

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 respeto e inclusión.



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



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.



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)



Module 04 – Evaluation & Integration

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



Evaluación



Evaluación

Módulo	Evaluación	%	Semana	Fecha
Módulo 1	Quiz	5	Semana 4	9 al 14 de febrero
	Informe teórico-práctico	20	Semana 5	16 al 21 de febrero
Módulo 2	Quiz	5	Semana 8	9 al 14 de marzo
	Informe teórico-práctico	20	Semana 9	16 al 21 de marzo
Módulo 3	Quiz	5	Semana 12	13 a 17 de abril
	Informe teórico-práctico	20	Semana 13	20 al 24 de abril
Módulo 4	Proyecto final e informe (Agente)	25	Semana 16	11 al 15 de mayo



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.

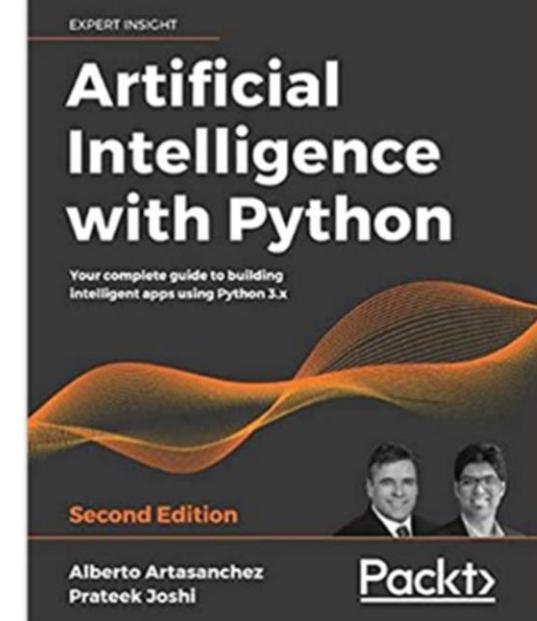
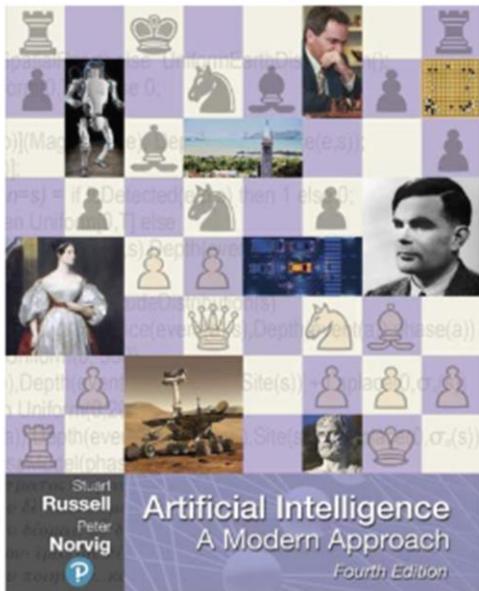


Textbooks



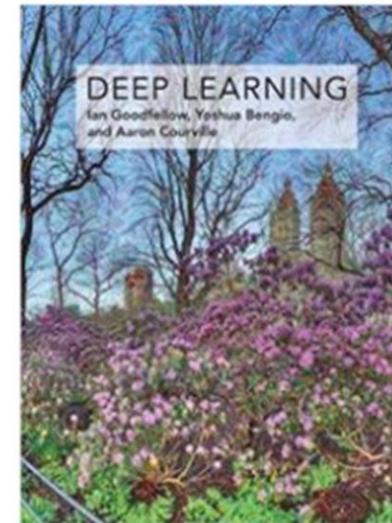
Textbooks

Stuart Russell y Peter Norvig
Artificial Intelligence
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.



