dictate techniques for
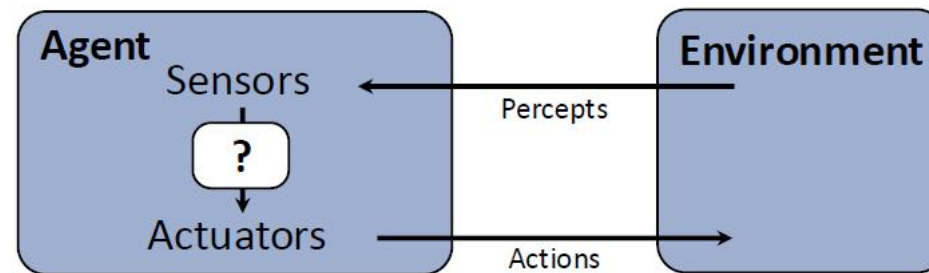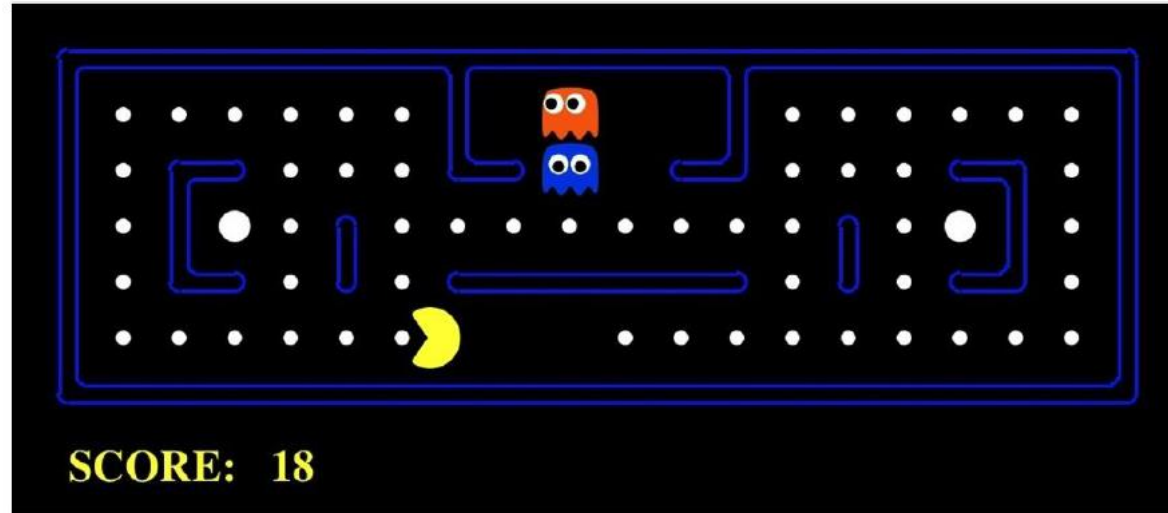selecting rational actions

This course is about:

- **General AI techniques for a variety of
  problem types**
- **Learning to recognize when and how a new
problem can be solved with an existing technique**

Pac-Man as an Agent

Course Topics

Course Topics

Search &
Planning

Reinforcement
Learning

Probability &
Inference

Supervised
Learning

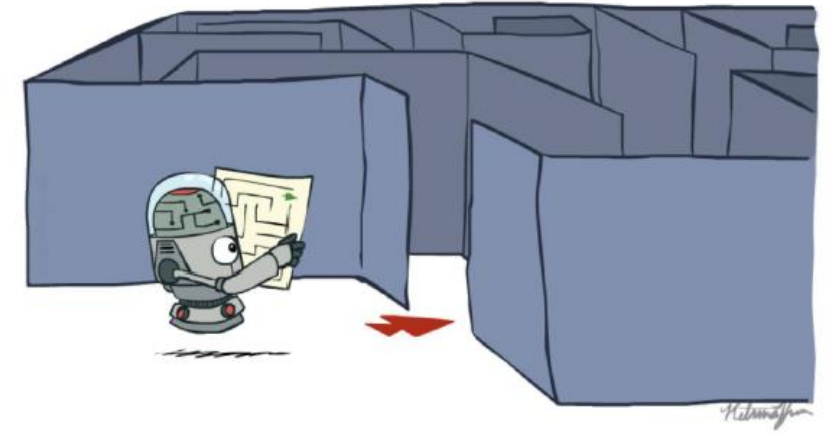**Core components of rational agents**

Course Topics

Search & Planning	Reinforcement Learning
Probability & Inference	Supervised Learning

