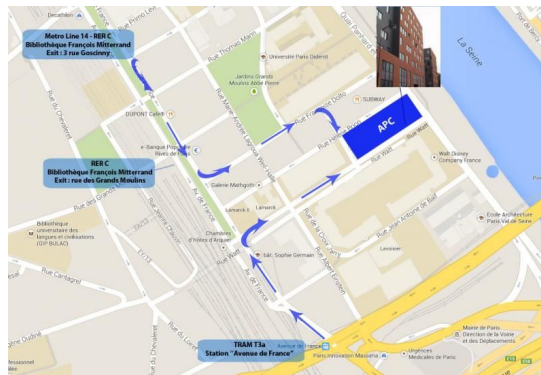


Artificial intelligence: Bridging Science, Society, and Innovation

—
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- My name is Yvonne Becherini
- I am an Astroparticle Physicist
- I work at University of Paris Cité, [Laboratoire Astroparticule et Cosmologie](#) & [Data Intelligence Institute of Paris](#)
- My principal interests are
 - Astroparticle Physics
 - Gamma-Ray & Neutrino Astronomy
 - Extra-galactic sources
- I develop Data Analysis methods with Machine Learning





- Introduction to AI's Impact
- Healthcare Innovations
- Finance Transformation
- Advancements in Science and Research
- Educational Changes
- Revolution in Transportation
- Industrial Evolution
- Opportunities with AI
- Challenges and Responsibilities
- Ultra-Fast AI Evolution
- Ethical and Societal Impacts
- Conclusions



AlphaFold

Accelerating breakthroughs in biology with AI

[Explore the AlphaFold Database](#)

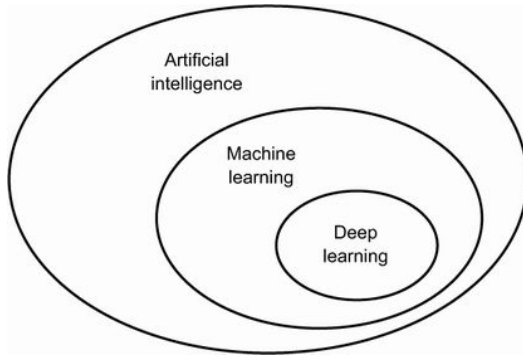
RESEARCH

Using AI to predict retinal disease progression

18 MAY 2020

Jason Yim, Reena Chopra, Jeffrey De Fauw, Joseph LedSAM

Applying AI to help solve
society's biggest challenges
and improve lives



Artificial Intelligence (1950s)

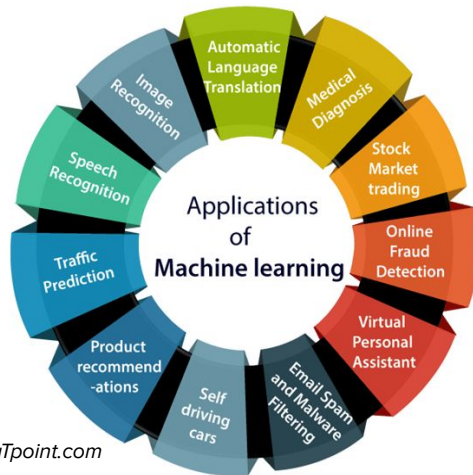
- **Artificial Intelligence (AI)** aims to automate tasks that typically require human intelligence, such as problem-solving, learning, and decision-making.