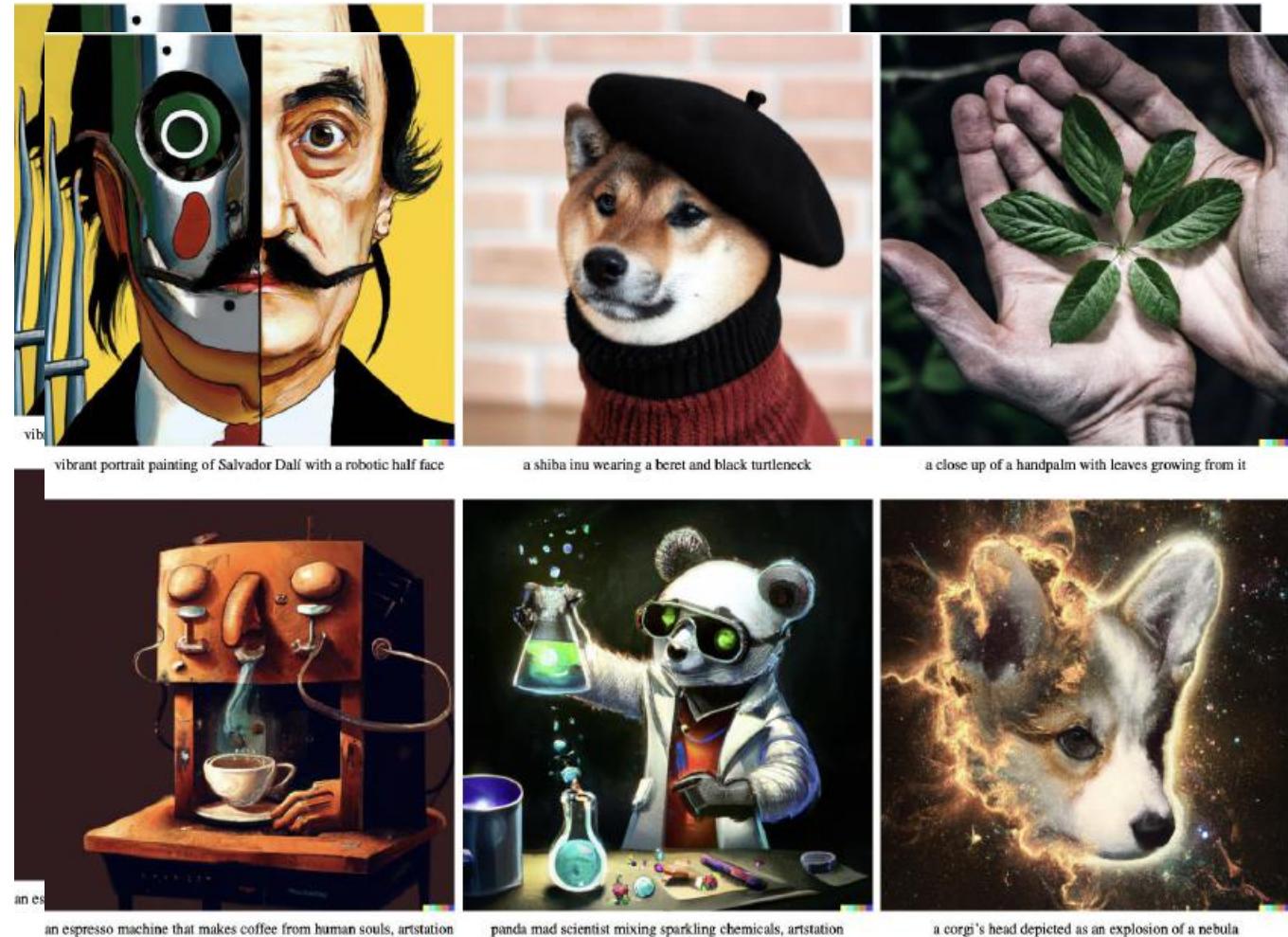
AI is having real-world impact

- Public Imagination
 - Text assistants



AI is having real-world impact

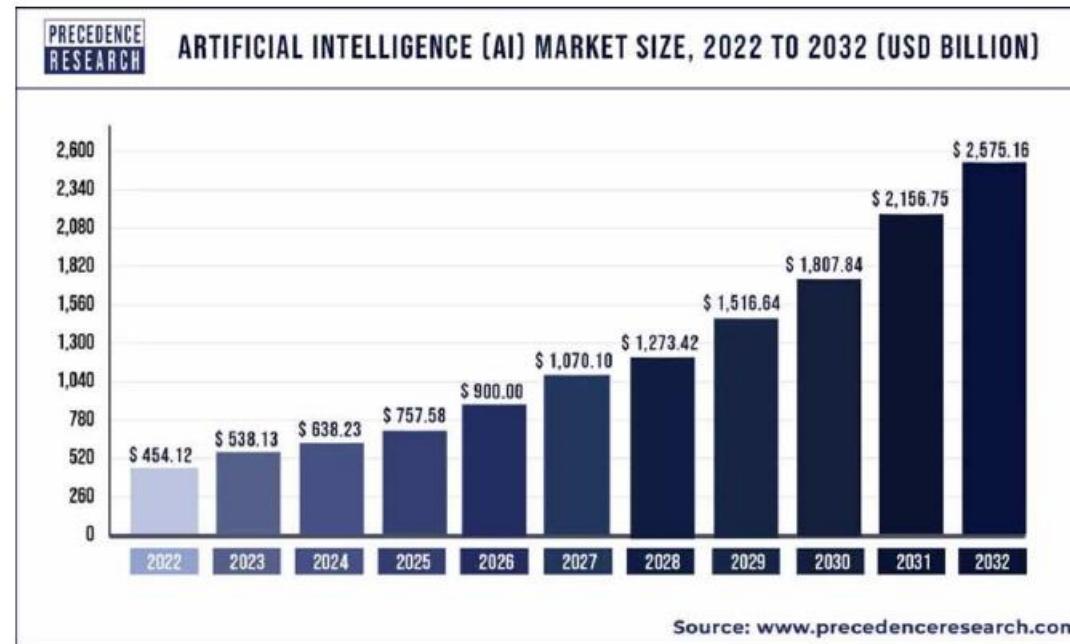
- Public Imagination
 - Text assistants
 - Image Generation



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.



<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
- Economy
- Politics



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



- 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



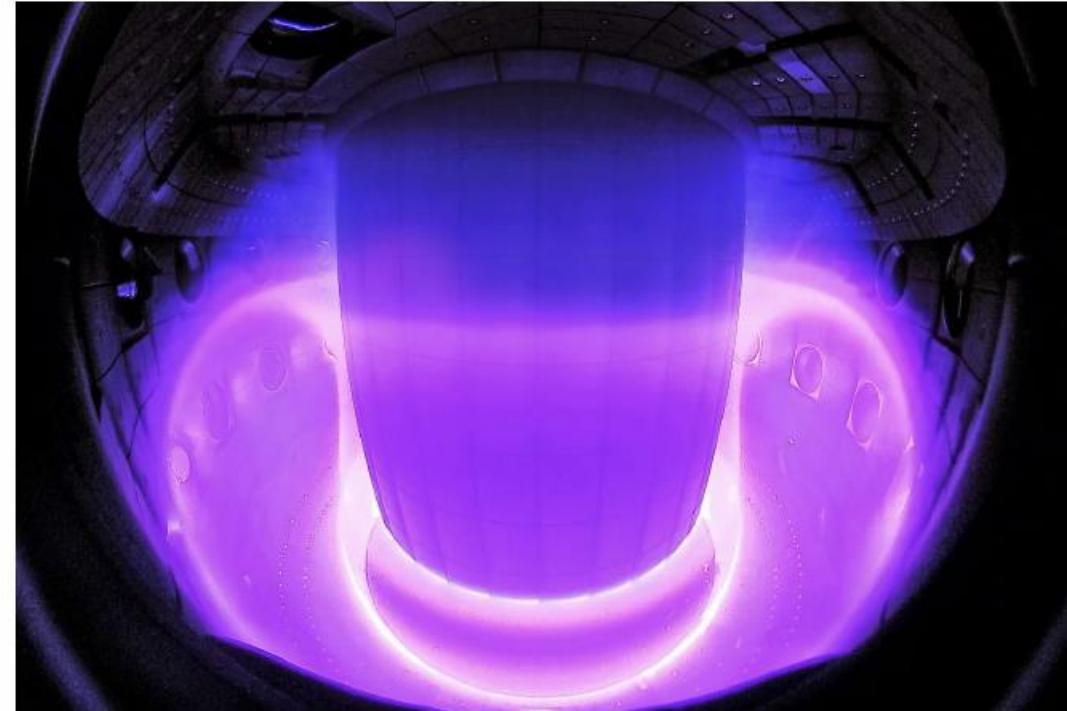
AI is having real-world impact

- 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.



A photograph showing the interior of a tokamak reactor. The central plasma is a bright, glowing purple and blue, surrounded by a complex array of metal coils and structures. The image is taken from a low angle, looking up into the reactor's circular opening.

PHOTOGRAPH: CURDIN WÜTHRICH, SPC/EPFL

Wired, 2022



- 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.

