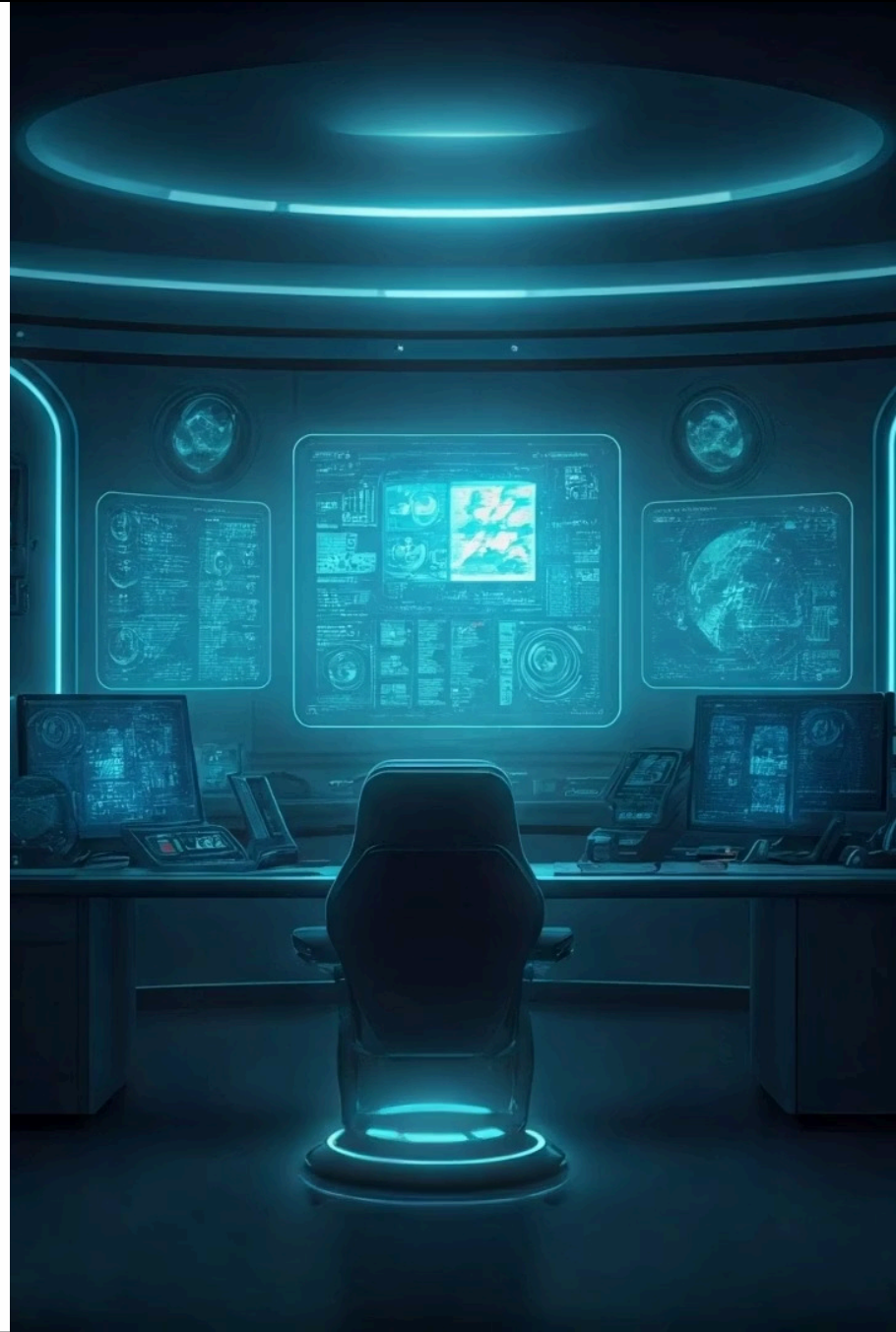
Introduction to AI

by Iván Ruiz Rube / Andrés Muñoz Ortega



Contents

- Artificial Intelligence
- Machine Learning
- GenAI
- AI Applications
- AI Applications at the University

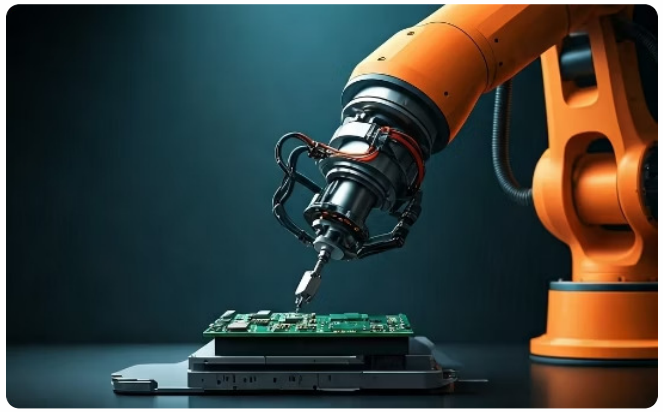
Artificial Intelligence

What is Artificial Intelligence?

- Artificial Intelligence

  A branch of computer science focused on creating systems capable of performing tasks that require human intelligence.

Types of Artificial Intelligence



Narrow AI

Specialised in specific tasks.

General AI

Capable of performing any intellectual human task.

Superintelligent AI

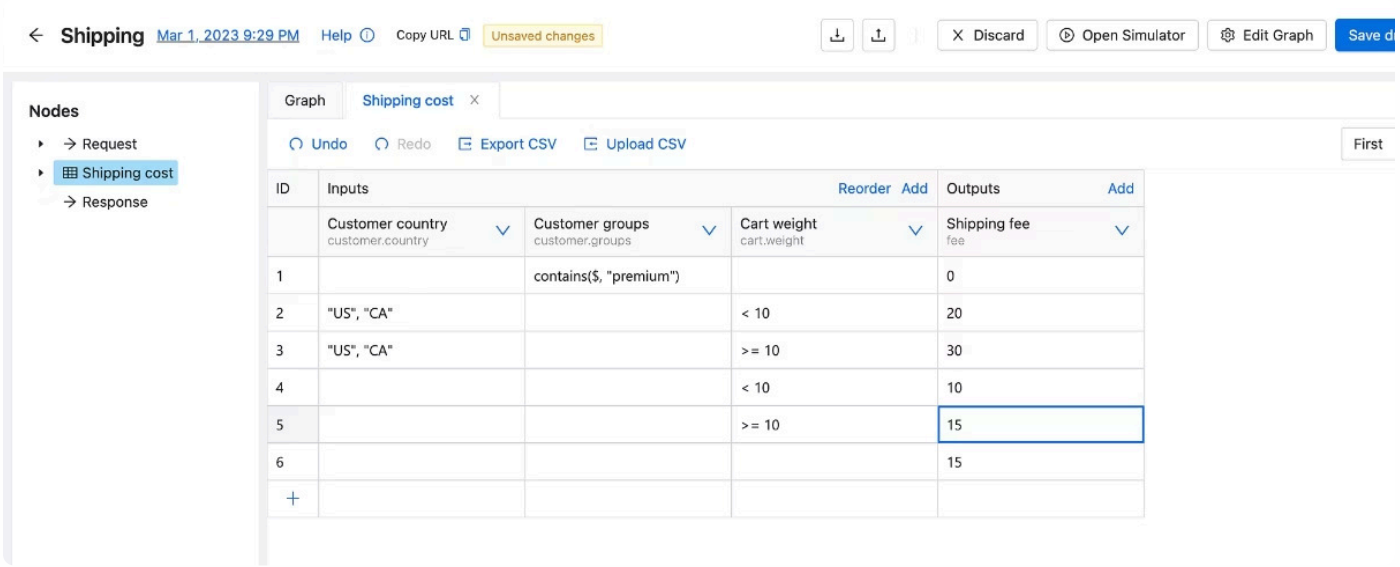
Exceeds human intelligence in all fields. **Technological singularity?**

Do you remember Deep Blue?