How to find the best **plan** for **to solve** a problem?
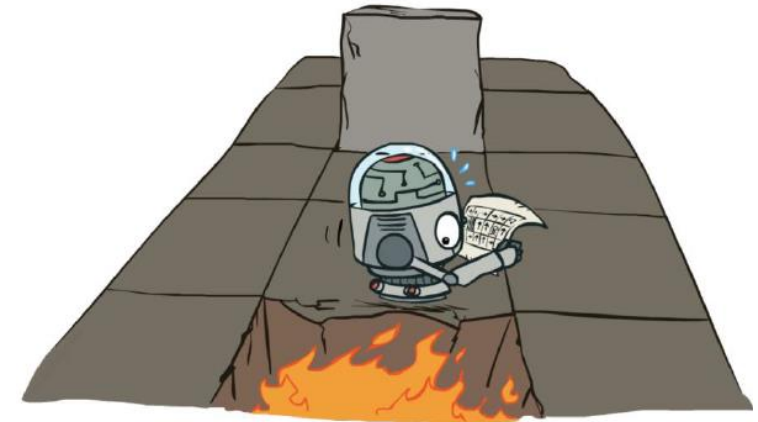
Course Topics

Search & Planning

Reinforcement Learning

Probability & Inference

Supervised Learning

How to learn to best **act** in the world?

Course Topics

Search & Planning	Reinforcement Learning
Probability & Inference	Supervised Learning

How to make sense of **uncertainty** in the world?

Course Topics

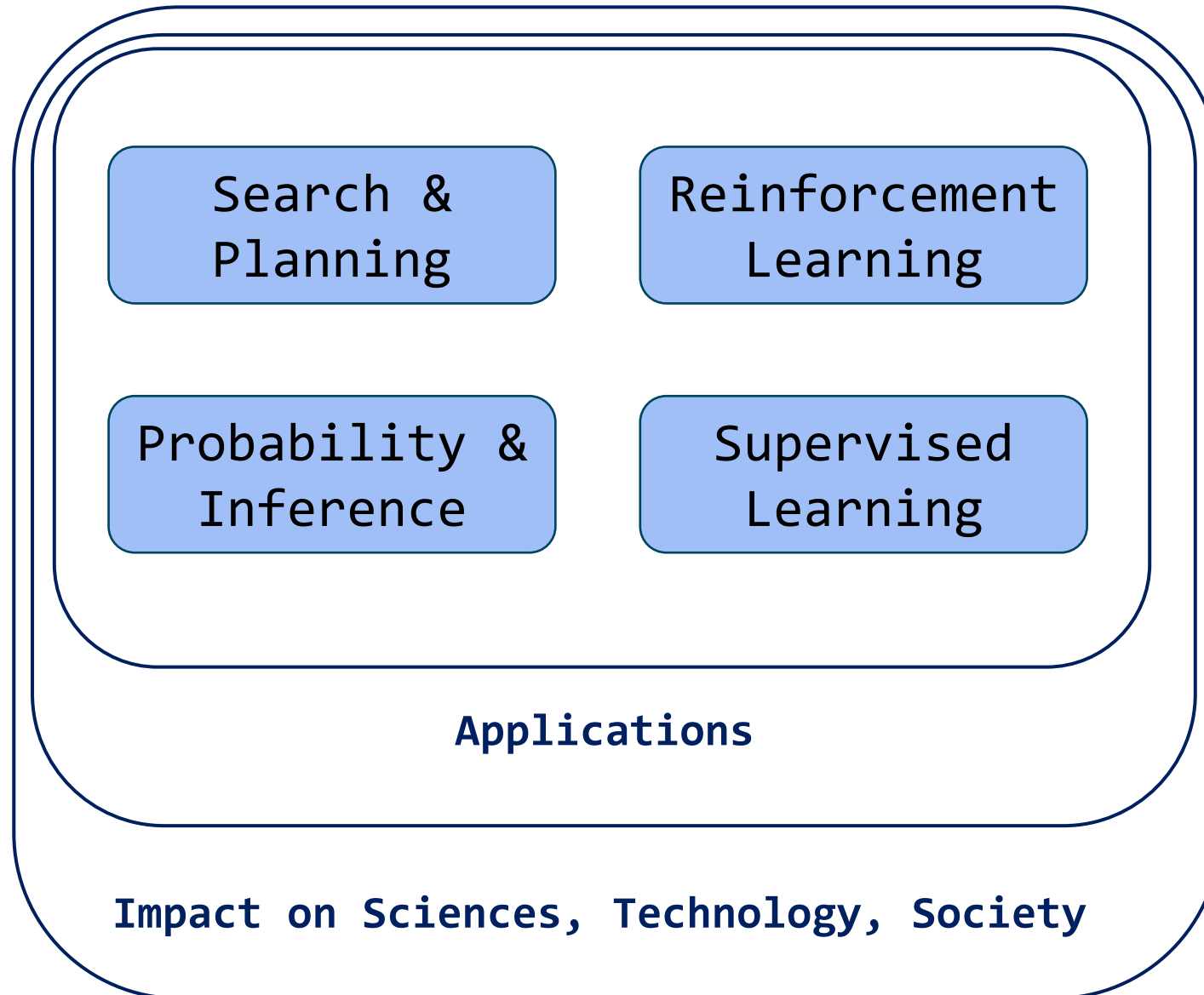|	
Search & Planning	Reinforcement Learning
Probability & Inference	Supervised Learning