Follow



2

Jan 18, 2023, 02:31pm EST

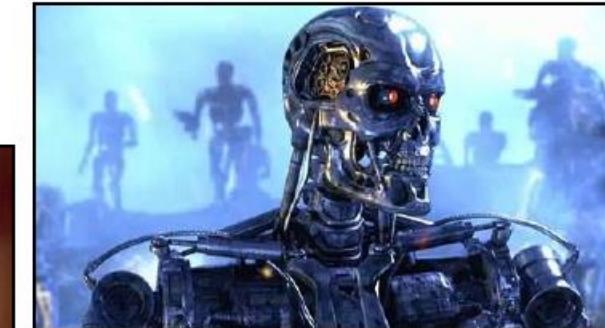
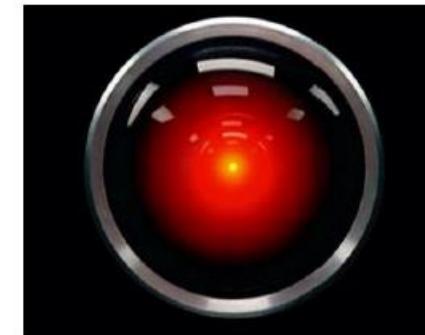
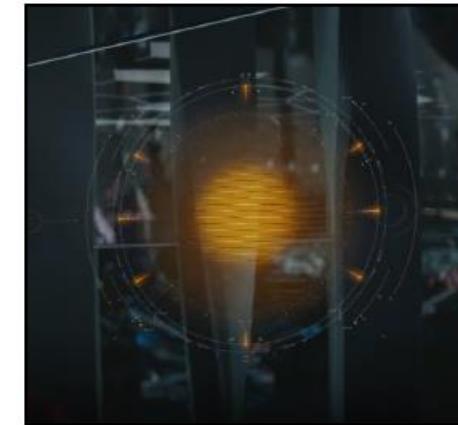
Forbes, 2023



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.

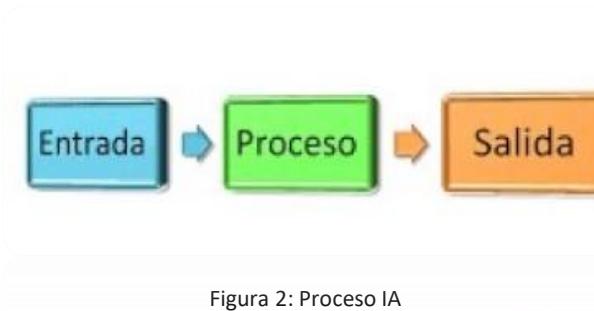


Figura 2: Proceso IA



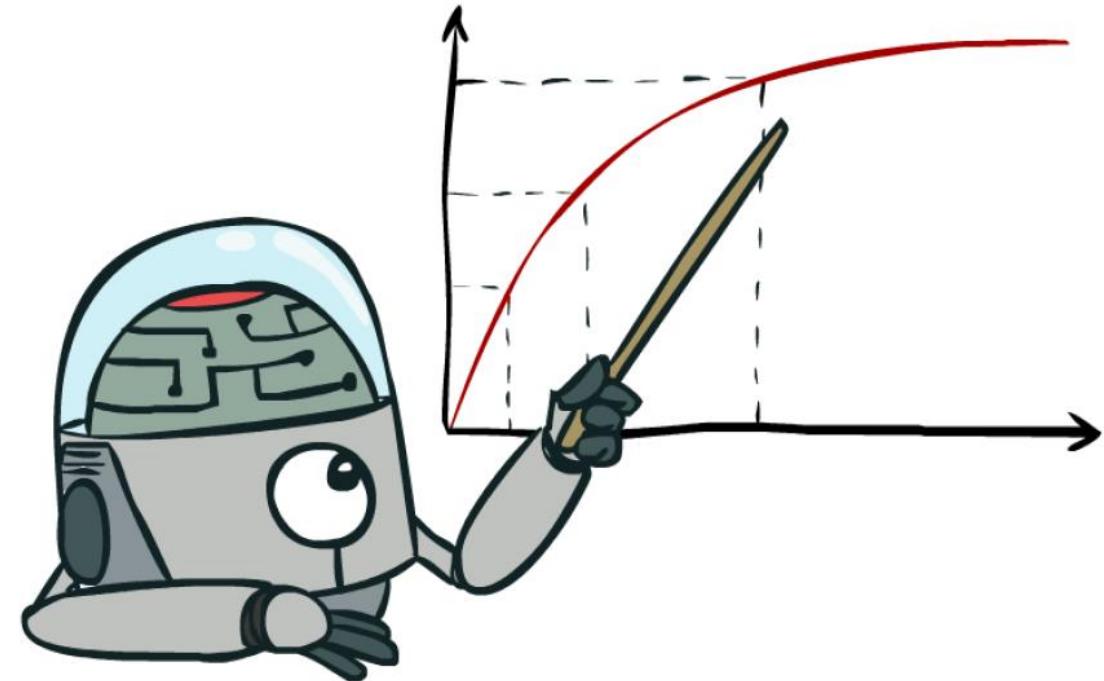
What is AI?



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

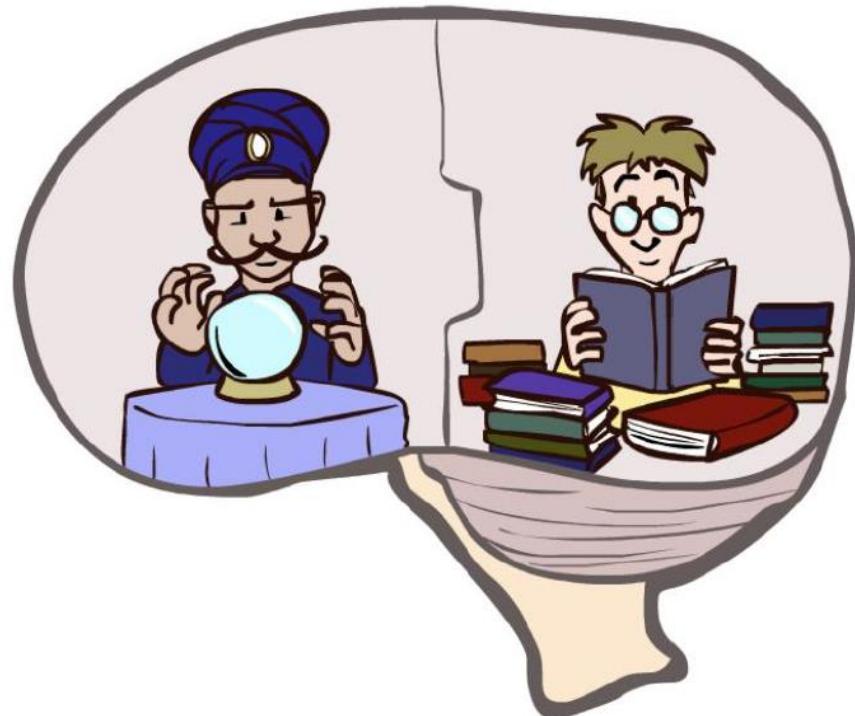
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- A better title for this course would be:
Computational Rationality