Before ChatGPT...

Name your AI tools you use for research/development before ChatGPT

Business Rule-Based Systems



Definition

Expert systems that imitate human decision-making through predefined rules and a knowledge base.

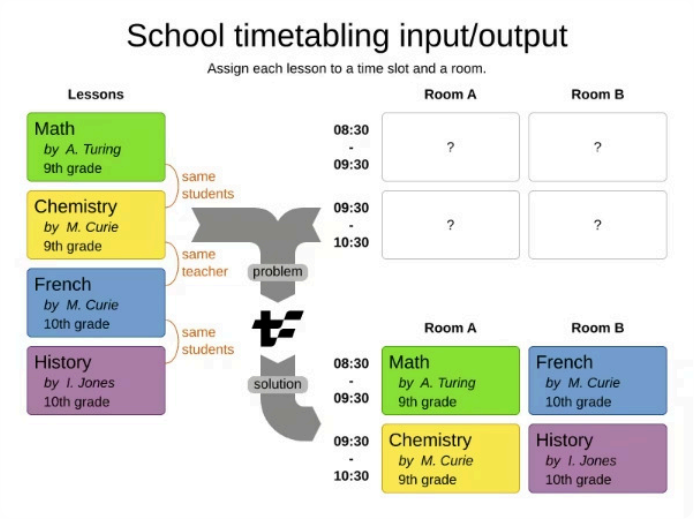
Applications

Anomaly detection, recommendation systems, etc.

Algorithms

Use "if-then" rules, domain-specific languages (DSLs) or decision tables on business rule engines, such as **Gorules**

Search-based systems



Definition

Systems aimed at solving complex problems by exploring possible solutions in a finite or infinitely large space of alternatives.

Applications

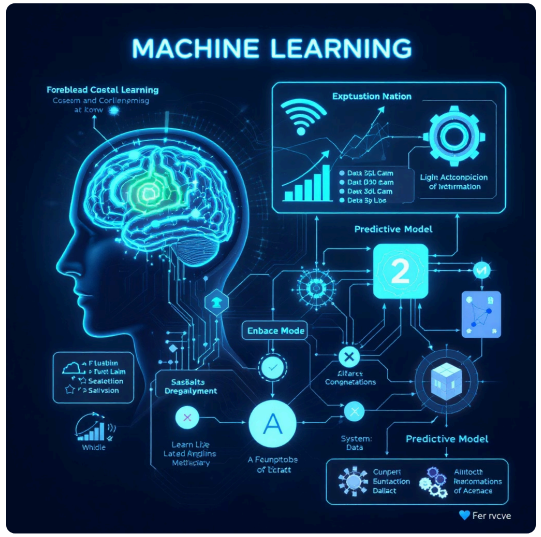
Resource allocation, task planning, route calculation, etc.

Algorithms

Optimisation algorithms such as local search and metaheuristics (simulated annealing, tabu search). Frameworks like **timefold** offer them ready to use.

Machine Learning

Machine Learning: The Heart of Modern AI



Machine Learning

Machine learning focuses on the development of algorithms that allow systems to learn to perform tasks without explicit instructions.

Model Building

These systems learn by analysing existing data to build a model that can solve tasks on previously unseen data.

Machine Learning: The Heart of Modern AI

1 Supervised Learning

Algorithms learn from labeled training data. Models predict outcomes based on past examples.

2 Unsupervised Learning

Systems find hidden patterns in unlabeled data. Clustering and dimension reduction reveal underlying structures.

3 Reinforcement Learning

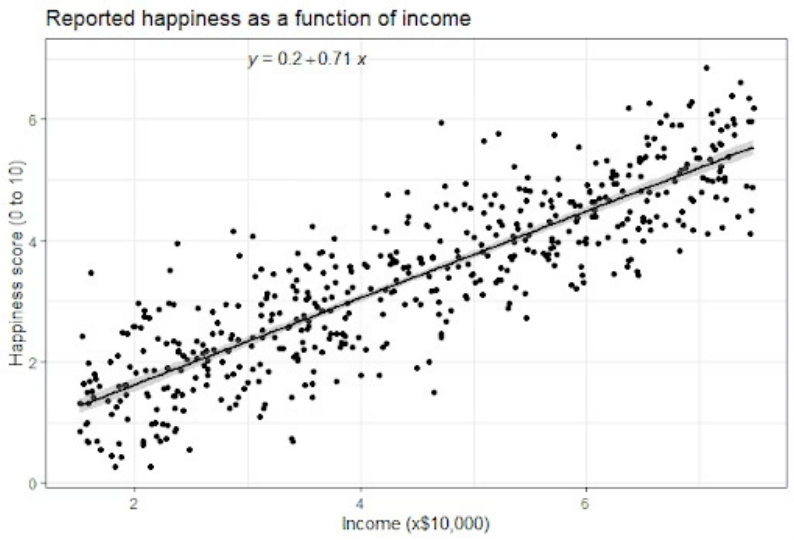
Agents learn optimal behaviors through trial and error. Actions receive rewards or penalties in dynamic environments.

4 Deep Learning

Neural networks with multiple layers process complex patterns. Powers breakthroughs in vision, language, and generative AI.

Regression

ID_Curso	Curso_Académico	Inscripciones_Pasadas	Encuesta_Curso	Porcentaje_Aprobados	Predicción_Demanda
507	2023-2024	202	4.1	62	210
701	2022-2023	150	3.2	51	160
702	2023-2024	170	4.3	49	175
704	2022-2023	180	5.0	43	190
705	2023-2024	160	2.1	22	140
706	2022-2023	155	3.4	30	150
707	2023-2024	185	4.1	51	195
708	2022-2023	270	4.8	43	280
709	2023-2024	197	2.9	39	205
710	2022-2023	201	4.0	42	220



Definition

Supervised learning systems that predict continuous numerical values based on historical data.

Applications

Demand forecasting, price estimation, etc.

Algorithms

Linear regression, polynomial regression, etc.

Classification

	ID_Estudiante	Notas_Parciales	Asistencia	Tareas	Actividades_Extra	Rendimiento
1	1	95	95	18	Sí	Alto
2	2	70	83	9	No	Medio
3	3	80	60	8	No	Bajo
4	4	95	85	12	Sí	Alto
5	5	48	75	4	No	Medio

Definition

Supervised learning systems that predict the **category** of new records based on labelled data.

Applications

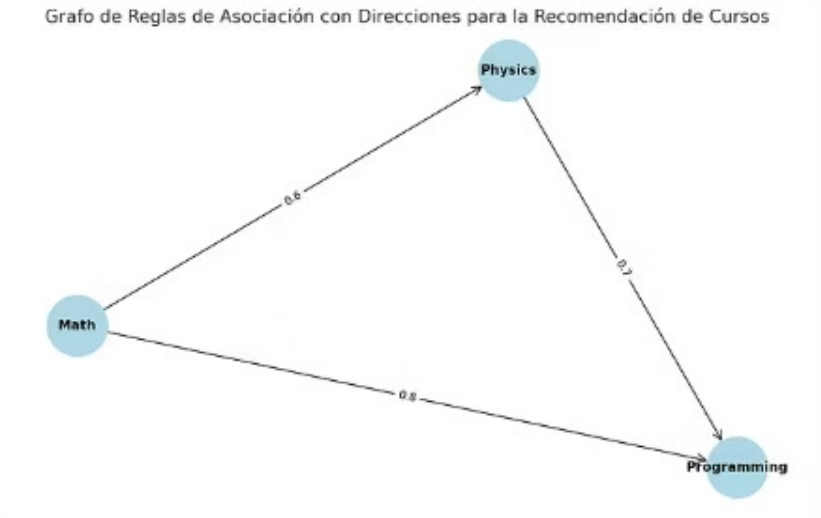
Spam detection, disease diagnosis and document classification, etc.