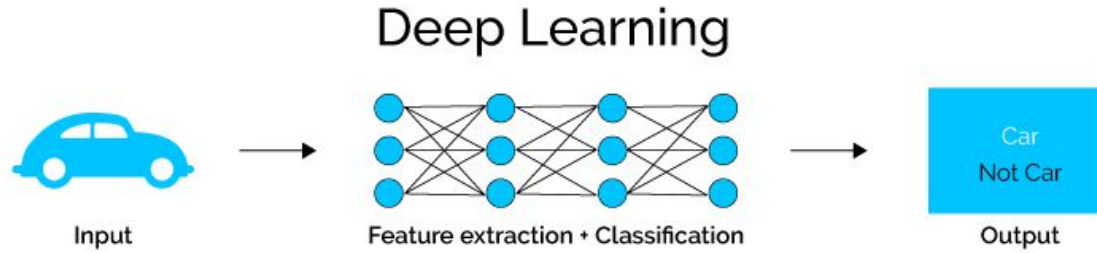
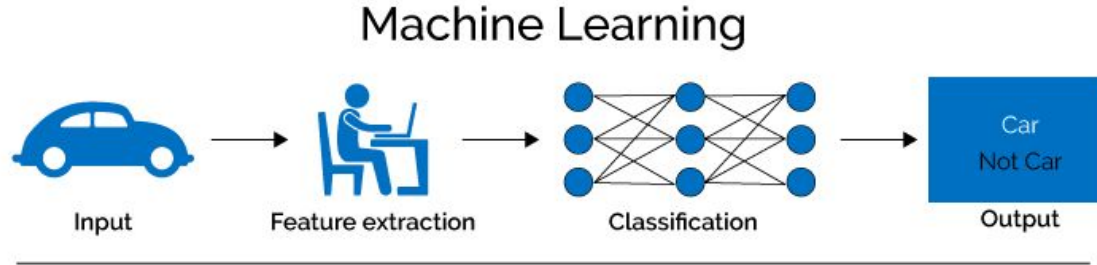
Machine Learning (1990s)

- **Machine Learning (ML)** allows machines to learn patterns from data to make predictions or decisions.
- The model is trained by examining input data and corresponding outputs, learning the underlying rules or patterns.
- **Feature engineering** (selecting relevant characteristics of the data) is often required and is typically defined manually by the user.

Deep Learning (2010s)

- **Deep Learning** automates **feature learning**, allowing the model to identify complex patterns in data on its own.
- Deep learning models learn representations in a **layered, hierarchical manner, refining features incrementally across multiple layers**.
- This process enables the model to capture complex relationships in data without the need for manual feature engineering.





Today's Data

- **High Granularity:** Observations and measurements are detailed and fine-grained in real-world phenomena.
- **Complexity:** Data is often high-dimensional, heterogeneous, and intricate.
- **Large Scale:** Data volume is significant, with some experiments generating terabytes of data per instance.