What about the brain



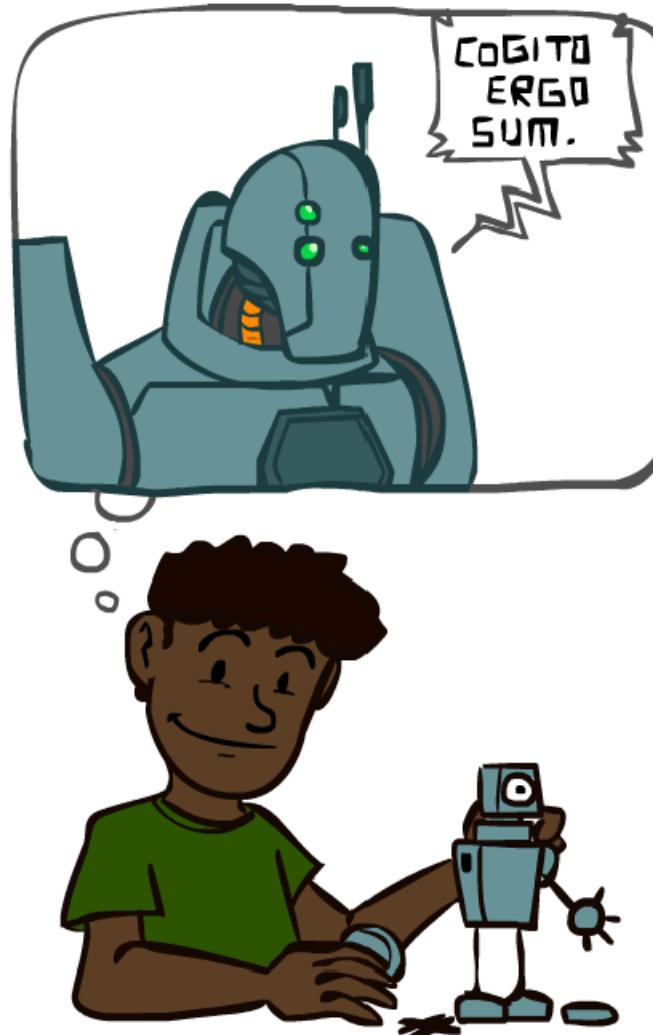
- Brains (human minds) are very good at making rational decisions, but not perfect
- Brains aren't as modular as software, so hard to reverse engineer!
- AI may be better than brains at some tasks
- *"Brains are to intelligence as wings are to flight"*
- We can't yet build AI on the scale of the brain
 - ~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



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.

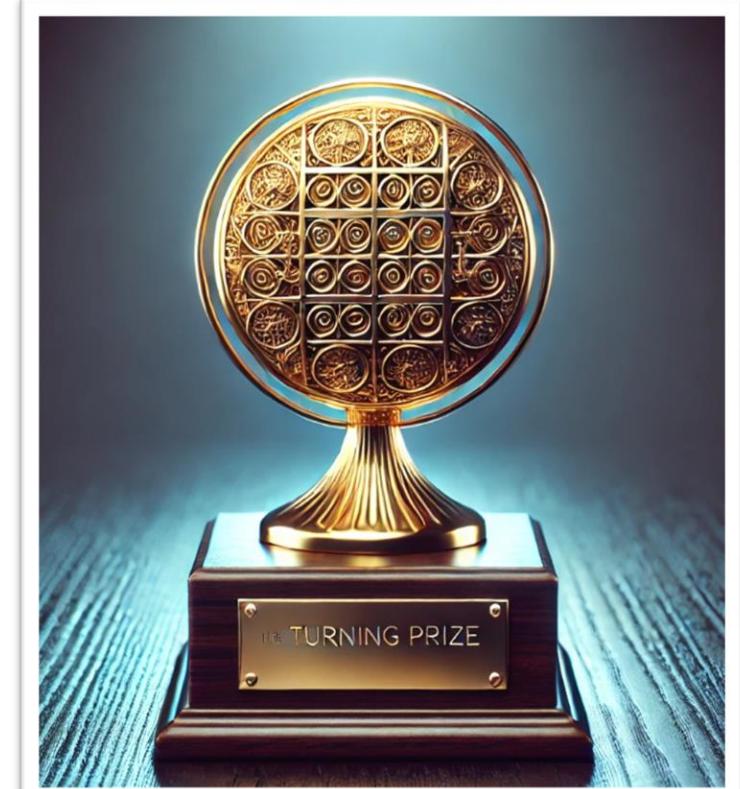


Figura 4: Inteligencia vs
Inteligencia Artificial



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?

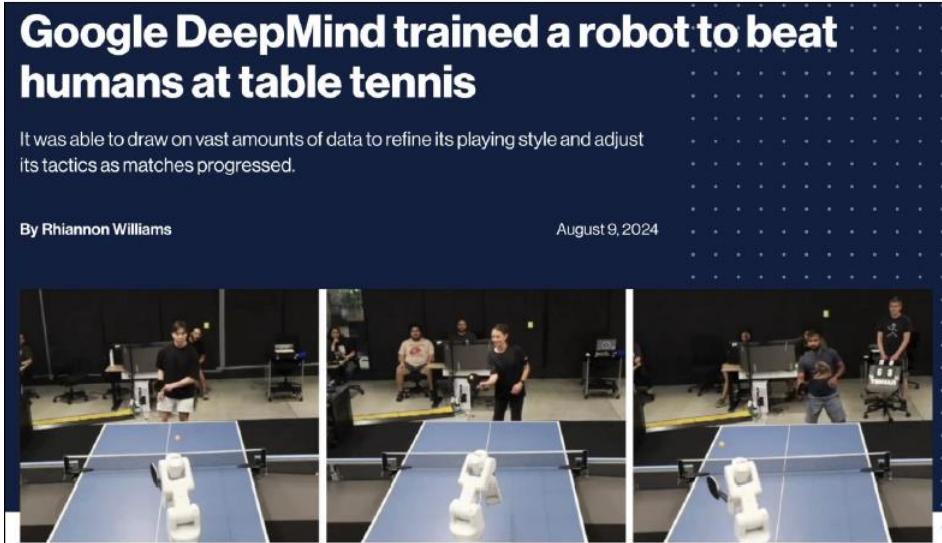
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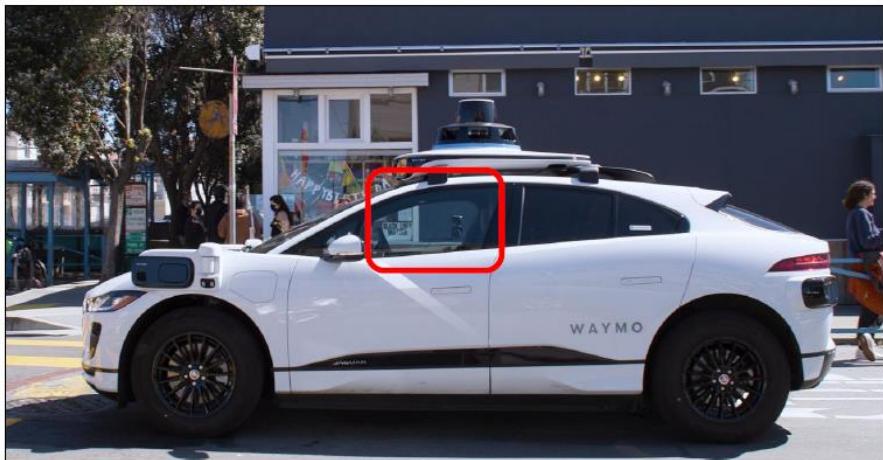
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What about the brain



The Register

California DMV hits brakes on Cruise's SF driverless fleet after series of fender benders

50% chop effective 'immediately' as department investigates traffic and safety issues

Jude Karabas

Mon 21 Aug 2023 14:28 UTC

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

Win against any human at chess?