Algorithms

Support Vector Machines, Logistic Regression, Random Forest

Association Rules

Student_ID	Math	Physics	Programming
1	1	1	1
2	1	0	1
3	0	1	1
4	1	1	1



Definition

Unsupervised learning systems that discover interesting **relationships** between variables in datasets.

Applications

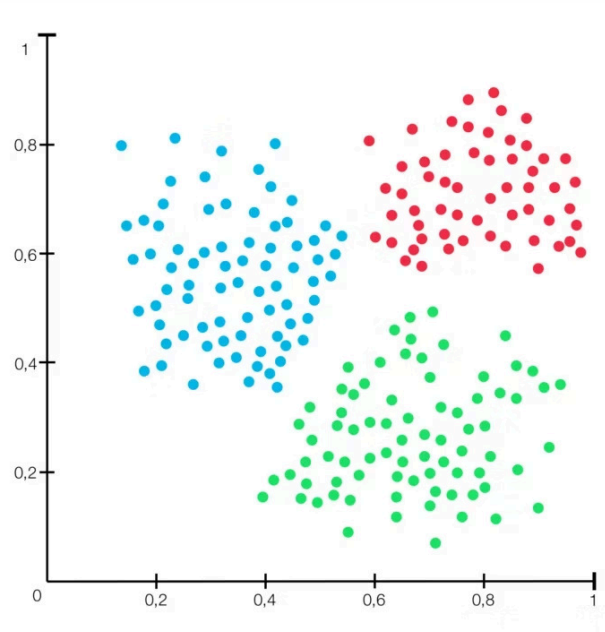
Market basket analysis, product recommendations and fraud detection.

Algorithms

Apriori and FP-Growth are common for finding frequent patterns in large datasets.

Clustering

Docente	Foros_Discussion	Examenes_En_Línea	Lecciones_Interactivas	Recursos_Multimedia	Cluster
Docente A	10	2	4	15	0
Docente B	5	1	6	10	1
Docente C	3	0	5	28	1
Docente D	8	3	7	10	0
Docente E	2	5	1	5	1



Definition

An **unsupervised** learning system that allows the discovery of groups of similar objects in unlabelled data, revealing hidden patterns.

Applications

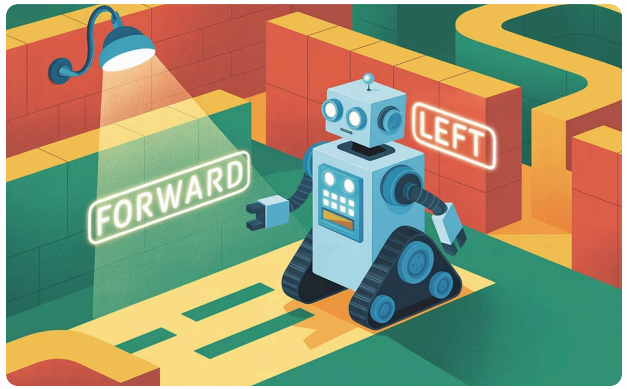
Customer segmentation, social network analysis and grouping of similar documents.

Algorithms

K-Means, Hierarchical Clustering, etc.

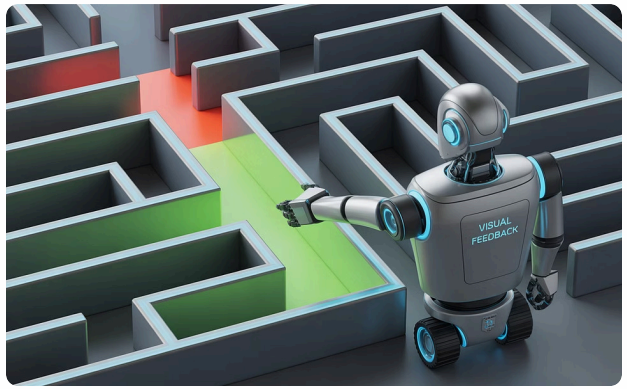
Reinforcement Learning

Reinforcement learning helps systems learn by trying things and getting feedback. A good example is a robot learning to find its way through a maze.



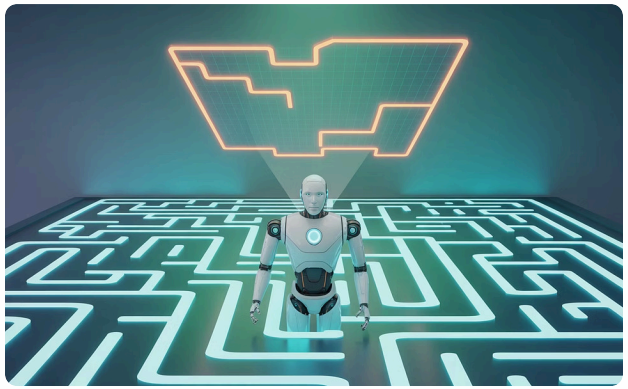
Exploration

The robot is put in the maze and tries different moves like going forward or turning to see what works.



Feedback

The robot gets rewards when it moves toward the exit and penalties when it hits walls or goes the wrong way.

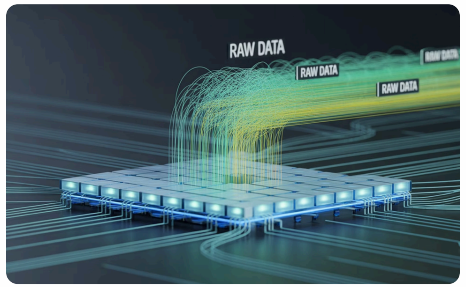


Learning

After many tries, the robot learns which moves work best. It builds a map in its memory to find the best path out.

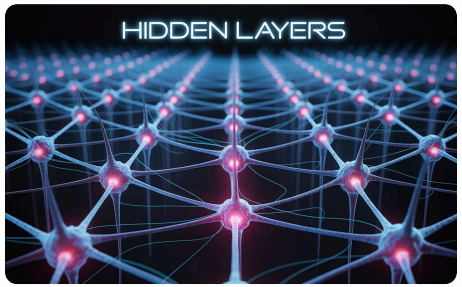
This try-and-test method helps the robot learn without someone telling it exactly what to do. This type of learning is used in games, self-driving cars, and managing resources.

Deep Learning



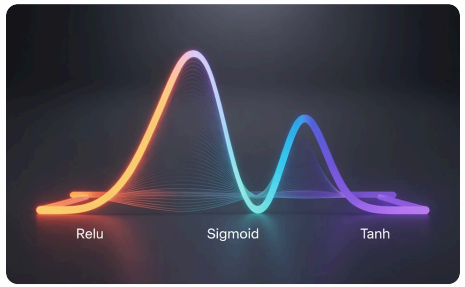
Input Layer

- Receives raw data (images, text, audio)
- Standardizes information for processing
- Prepares features for neural network analysis



Hidden Layers

- Multiple processing layers extract features
- Each neuron transforms data using weights
- Complex patterns emerge through hierarchical learning