How to learn a **model** of the world from **data?**

Course Topics

- Reconocimiento facial en smartphones.

- Sistemas de recomendación (Netflix, Amazon).

- Vehículos autónomos.

Figura 5: Ejemplos

- **Agente:** Sistema que percibe un entorno y actúa sobre él para alcanzar objetivos.
- Caracterizado por:
    Su estructura (arquitectura)
    Sus acciones (comportamiento)}
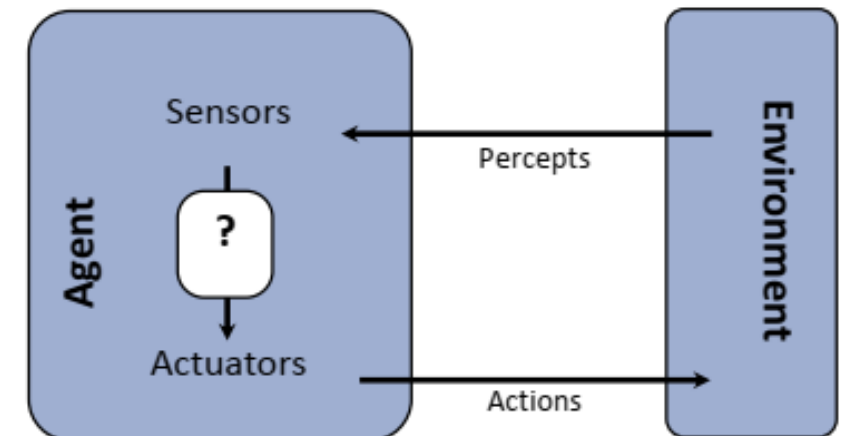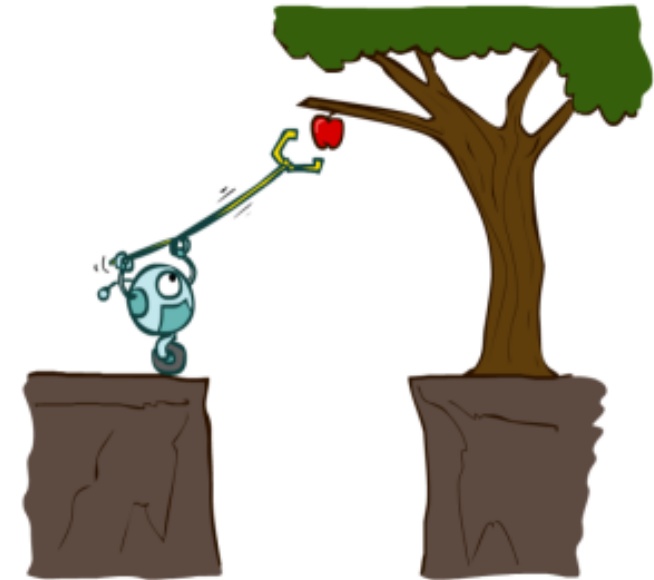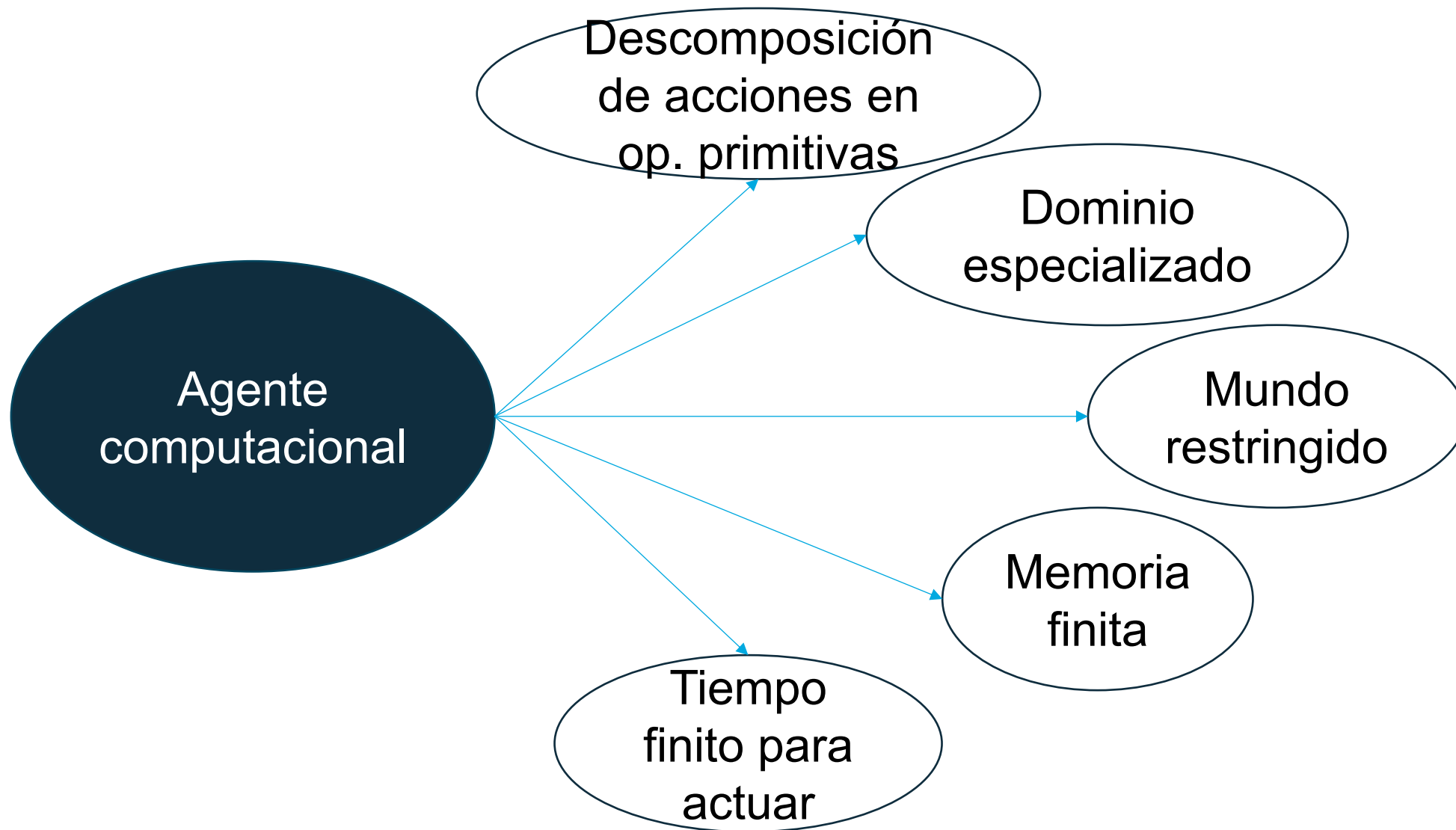- Agente = Arquitectura + programa

Figura 4: Agente

Un agente racional es aquel que hace lo correcto.