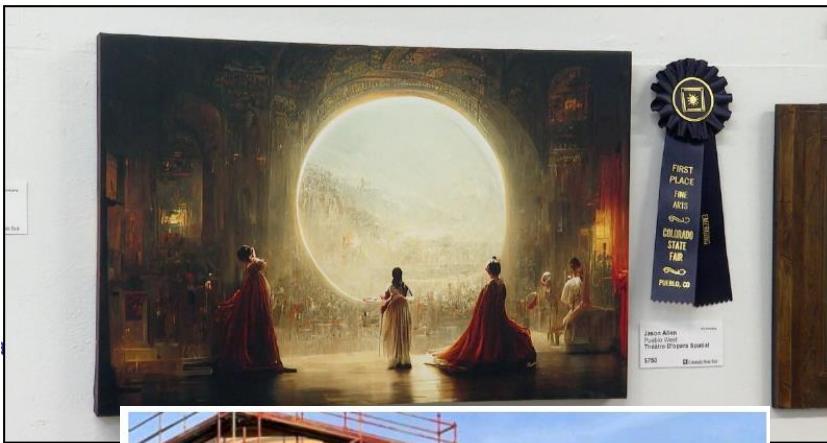
Win against the best humans at Go?

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?**
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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?
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- ➡ Translate spoken Chinese into spoken English in real time?
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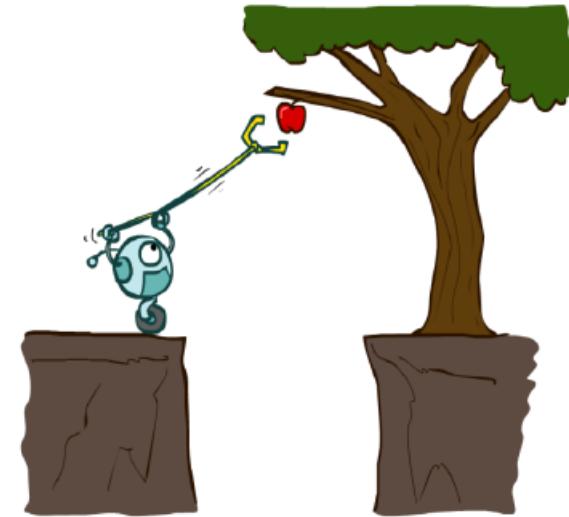
This course: Designing rational agents



This course: Rational Agents

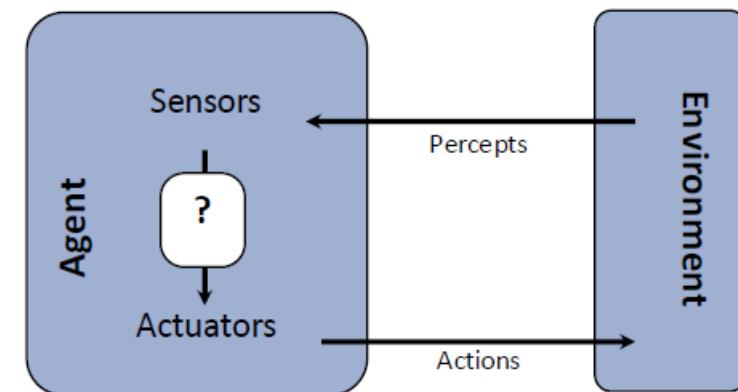
An agent is an entity that perceives and acts.

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

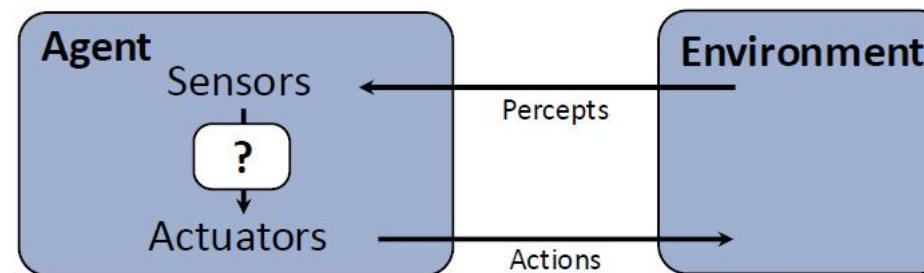
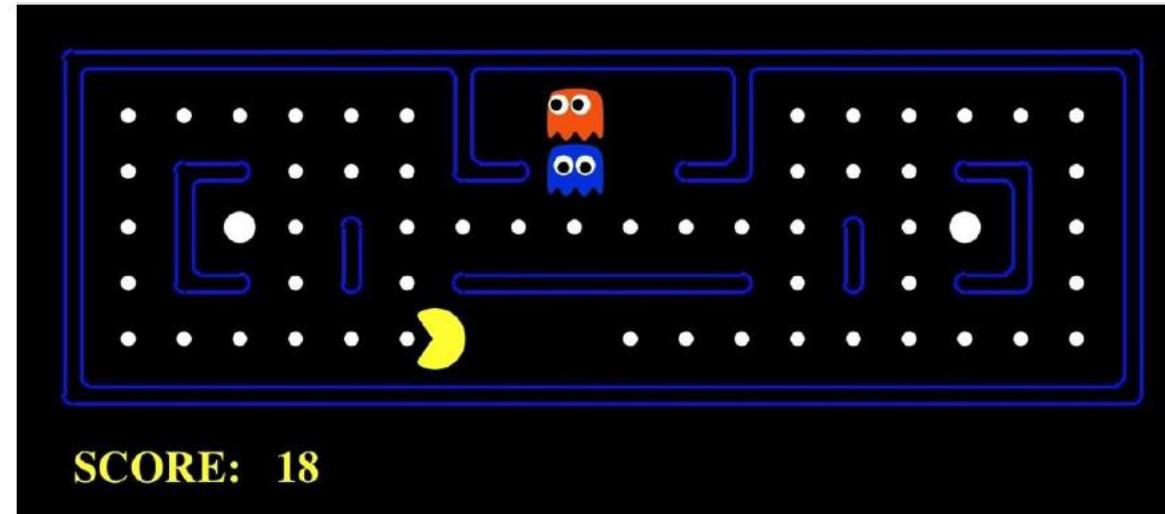


This course is about:

- 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



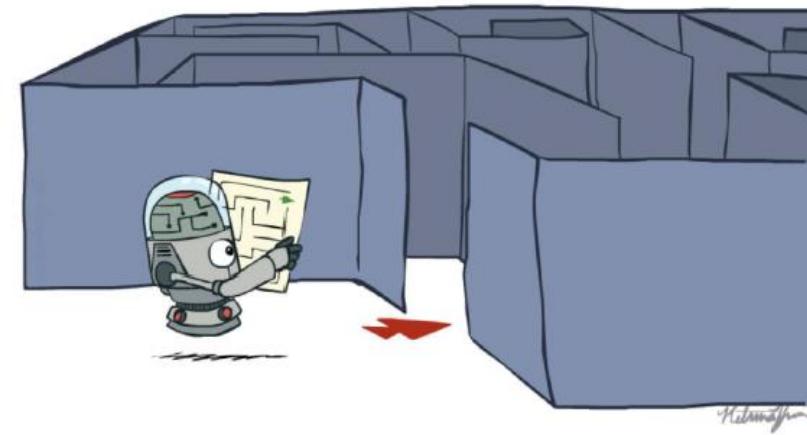
Course Topics

Search &
Planning

Reinforcement
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Probability &
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Supervised
Learning



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



Course Topics

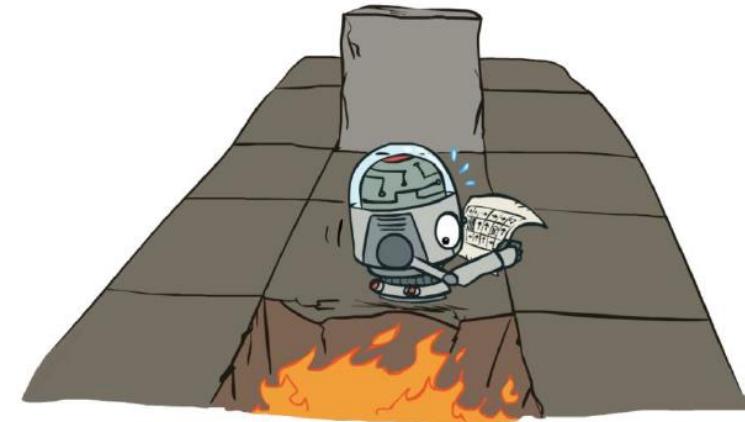
Search &
Planning

Reinforcement
Learning

Probability &
Inference

Supervised
Learning

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



Course Topics

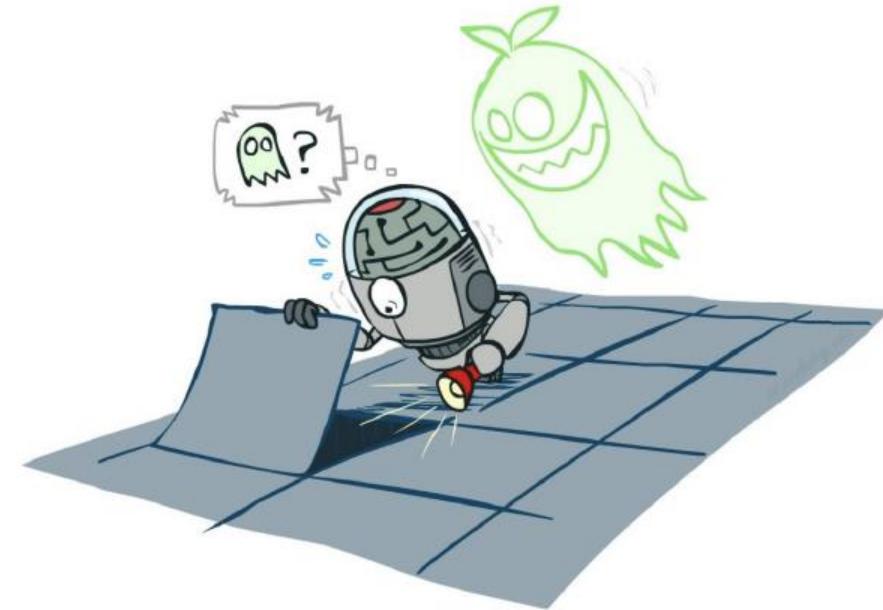
Search &
Planning

Reinforcement
Learning

Probability &
Inference

Supervised
Learning

How to make sense of uncertainty in the world?