Activation Functions

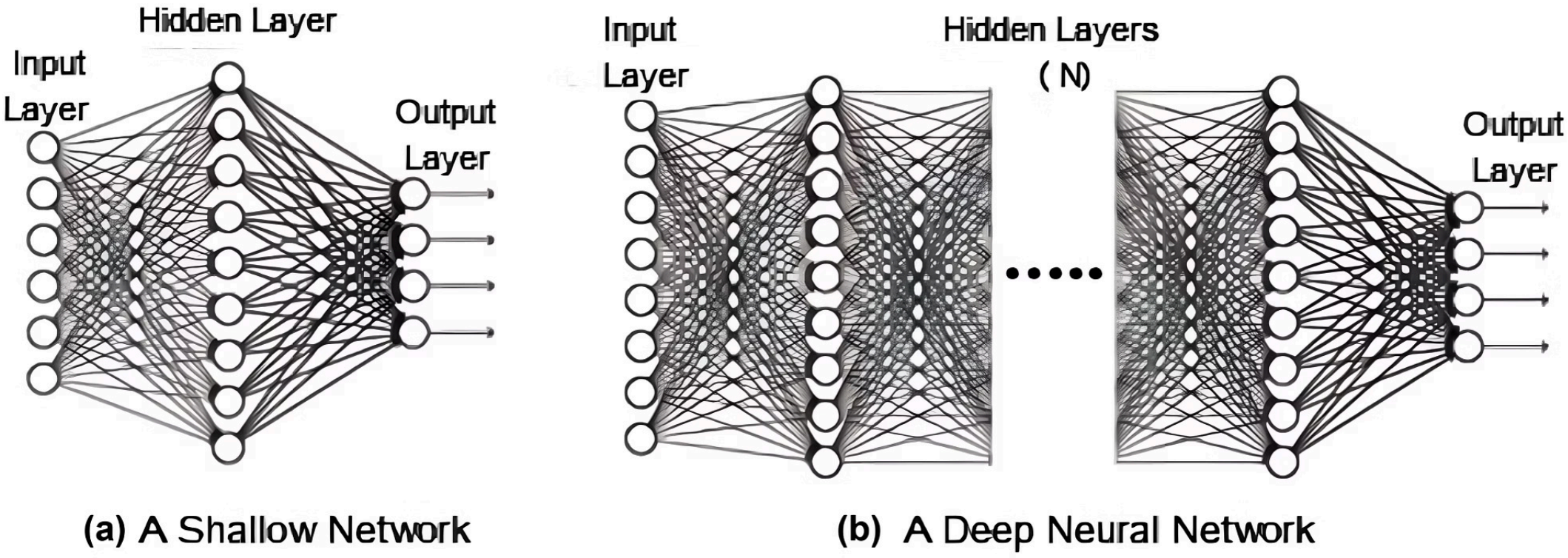
- ReLU, sigmoid, or tanh transform signals
- Introduce non-linearity for complex modeling
- Enable networks to learn sophisticated patterns

Output Layer

- Produces final predictions or classifications
- Confidence scores guide decision-making
- Results drive applications across industries

Deep learning systems learn through backpropagation. This process adjusts weights by comparing outputs with correct answers. Training requires vast datasets and significant computational power.

Deep Learning



Deep Learning in Action

Facial Recognition

Deep neural networks learn facial features from millions of images. They can identify individuals with remarkable accuracy across lighting conditions.

Autonomous Vehicles

Deep learning helps cars interpret complex road scenes. The systems process camera and sensor data to navigate safely.

Medical Diagnostics

Deep learning models analyze medical images to detect diseases. They often match or exceed human doctors in diagnostic accuracy.

Machine Learning vs. Deep Learning

Machine Learning

Algorithms learn patterns from data without explicit programming.

- Requires feature engineering by humans
- Works well with smaller datasets
- Less computational resources needed
- More interpretable results

Common algorithms include decision trees, random forests, and support vector machines.

Deep Learning

Neural networks with multiple layers that automatically extract features.

- Automatic feature extraction
- Requires massive datasets
- Demands significant computational power
- Often works as a "black box"

Excels in complex tasks like image recognition, natural language processing, and speech recognition.

Machine Learning Frameworks

Weka 3 - Open Source Machine Learning Software in Java

Weka is an open-source machine learning software published under the GNU General Public License.

scikit-learn: Machine Learning in Python — scikit-learn 1.5.2 documentation

Applications: spam detection, image recognition. Algorithms: gradient boosting, nearest neighbours, random forest, logistic regression and more...

MLlib | Apache Spark

MLlib is the scalable machine learning library of Apache Spark, with APIs in Java, Scala, Python and R.

GenIA

Generative AI: The Future of Digital Creativity

Generative AI is revolutionising the creation of digital content. This technology uses deep neural networks to produce text, images, music and more.

Fundamentals of Generative AI

Machine Learning

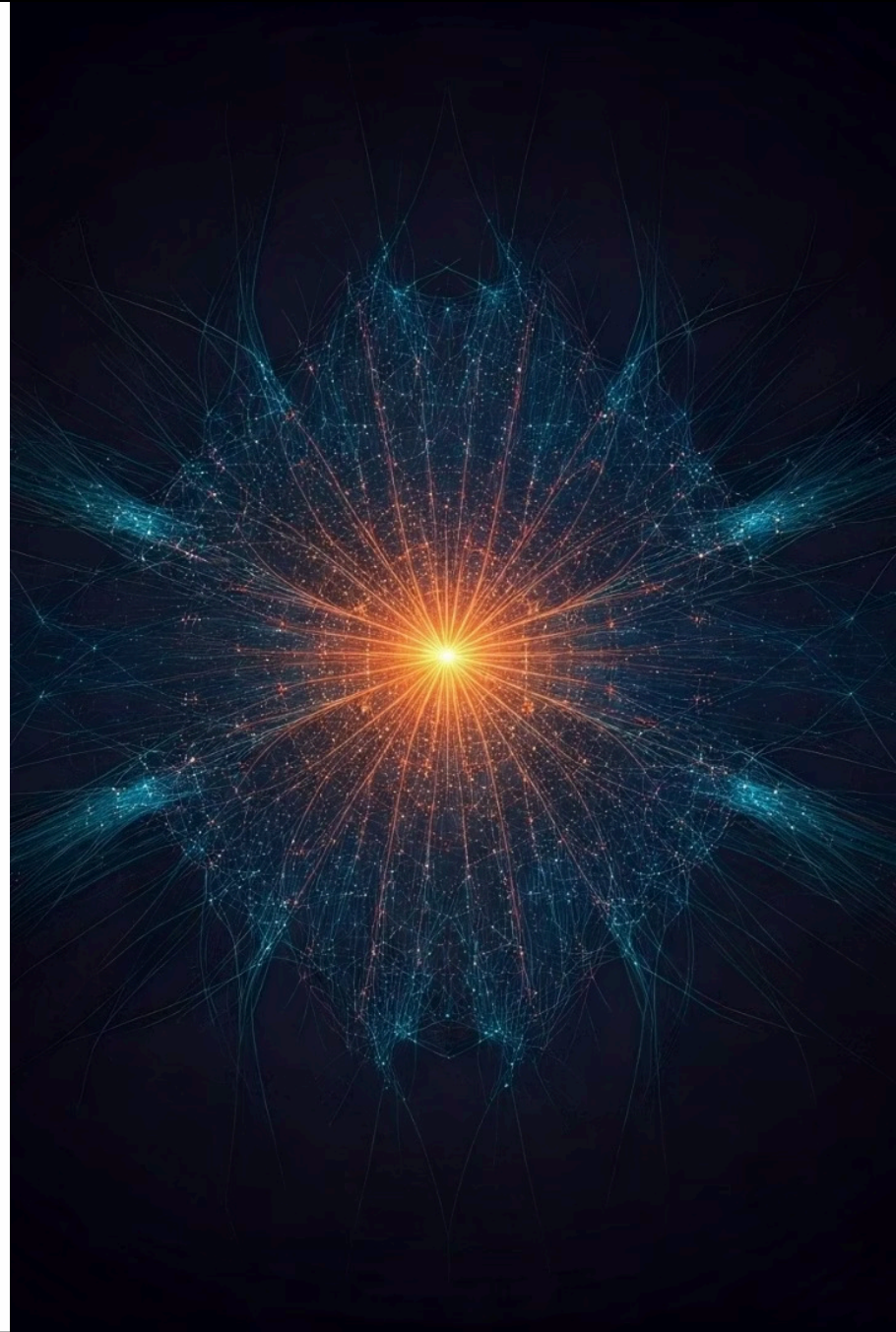
They use supervised, unsupervised and reinforcement learning techniques to create models capable of generating coherent and relevant content.