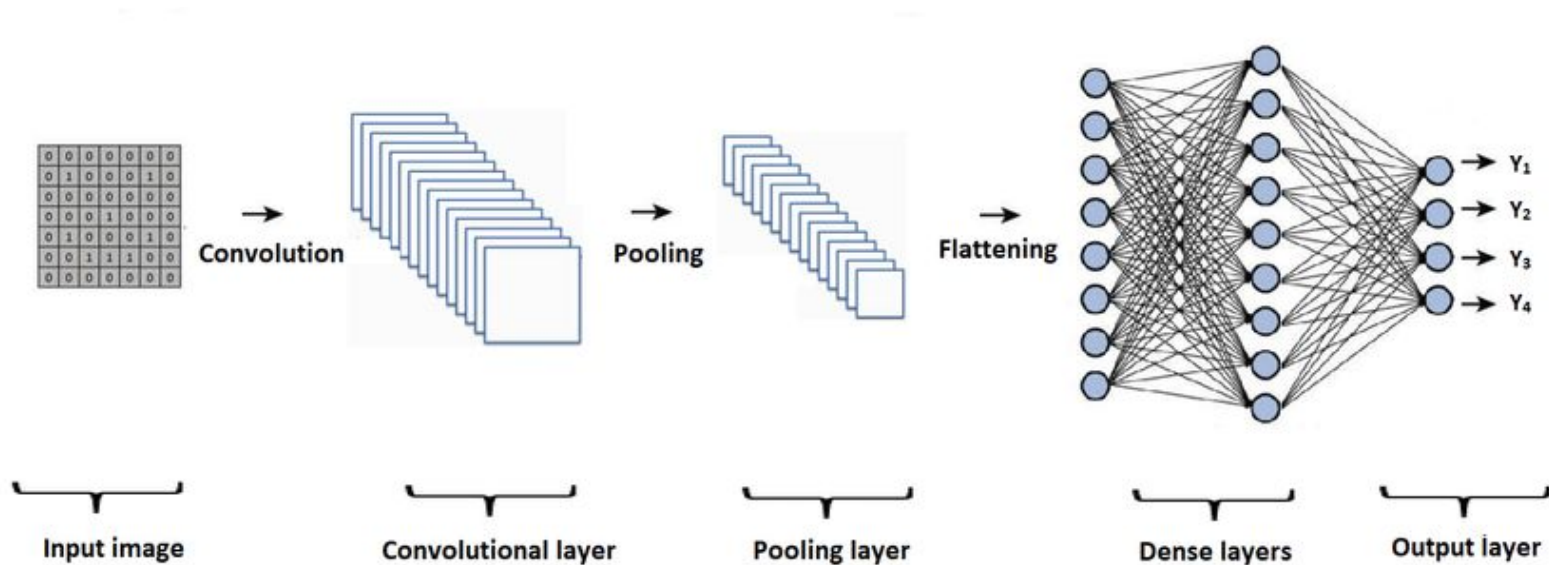
Analytical Challenges

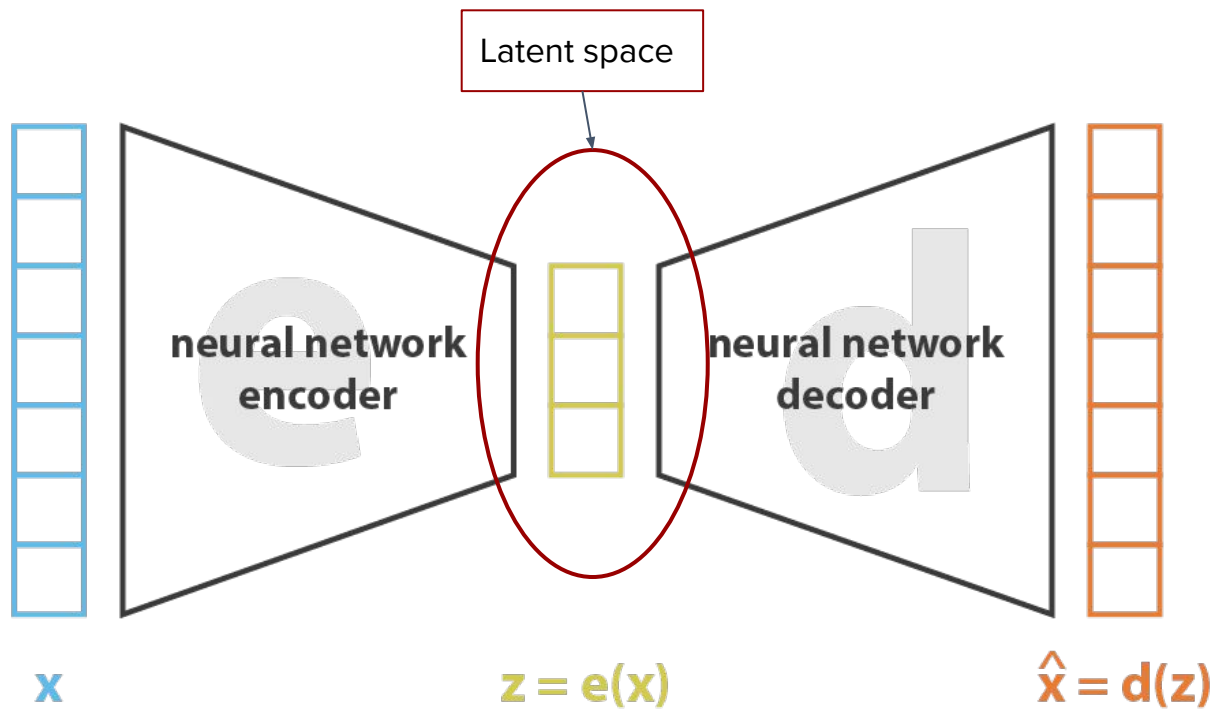
- **Data-Driven Discovery:** Using data to drive new scientific insights.
- **Model Refinement and Development:** Improving existing models or creating new ones to better explain real-world phenomena.
- **Complexity of Analysis:** Analysis becomes challenging due to data size and complexity, necessitating advanced tools and techniques.
- **Need for New Tools:** New data analysis and intelligence techniques are essential to handle these challenges effectively.

Data Science

- **Rapidly Evolving Field:** Data science is a fast-growing area, driven by scientific needs across various domains (e.g., biology, medicine).
- **Cross-Domain Applicability:** An algorithm developed for one field, like biology, could potentially be adapted for use in another domain.

[Source](#)







The key innovation of the **Attention Mechanism** allows the model to focus on different parts of the input sequence when predicting a part of the output sequence.



Transformers can process **entire sequences of data simultaneously and in parallel**, unlike RNNs or LSTMs that process data sequentially.