Course Topics

Search &
Planning

Reinforcement
Learning

Probability &
Inference

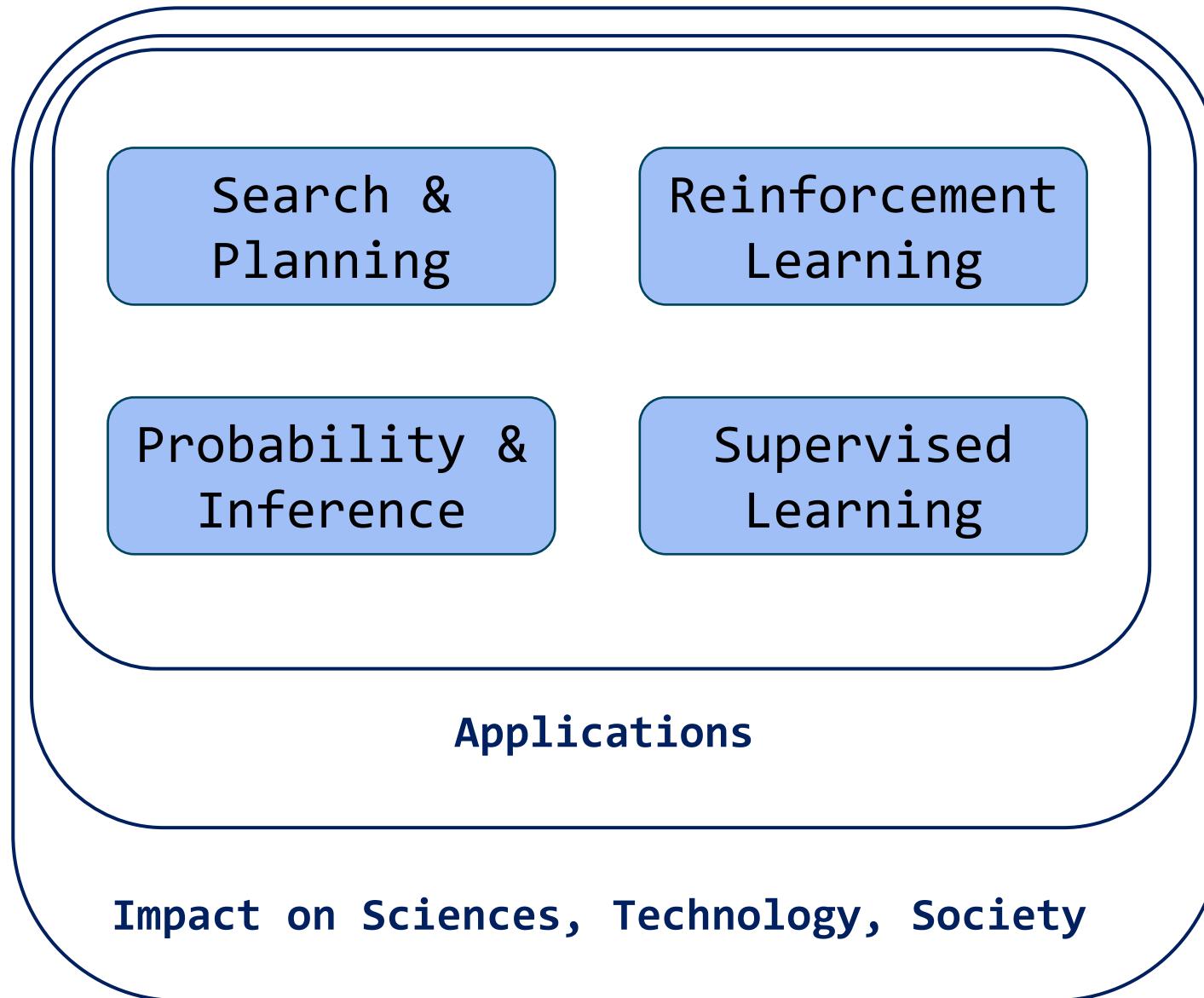
Supervised
Learning



How to learn a model of the world from data?



Course Topics



IN PROGRESS



- 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

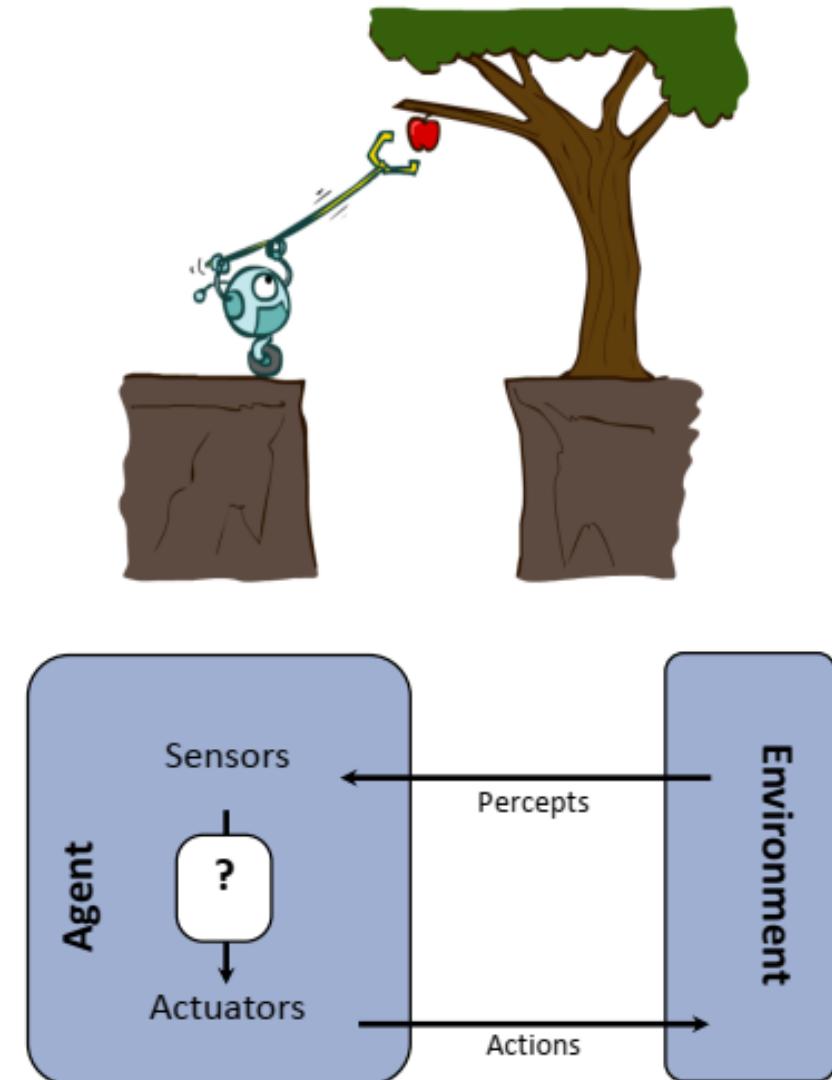
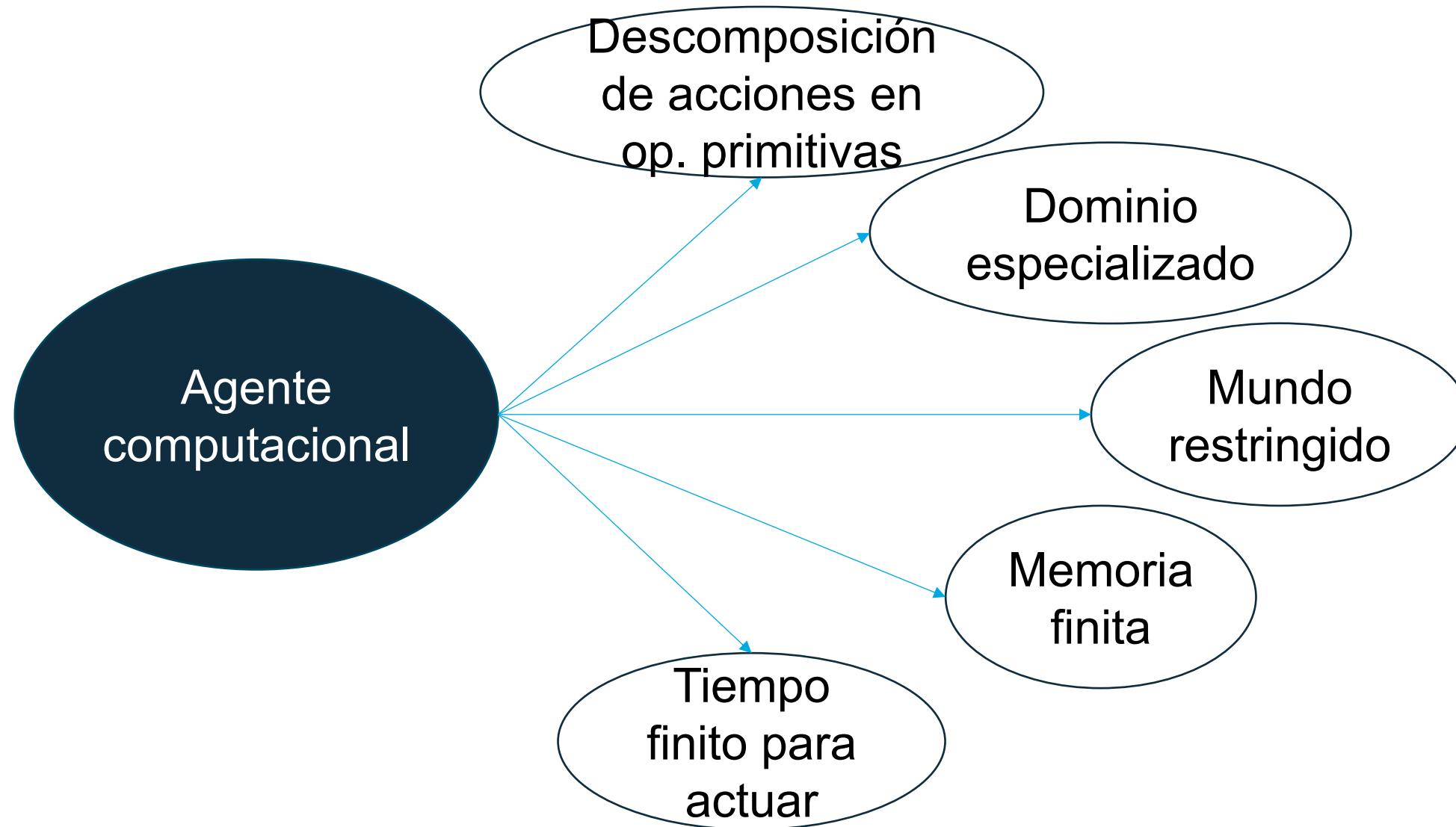