Deep Neural Networks

Complex structures inspired by the human brain. Systems trained on large volumes of data.

Pre-Trained Models

Availability of generative models for different purposes and with different capabilities. They can be re-trained to improve and specialise in certain tasks.



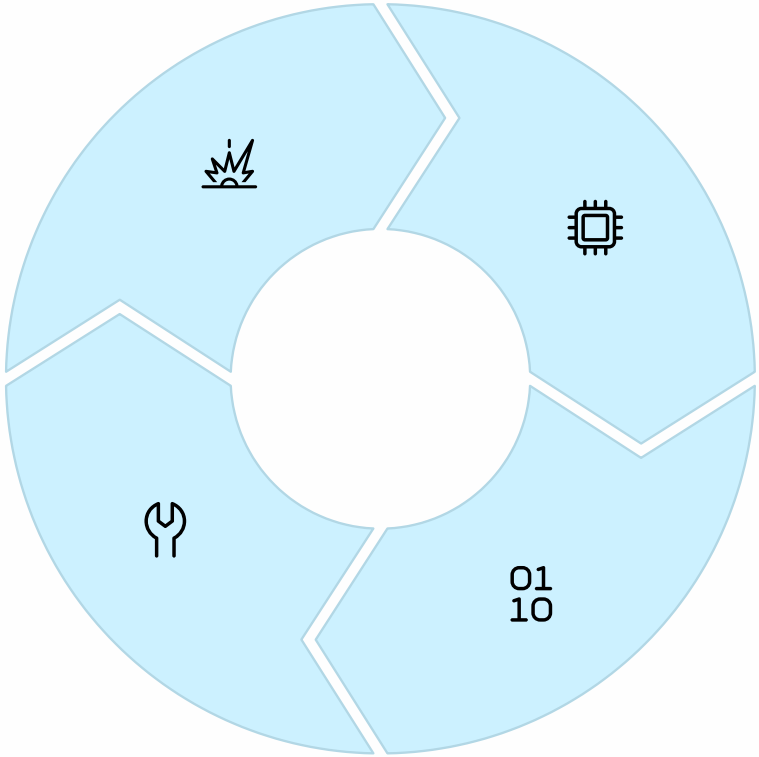
Drivers of Generative AI

Data Explosion

The internet, mobile devices, and sensors generate massive amounts of information. They provide the fuel to train more powerful models.

Development Platforms

Tools like TensorFlow and PyTorch democratize AI. They facilitate experimentation and application development.



Computing Capacity

GPUs and TPUs have accelerated the training of complex models. They allow processing large volumes of data in parallel.

Algorithmic Advances

New architectures like CNNs and Transformers. They improve the efficiency and capability of AI models.

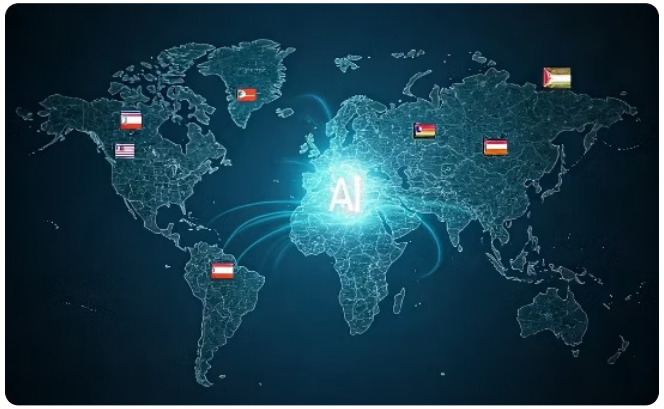
Text Generation

Advanced Chatbots

Models like GPT-4 enable natural conversations. They can answer questions, provide technical support, and more.

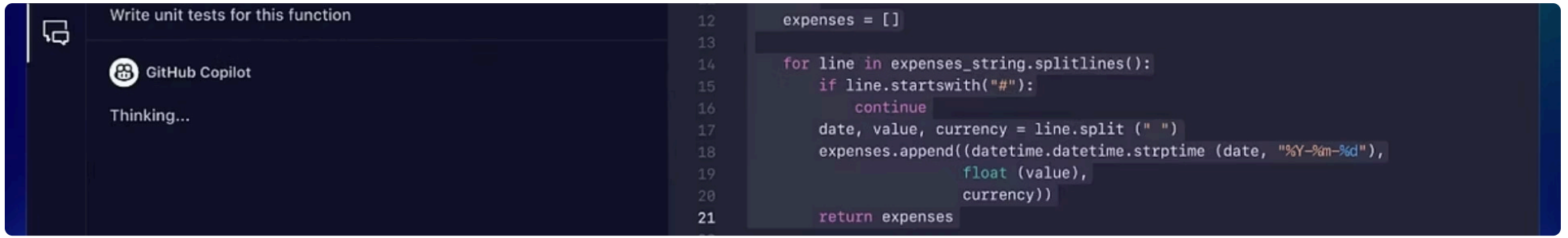
Content Generation

Automated creation of articles, reports, and summaries. Helps developers produce technical documentation efficiently.



Translation and Localisation

Improves the adaptation of applications to different languages and cultures. Facilitates the global expansion of software products.



Source Code Generation

Intelligent Auto-completion

Suggests code lines based on context. Increases programmer productivity.

Automated Refactoring

Improves the quality of existing code. Applies design patterns and best practices.

Test Generation

Automatically creates test cases. Improves test coverage and quality.

Migrations

Translates code between different programming languages and/or frameworks.

Documentation Generation

Creation of user manuals, technical documentation, diagrams, etc.

Problem Solving

Identification of errors and solutions.