This parallelization significantly speeds up training and makes the model highly scalable with increasing data and compute power.



Many Transformer models use an **Encoder-Decoder** structure to process and generate sequential data.

Traditional sequence models (RNNs and LSTMs)

- Process data in sequential order
- Unable to focus on specific parts of the sequence

Transformer's Attention Mechanism

- Can focus on different parts of the input sequence
- Allows the model to capture complex dependencies and relationships in the data



Natural Language Processing (NLP)



BERT

Bidirectional Encoder Representations from Transformers.
Understands the context of a word in a sentence.



GPT

Generative Pretrained Transformer.
Known for its text generation capabilities.



T5

Text-To-Text Transfer Transformer.
Converts all NLP tasks into a text-to-text format.

Focus on: Syntax (sentence structure), semantics (meaning), and context of the language

Speech processing

Involves analysing the sound waves generated by human speech, detecting phonemes (basic units of sound), and understanding accents, intonation, and rhythm



Use in Speech Recognition

- Transformers are employed in models to convert spoken language into text.
- They can effectively handle the sequential nature of speech for accurate transcription.



Role in Speech Synthesis

- In text-to-speech systems, transformers help in generating natural and human-like speech from text.
- They enable converting spoken language into text.



ChatGPT

ChatGPT is an advanced AI language model developed by OpenAI, designed to understand and generate human-like text based on input prompts.



Applications Across Fields

Used in healthcare for patient interaction, in finance for customer support, and in education for tutoring and content generation.



Internal Architecture

Built on a transformer architecture, ChatGPT utilizes self-attention mechanisms and deep learning to process and generate contextual text.



Future Prospects

Continued improvements in AI technology promise to enhance ChatGPT's capabilities, making it even more versatile and efficient.



Success and Adoption

ChatGPT has achieved widespread success, being adopted in various industries such as customer service, education, and content creation.



Ethical Considerations

Ongoing discussions focus on responsible use, data privacy, and preventing misuse of AI-generated content.

Artificial Intelligence is experiencing unprecedented rapid development, transforming our world at an astonishing pace.

Its influence can be seen across various sectors, including healthcare, finance, research, education, transportation, and industry.

As AI models improve **weekly**, they are not only enhancing productivity but also driving innovation and reshaping the way we live and work.

Recent advancements highlight AI's acceleration, with significant investments in AI funding, and tools like ChatGPT crossing 100 million users within two months of release.

Accelerated Research

AI is transforming research methodologies.

For example, **DeepMind's AlphaFold** has revolutionized protein structure prediction, providing accurate models for over 200 million proteins in 2023, accelerating drug discovery and disease research.

[Highly accurate protein structure prediction with AlphaFold, Nature, 2021](#)

[Chemistry 2024 Nobel goes to developers of AlphaFold AI that predicts protein structures](#)

Predictive Modeling

AI enhances **predictive modeling** capabilities, allowing researchers to **forecast environmental changes** and understand **genetic variations**. In 2024, AI models accurately predicted regional drought patterns months in advance, aiding disaster preparedness. Additionally, AI tools like **CRISPR-AI** are helping scientists predict off-target genetic edits, making gene therapy safer.

[Drought prediction using artificial intelligence models based on climate data and soil moisture, Scientific Reports, 2024](#)