Figura 4: Agente



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.

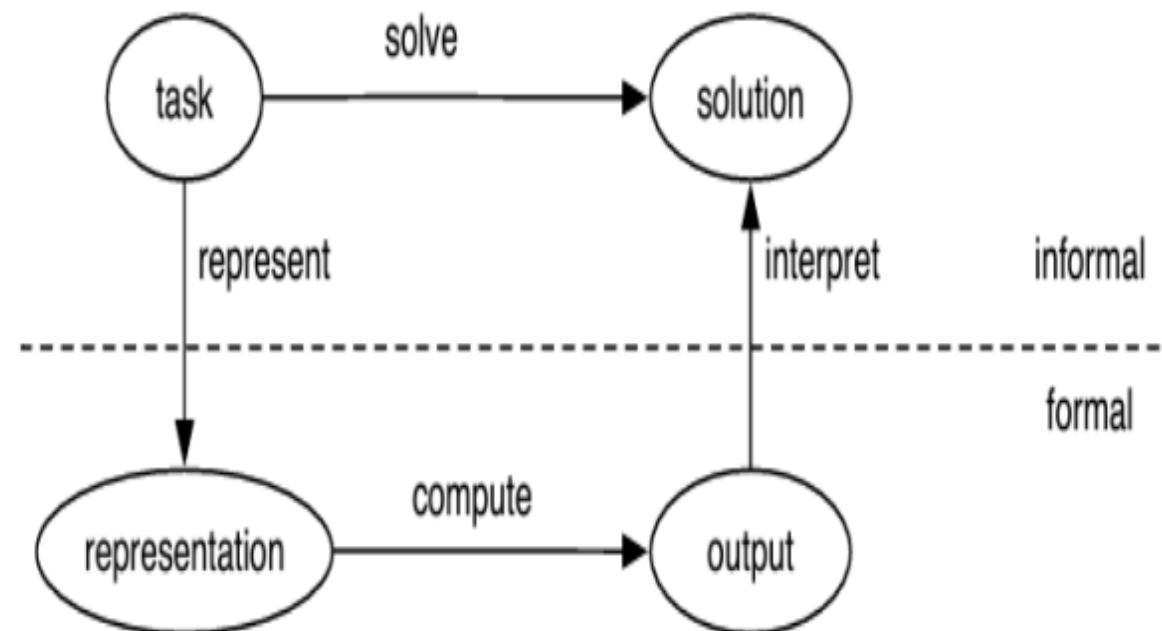


TAREA: Se refiere a una actividad o problema específico que un agente debe resolver o ejecutar. La tarea define los objetivos que el agente debe alcanzar y puede implicar una serie de acciones que el agente debe llevar a cabo en su entorno para cumplir con esos objetivos.



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.



SOLUCIÓN

ÓPTIMA
La mejor de acuerdo con una medida de calidad.

SATISFACTORIA
Suficientemente buena en el marco de acciones adecuadas.

APROX. ÓPTIMA
Donde la medida de calidad es cercana a la solución óptima.

PROBABLE
Aunque no sea la solución definida, puede ser una solución.



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**.

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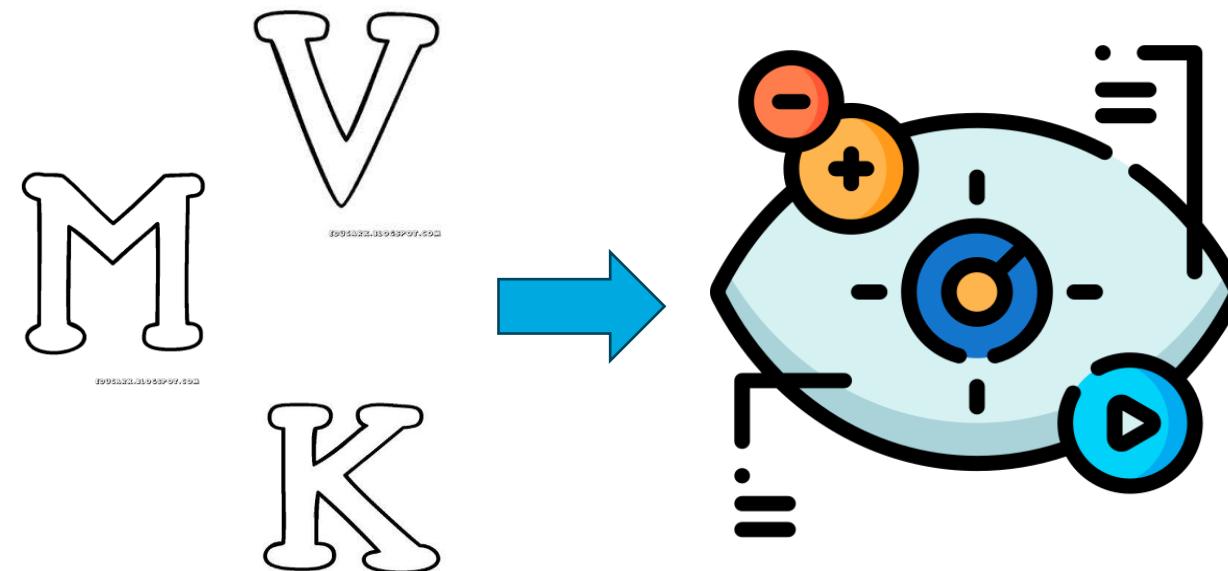


INTELIGENCIA

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

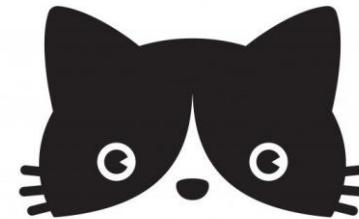
Ejemplos de Símbolos Físicos

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



Actividad:

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

- 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?



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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