¿Qué significa hacer lo correcto?

Lo que es racional en un momento dado depende de:

- La medida de desempeño que define el criterio de éxito.

- El conocimiento previo del agente sobre el entorno.

- Las acciones que el agente puede realizar.

- La secuencia de perceptos del agente hasta el momento.

El entorno podría ser cualquier cosa ¡el universo entero! En la práctica, se trata solo de esa parte del universo cuyo estado nos importa al diseñar este agente, la parte que afecta lo que el agente percibe y que es afectada por las acciones del agente.

Los entornos de tarea son esencialmente los "problemas" para los cuales los agentes racionales son las "soluciones".

Figura 5: Entorno

Para un agente racional debemos especificar la medida de rendimiento, el entorno y los actuadores y sensores del agente. Agrupamos todo esto bajo el título de **entorno de tarea** o **PEAS**

Agent Type	Performance Measure	Environment	Actuators	Sensors
Taxi driver	Safe, fast, legal, comfortable trip, maximize profits, minimize impact on other road users	Roads, other traffic, police, pedestrians, customers, weather	Steering, accelerator, brake, signal, horn, display, speech	Cameras, radar, speedometer, GPS, engine sensors, accelerometer, microphones, touchscreen

- Totalmente Observable Vs. Parcialmente Observable.

- Un Solo Agente Vs. Multiagente.

- Determinista vs. No determinista.

- Episódico Vs. Secuencial.

- Estático Vs. Dinámico.

- Discreto Vs. Continuo.

Task Environment	Observable	Agents	Deterministic	Episodic	Static	Discrete
Crossword puzzle	Fully	Single	Deterministic	Sequential	Static	Discrete
Chess with a clock	Fully	Multi	Deterministic	Sequential	Semi	Discrete
Poker	Partially	Multi	Stochastic	Sequential	Static	Discrete
Backgammon	Fully	Multi	Stochastic	Sequential	Static	Discrete
Taxi driving	Partially	Multi	Stochastic	Sequential	Dynamic	Continuous
Medical diagnosis	Partially	Single	Stochastic	Sequential	Dynamic	Continuous
Image analysis	Fully	Single	Deterministic	Episodic	Semi	Continuous
Part-picking robot	Partially	Single	Stochastic	Episodic	Dynamic	Continuous
Refinery controller	Partially	Single	Stochastic	Sequential	Dynamic	Continuous
English tutor	Partially	Multi	Stochastic	Sequential	Dynamic	Discrete

"Un acoplamiento de percepción, razonamiento y actuación comprenden **un agente**. Un agente actúa en un **entorno**. El ambiente de un agente también puede incluir otros agentes. Un agente junto con su entorno es llamado un **mundo**".

Simple Reflex Agents: Responden directamente a percepciones actuales del entorno, ignorando cualquier historial pasado.

Model-Based Reflex Agents: el agente realiza un seguimiento de la parte del mundo que no puede ver en ese momento.

Goal-Based Agents: Toman decisiones con base en un objetivo definido que desean alcanzar.