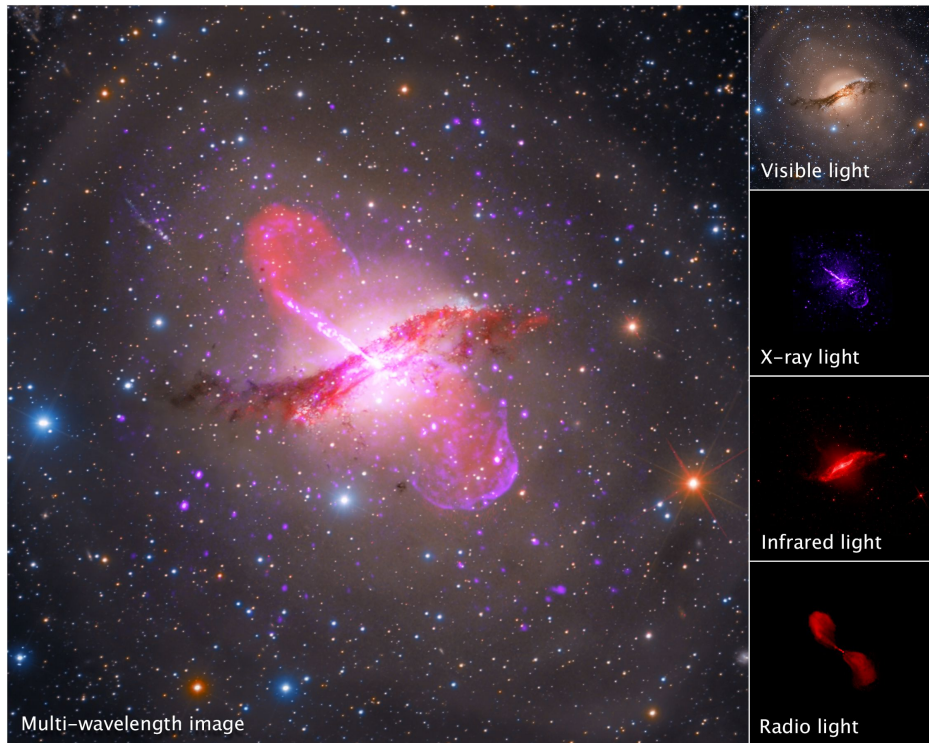
[Convergence of CRISPR and artificial intelligence: A paradigm shift in biotechnology, Human Gene, 2024](#)

New Discoveries

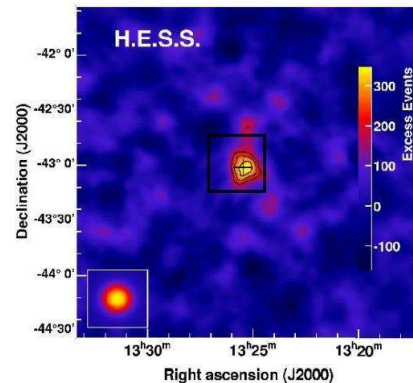
AI is paving the way for groundbreaking discoveries, such as identifying new materials and uncovering potential antibiotic compounds. In 2023, an AI model developed by MIT discovered Halicin, a powerful new antibiotic capable of killing drug-resistant bacteria, through extensive chemical analysis.

[A Deep Learning Approach to Antibiotic Discovery, Cell, 2020](#)

The Active Galactic Nucleus
Centaurus A



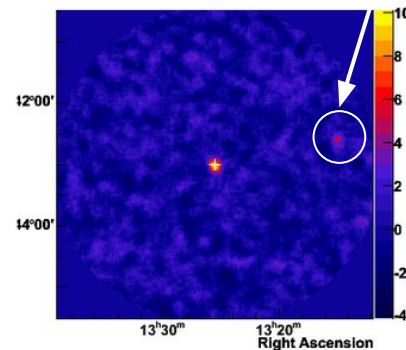
2008: discovery with a detection significance of 5σ with standard analyses (no ML)



2016: Re-analysis of data using supervised ML 9.8σ !



Appearance of a second source in the field of view!



A clear gain in the detectability of gamma-ray emitting sources

Precision Medicine

AI analyzes genetic information to tailor treatments, identifying specific genetic markers for personalized therapies, such as in cancer treatment.

[AI in Precision Oncology Springer Nature Collection, 2024](#)

Radiology Advancements

AI models outperform radiologists in detecting **lung nodules** in CT scans, increasing diagnosis accuracy and reducing time to treatment.

[Deep learning for the detection of benign and malignant pulmonary nodules in non-screening chest CT scans, Nature Communications Medicine, 2023](#)

Improved Diagnostics Artificial intelligence for retinal diseases

AI-powered imaging tools enhance **early disease detection**, exemplified by Google's DeepMind AI identifying **diabetic retinopathy** with an accuracy of over 90%. Recent studies also show AI systems detecting early-stage breast cancer at rates comparable to experienced radiologists.

[Artificial intelligence for retinal diseases, Elsevier, Asia-Pacific Journal of Ophthalmology](#)

[Volume 13, Issue 4, July–August 2024, 100096](#)

Fraud Detection

As digital transactions increase fraud complexity, banks now use machine learning—like unsupervised algorithms and neural networks—to detect intricate fraud patterns beyond the capability of traditional rule-based methods.

[Financial fraud detection through the application of machine learning techniques: a literature review, Humanities and Social Sciences Communications \(2024\)](#)

Credit risk and market risk Management

AI systems analyze vast market data to predict financial risks with increased accuracy.