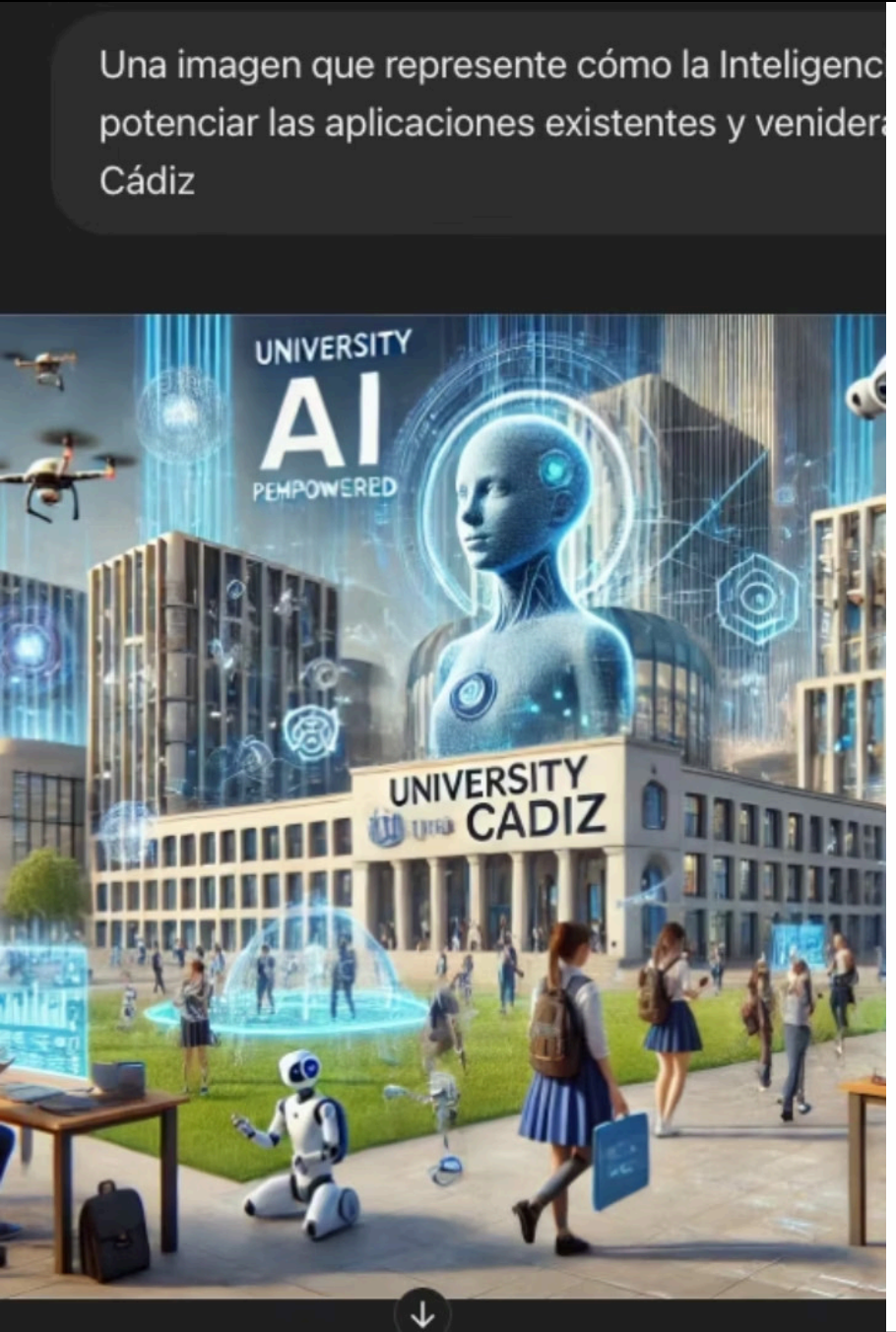


Image Generation

UI/UX Design

Quickly create mockups and prototypes. Accelerate the interface design process.

Data Visualisation

Automatically generate charts and infographics. Improve the presentation of complex information.

Customised Avatars

Create unique representations for users. Enrich the experience in social applications.

Backgrounds and Textures

Generate graphic assets for applications. Reduce design and production costs.

Audio Generation

AI can create high-quality music, sound effects, and voice. AI models can even learn to imitate the style of a specific artist. This opens up new possibilities for music creation and multimedia content production.

suno_ai_

Universidad de Cádiz by @cheekyclavichord322 | Su...

inspirador pop rítmico song. Listen and make your own with Suno.

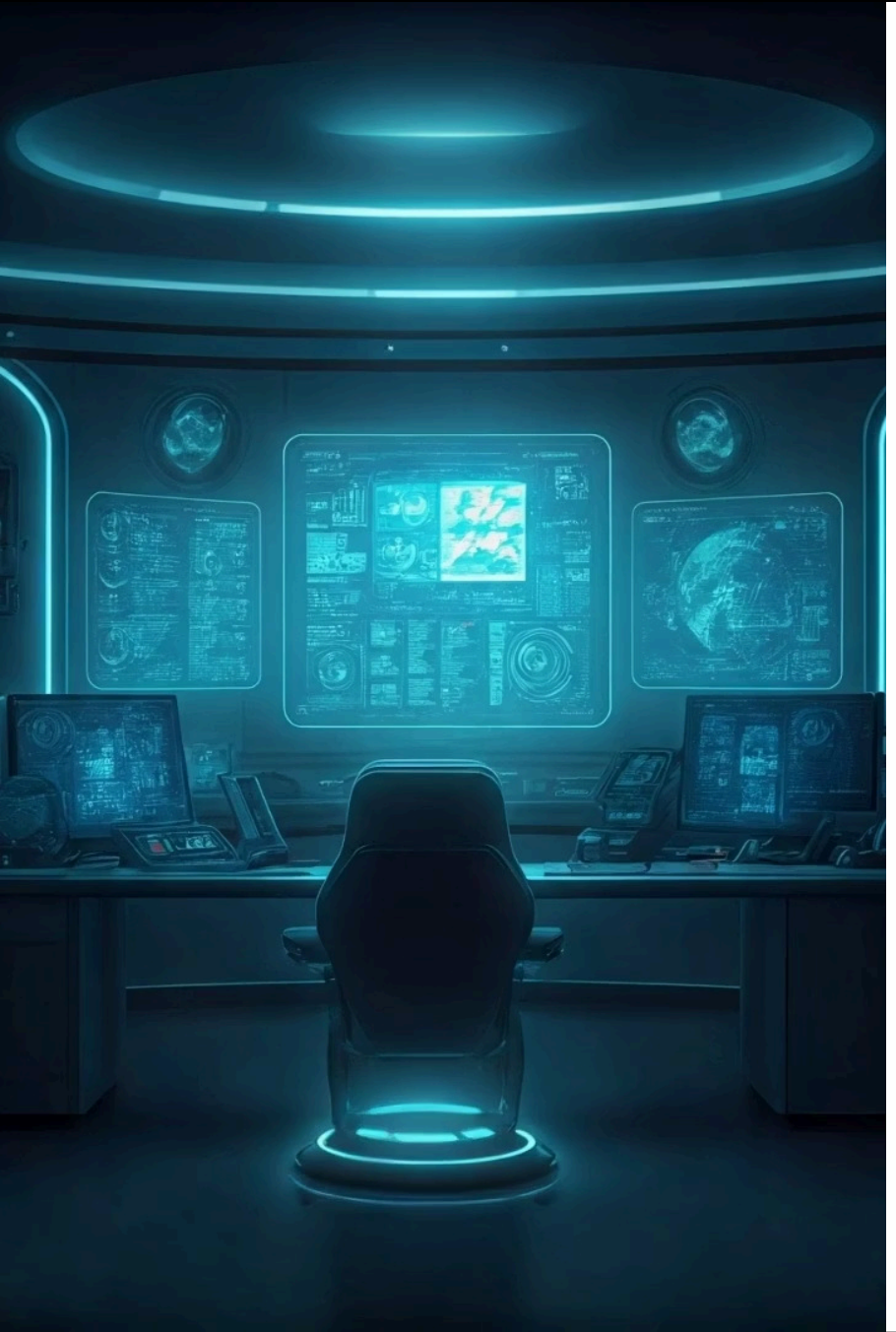
Video Generation

YouTube

Explode it seed2551689592

AI models can generate realistic videos, animations and visual effects that previously required hours of manual work.

Applications of AI



AI in Health and Medicine

Assisted Diagnosis

Analysis of medical images and symptoms.

Drug Development

Acceleration in the creation of new medicines.

Patient Monitoring

Real-time tracking of vital signs.

AI in Transport and Mobility

1

Autonomous Vehicles

Driving without human intervention.

2

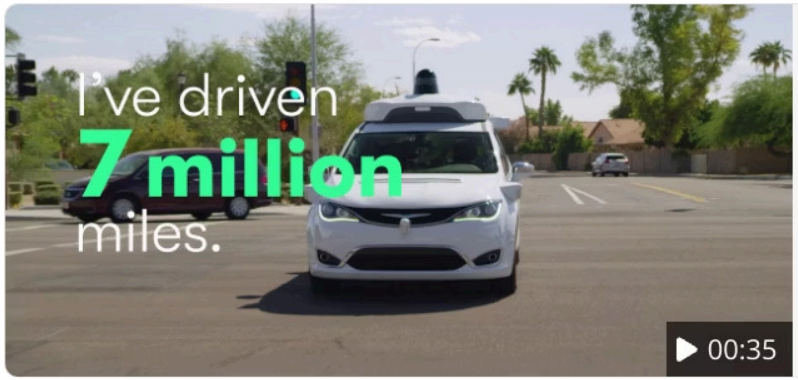
Traffic Management

Optimisation of flows and reduction of congestion.

3

Intelligent Logistics

Efficient planning of routes and deliveries.