Utility-Based Agents: Eligen acciones que maximizan la utilidad esperada, considerando las posibles consecuencias.
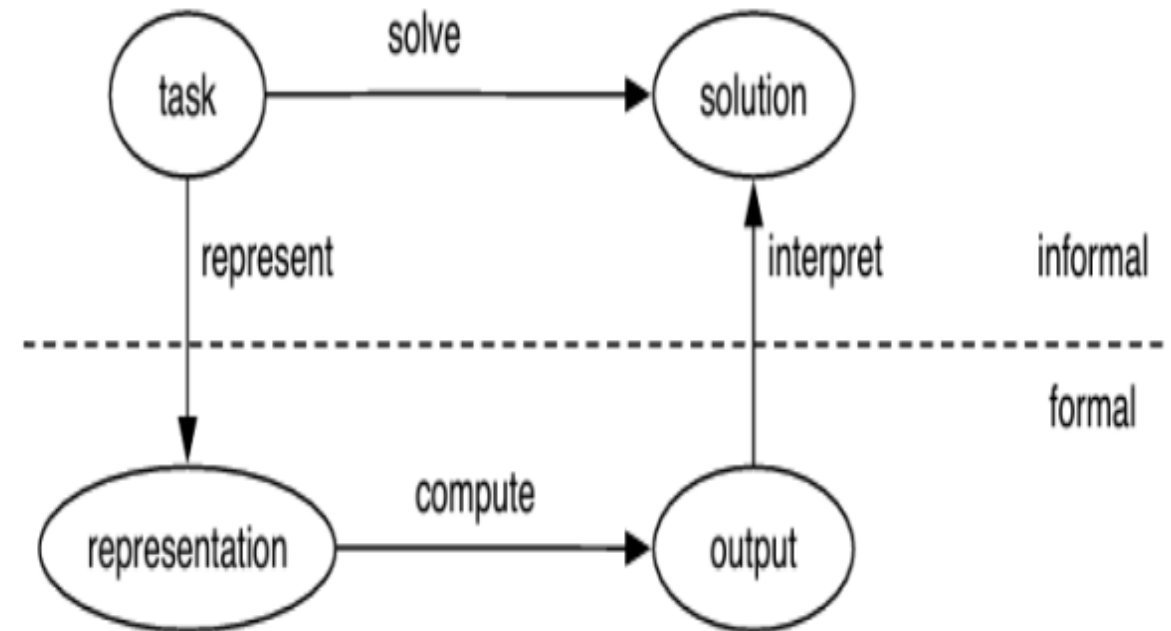
TAREA: Se refiere a una actividad o problema específico que un agente debe resolver o ejecutar. La tarea define los objetivos que el agente debe alcanzar y puede implicar una serie de acciones que el agente debe llevar a cabo en su entorno para cumplir con esos objetivos.

SOLUCIÓN DE TAREA:

- Determinar que constituye una solución.

- Representar la tarea de una forma que el computador pueda razonar sobre ella.

- Usar el computador para calcular una salida que será presentada al usuario o una acción que debe ejecutar sobre el ambiente.

- Interpretar la salida como una solución a la tarea.

DOMINIO: campo dentro del cual un agente opera y para el cual está diseñado buscando la resolución de **tareas**. Este dominio incluye todos los elementos, reglas, hechos, y relaciones relevantes que el agente debe conocer y utilizar para llevar a cabo sus funciones de manera efectiva.

CONOCIMIENTO: es la información sobre un **dominio** que puede ser usada para resolver **tareas** en ese **dominio**. Ese conocimiento debe poderse representar en un computador.

LENGUAJE DE REPRESENTACIÓN: Herramienta para la expresión del **conocimiento** que será usado por un agente

BASE DE CONOCIMIENTO: representación de todo el conocimiento que tiene almacenado un agente.

REPRESENTACIÓN DEL CONOCIMIENTO: la estructura particular de los datos usados para codificar el conocimiento, de tal forma que pueda ser usado para razonar.

¿CUAL ES LA SOLUCIÓN?

Dada una descripción informal de una tarea, antes de considerar un computador, un diseñador de agentes debe determinar que constituiría una solución.

Una vez se consiga una buena especificación de la tarea, la siguiente cuestión es tener en cuenta si importa si la tarea esta incorrecta o incompleta.

Una vez que se tienen los requerimientos sobre la naturaleza de la solución, se debe representar la tarea de tal forma que el computador la pueda resolver.