[Machine Learning and AI for Risk Management, 2019](#)

Decision-Making Processes

AI enhances decision-making by enabling algorithmic trading, executing trades at optimal times based on real-time data analysis.



Personalized Learning

AI-powered platforms **adapt content to individual student needs**, enhancing engagement and comprehension. For example, **Duolingo** uses AI algorithms to adjust language lessons based on a user's progress and learning speed. Similarly, platforms like **Coursera** use adaptive learning technologies to create custom learning paths for students, ensuring maximum retention.

Accessibility Improvements

AI tools provide real-time transcription and translation, ensuring lectures are accessible to all students, including those with hearing impairments and language barriers.

[Artificial intelligence in education, UNESCO](#)

Future of Education

AI, combined with Virtual Reality (VR), offers immersive learning experiences, enabling students to explore historical events, scientific phenomena, and complex systems in an interactive environment. For example, Labster's AI-enhanced VR simulations let students conduct virtual experiments. Additionally, predictive analytics tools help educators identify struggling students early, ensuring timely interventions and better outcomes. [The Future of Science Education and Learning Transformed by Labster](#)

The integration of AI in education promises to **democratize learning**, making it **more personalized, inclusive, and engaging**. AI-driven tools are not just aiding educators but also shaping a future where education is accessible anytime, anywhere, to anyone.

Traffic Management

AI **optimizes traffic flow** by analyzing **real-time data** to adjust signals and manage public transportation. In Pittsburgh, AI-driven traffic lights by Rapid Flow Technologies reduced traffic wait times by 40%, cutting down emissions and commute times significantly. Similarly, cities like Los Angeles are deploying AI-based systems to monitor congestion patterns and adapt dynamically to traffic conditions.

[AI and Transportation: How to Enhance Traffic Flow with AI Technology](#)

Safety Improvements

Advanced Driver Assistance Systems (ADAS) utilize AI to enhance road safety. Features like lane-keeping assistance, collision avoidance, and adaptive cruise control, as seen in vehicles by BMW and Volvo, rely on AI to reduce accident rates. Volvo's Pilot Assist system, for example, combines AI with radar and cameras to maintain safe distances and keep vehicles centered in lanes, decreasing crash risks by over 30%.

Autonomous Vehicles

AI technology is driving the development of **self-driving cars** by companies like Tesla, Waymo, and Cruise.

[Waymo](#)



Smart Manufacturing

AI integrates with robotics to enhance precision in manufacturing tasks, reducing errors and waste. With more intelligent and responsive processing systems, robots are more responsive and can complete more complex tasks. This tune-up is largely thanks to AI's ability to process large quantities of data, enabling these systems to make informed decisions regarding production workflows and quality control.

[AI's Impact on Robots in Manufacturing](#)

Supply Chain Optimization

AI predicts demand patterns and optimizes inventory levels, significantly reducing storage costs.

Companies like [DHL use AI-powered solutions for route optimization, cutting delivery times by up to 25% and saving millions in logistics expenses.](#)

Amazon's AI-driven supply chain management system ensures seamless inventory handling and faster delivery worldwide

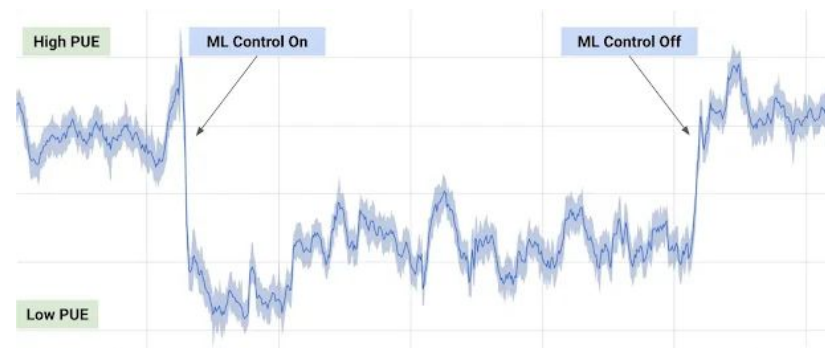
[Amazon's Supply Chain Is Speeding Up by 75% With the Help of AI](#)

Sustainability Efforts

AI plays a crucial role in energy management, helping industries reduce energy consumption and carbon footprints.

For example, Google's AI systems optimized cooling in its data centers, leading to a 40% reduction in energy use.