YouTube

Hello from Waymo (Formerly the Google Self-Driving Car Project)

Waymo—formerly the Google self-driving car project—has autonomously-driven more than 8 million miles to date. Be one of the first to ride with Waymo in Phoeni...

AI in Financial Environments

Fraud Detection

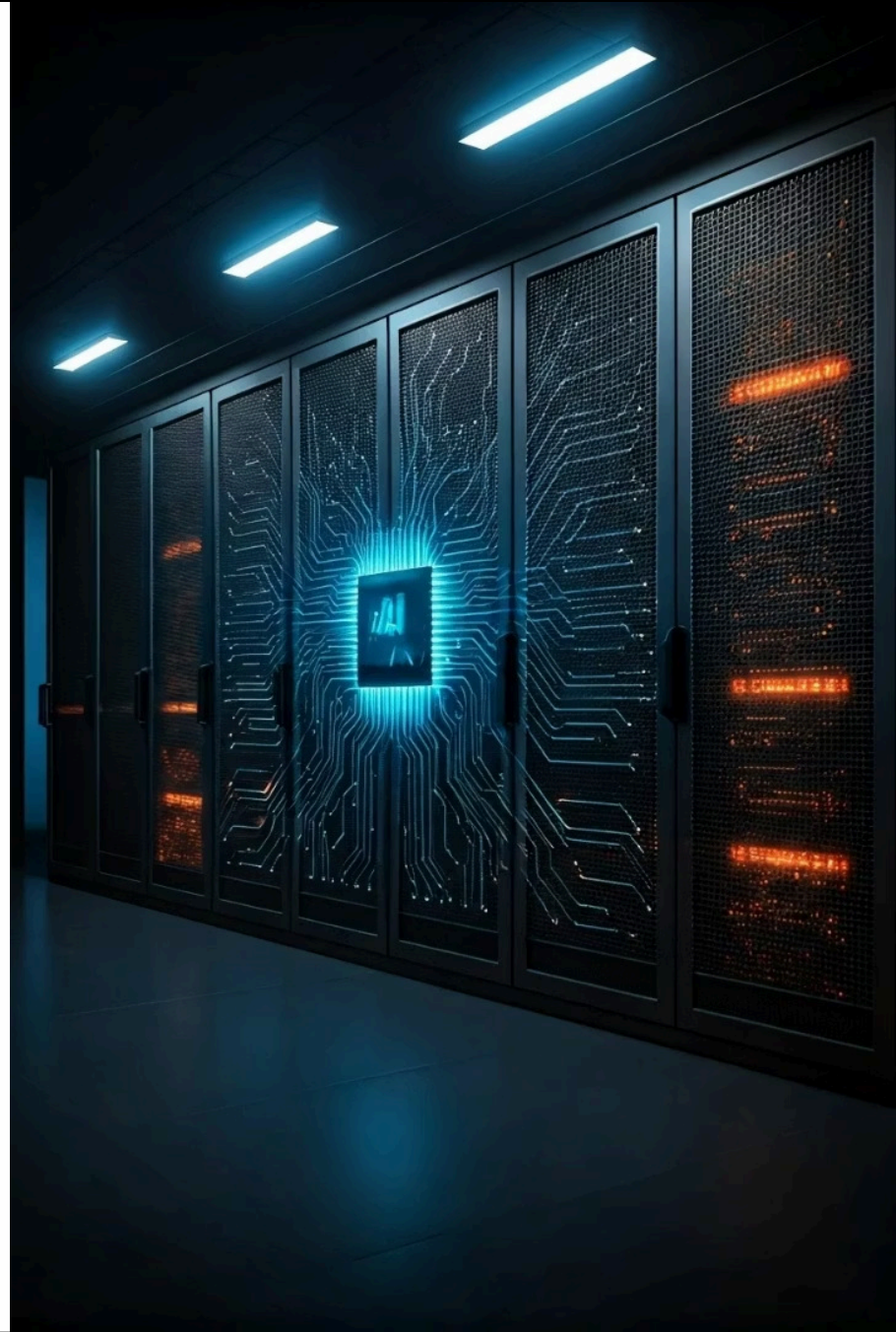
Identification of suspicious patterns in transactions.

Risk Evaluation

Predictive analysis for investment decisions.

Customer Advice

Chatbots and virtual assistants for financial inquiries.



AI in E-Commerce

Product Recommendation

Personalised suggestions based on user behaviour.

Inventory Optimisation

Demand forecasting and efficient stock management.

Customer Support

Virtual assistants for 24/7 query resolution.

AI in Manufacturing and Production

- **Advanced Robotics**
- **Process Automation**
- **Predictive Maintenance**
- **Quality Control**
- **Supply Chain Optimisation**
- **AI-Assisted Design**

AI in Human Resources

Intelligent Recruitment

Efficient selection of candidates through CV analysis.

Personalised Training

Learning programmes tailored to each employee.

Performance Analysis

Objective evaluation based on data and metrics.

AI in Marketing and Advertising

1 **Sentiment Analysis**

Evaluation of brand perception on social media.

2 **Market Segmentation**

Precise identification of consumer niches.

3 **Programmatic Advertising**

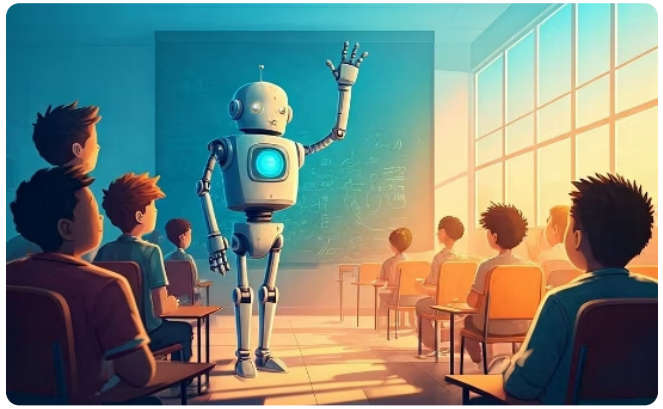
Real-time optimisation of advertising campaigns.

4 **Content Personalisation**

Adaptation of messages according to user preferences.

Applications of AI in the University

AI for Teaching/Learning



Virtual Tutors

Personalised 24/7 assistance. AI-based virtual tutors offer individualised support, answering questions and providing feedback.

Automated Assessment

Rapid marking of exams and assignments. AI enables efficient evaluation, freeing up time for personalised teaching.

Content Adaptation

Materials tailored to each student. AI facilitates the creation of personalised courses and materials to improve comprehension.

AI for Research

1

Literature Search

AI can analyse millions of scientific articles to identify the most relevant documents. This allows researchers to save time and effort in searching for information.

2

Data Analysis

AI can analyse large datasets to discover patterns and trends that would be difficult to identify using traditional methods.

3

Hypothesis Generation

AI can analyse existing data to identify unexplored areas of research. This can help researchers generate new hypotheses and explore new areas of investigation.

4

International Collaboration

AI can translate scientific texts and facilitate communication between researchers from different countries and disciplines. This enables the creation of broader and more collaborative research projects.