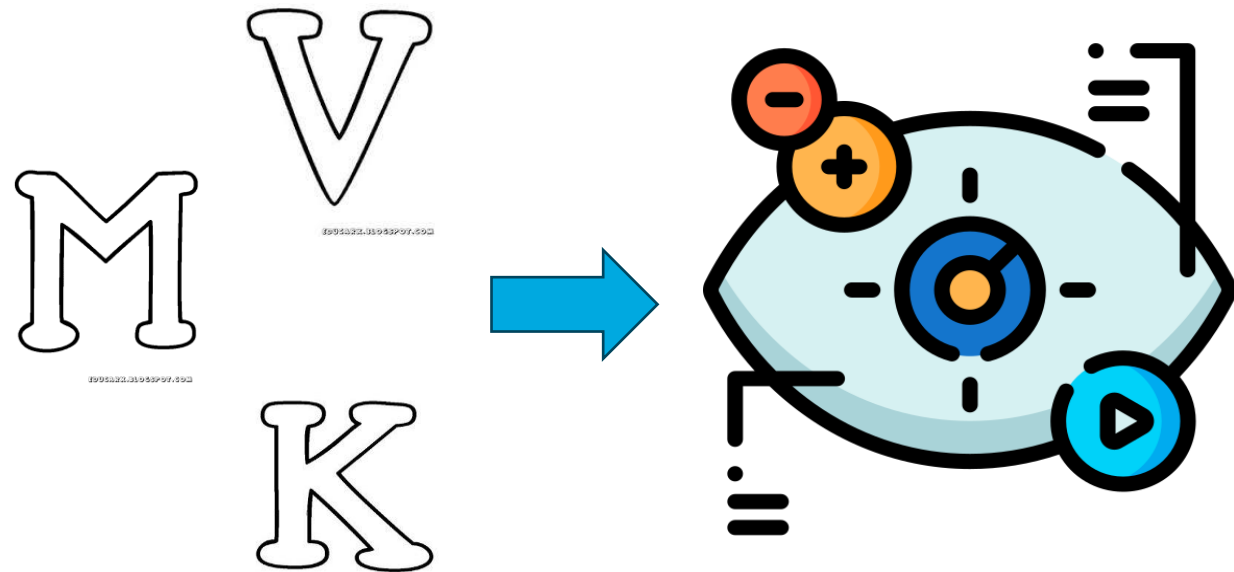Las mentes de los computadores y las personas son ejemplos de sistemas de **símbolos físicos.**

INTELIGENCIA

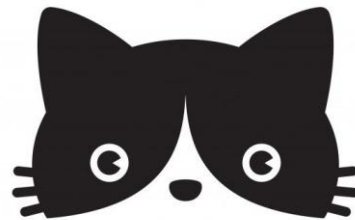"La inteligencia puede ser representada mediante la manipulación de símbolos." Newell & Herbert.

Ejemplos de Símbolos Físicos

Letras como 'A', 'B', 'C', etc., y números como '1', '2', '3', etc., que son identificados y procesados por un sistema de reconocimiento óptico.

Ejemplos de Símbolos Físicos

Palabras individuales como "gato", "casa" que son analizadas y manipuladas en tareas de comprensión y generación de lenguaje natural.

"El gato está en la casa"

En pareja, identifiquen 3 aplicaciones de IA que utilizan en su vida diaria.

Clasifiquen cada aplicación según las siguientes categorías:

- Piensa como humano
- Actúa como humano
- Piensa racionalmente
- Actúa racionalmente

Completar la tabla:

Aplicación	¿Qué hace?	Categoría	Razón de la clasificación
Google Maps	Calcula rutas óptimas	Actúa racionalmente	Maximiza la eficiencia en los trayectos

```
def decidir_accion(entorno):
    if entorno == "amenaza":
        return "Defender"
    elif entorno == "recurso":
        return "Recolectar"
    else:
        return "Explorar"
```

Actividad:

- Agregar nuevos entornos.

- Modificar las decisiones del agente según las reglas dadas.

- Probar el código y compartir los resultados.

- ¿Qué tan flexible es este agente?

- ¿Cómo podrían hacerlo más sofisticado?

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Actividad:

- Diseñar un agente que decida si debe cruzar una calle.

- El agente sigue las siguientes reglas:

  - Si el semáforo está en verde y no hay autos en la intersección, cruza.

  - Si el semáforo está en rojo o hay autos, no cruza.

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