[DeepMind AI Reduces Google Data Centre Cooling Bill by 40%](#)



Productivity Gains

AI automates repetitive tasks, allowing human workers to focus on creative and strategic roles, boosting overall productivity.

AI can generate code, can improve text, can improve communication between humans by efficiently translating text.

AI agents can be of support retrieving information.

Innovation Driver

AI enables startups to develop disruptive technologies, lowering barriers to entry and fostering a culture of innovation across industries.

Data Utilization

AI transforms big data into actionable insights, **improving decision-making in business and policy**. For example, Netflix uses AI algorithms to analyze viewer preferences, optimizing content recommendations and increasing viewer engagement by 80%.

In retail, companies like Walmart use AI to forecast demand patterns, improving inventory management and minimizing waste.

Data Privacy

The increasing use of AI raises concerns about **data breaches and the misuse of personal information**. Robust regulations like GDPR in the EU and CCPA in California enforce stricter data protection standards. For example, Facebook faced a \$5 billion fine in 2019 for privacy violations, highlighting the need for vigilance in data handling.

Ethical Use

Deploying AI in sensitive contexts, like surveillance and autonomous weapons, poses significant ethical dilemmas. For example, the use of **AI-driven surveillance tools** has sparked debates about privacy and human rights. Frameworks like the Asilomar AI Principles provide guidelines to ensure responsible development and application of AI.

Society Bias

AI systems may reflect **societal biases present in their training data**, leading to unfair outcomes. For instance, a 2019 MIT study revealed that facial recognition systems had error rates of up to 34% for dark-skinned women compared to 1% for light-skinned men. Initiatives like IBM's AI Fairness 360 aim to reduce such biases by providing tools to **test and mitigate discrimination** in AI models.

Regulation Needs

Balancing innovation with oversight is crucial. Governments worldwide are forming **AI ethics committees** to create standards that prevent misuse while promoting responsible development. For example, the EU's Artificial Intelligence Act aims to classify AI systems based on risk and establish regulations for high-risk applications like healthcare and finance.

Rapid Advancements in AI

- AI models like GPT-4 are achieving unprecedented language understanding.
- Breakthroughs in areas such as computer vision and natural language processing are happening weekly.
- New applications of AI are emerging across various industries, reshaping existing paradigms.

Challenges in adaptation and Future Predictions

- **Skill Gaps and Infrastructure:** Organizations face a shortage of professionals skilled in AI technologies. Reports show a 60% increase in demand for AI expertise by 2030, with initiatives like Google's AI for Everyone program addressing the gap.
- **Keeping Pace with Change:** **Governments and institutions are struggling to regulate AI as technologies evolve faster than policies.**
- **Path to Artificial General Intelligence (AGI):** Predictions about achieving AGI range from 10 to 50 years, sparking debates on its potential impact. Experts discuss scenarios where AGI could drive innovation or raise ethical and existential risks for humanity.

Job Displacement

The rise of AI and automation may displace jobs across sectors, particularly in manufacturing and transportation. For example, in the U.S., automated warehouses operated by companies like Amazon **have reduced the need for human labor while creating demand for new technical roles**. Local governments and organizations, such as [France's National Digital Council](#), are investing in reskilling programs to prepare the workforce for collaboration with AI technologies.

Social Equity

AI has the potential to widen the gap between those with access to technology and those without. In Africa, programs like [Google's AI for Social Good](#) focus on providing AI tools for underserved communities to address healthcare and education gaps.

Ensuring equitable access to AI tools and education is essential **to prevent marginalization and foster inclusivity**.

Global Collaboration

International cooperation is crucial for establishing AI standards and sharing best practices.

Initiatives like [UNESCO's Recommendation on the Ethics of Artificial Intelligence](#) emphasize the importance of collaborative approaches. For instance, the European Union and Japan are jointly working on AI ethics frameworks to address global challenges like climate change and cybersecurity. [EU and Japan advance joint work on digital identity, semiconductors, artificial intelligence](#)

AI Transformative Potential

- AI is reshaping industries and enhancing productivity.
- It offers innovative solutions to complex global challenges.
- The rapid advancement of AI creates vast opportunities for growth.

Importance of Ethical Development

- Responsible AI development ensures alignment with human values.
- Individual advocacy is crucial for transparency in AI practices.
- Collaborative efforts among stakeholders promote ethical standards.