AI for Academic Management

Process Optimisation

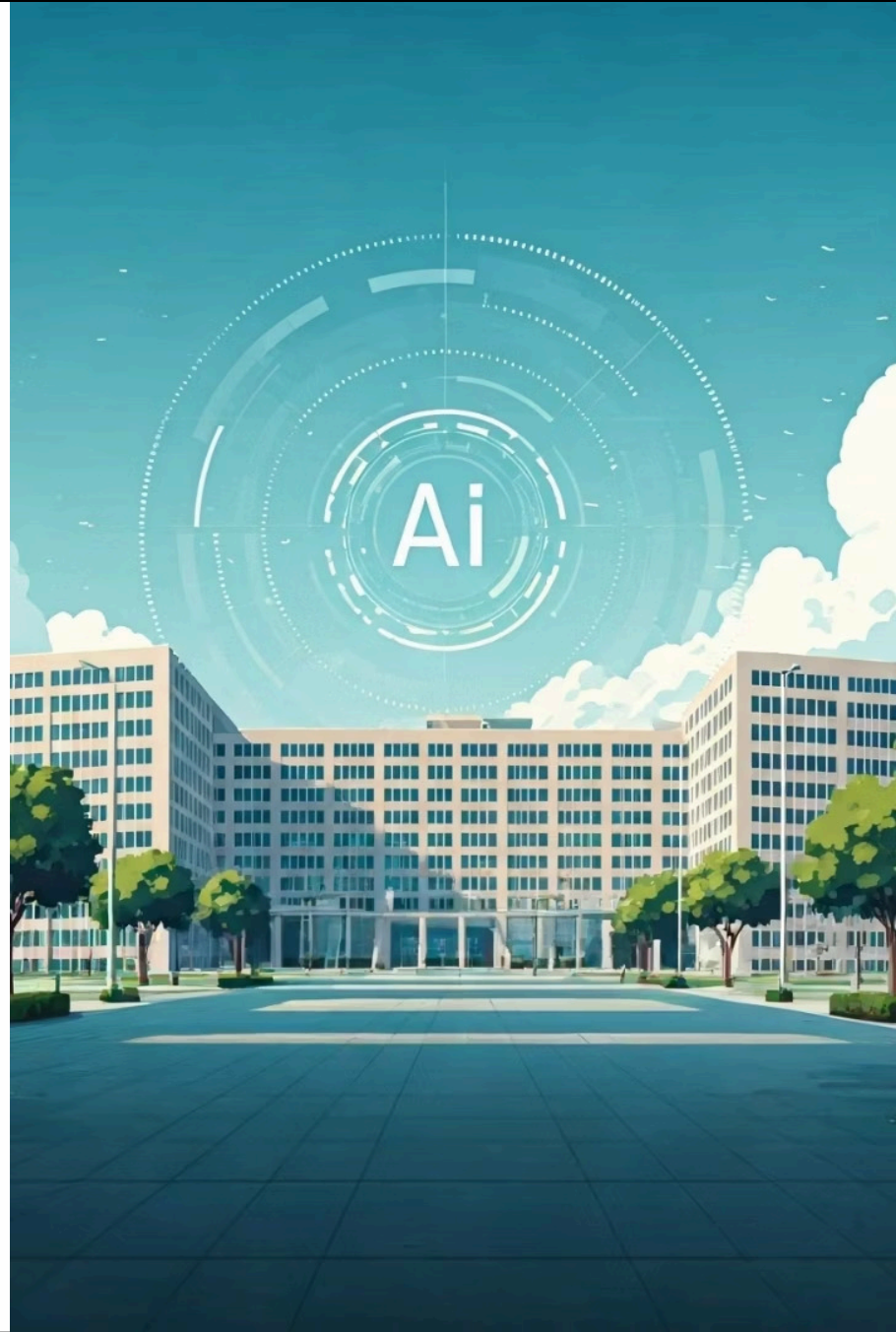
AI can analyse large datasets to identify areas for improvement in the university's administrative processes, such as enrolment, academic planning, etc.

Resource Control

AI algorithms can predict resource demands, such as classrooms, laboratories or teaching staff, enabling more efficient allocation and cost reduction.

Intelligent Chatbots

AI-powered chatbots can respond to frequently asked questions from professors and researchers, freeing up administrative staff for more complex tasks.



The Future of AI in Universities

Personalised Education

Improve the quality of teaching and learning processes.

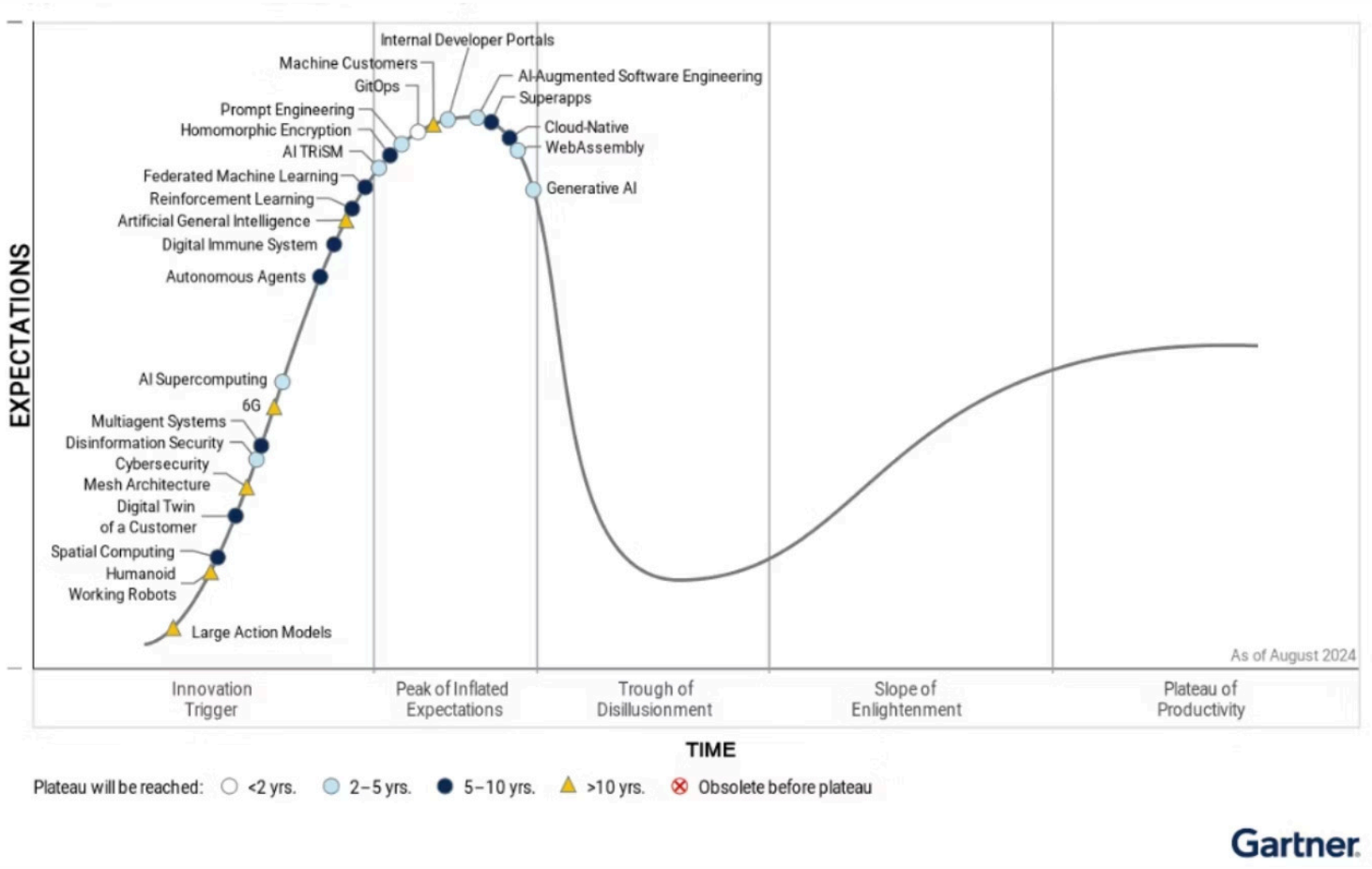
Advanced Research

Enable researchers to focus on innovative ideas and solve problems more quickly.

Efficient Management

Optimise administrative processes and resource management.

Cycle of Expectations for AI



Summary

Artificial Intelligence (AI) is transforming the world. This presentation explores its different types, applications and the impact it has on various areas.

From medicine to education, AI is opening up new possibilities. The presentation also examines generative AI technologies, such as text, image, audio and video generation.