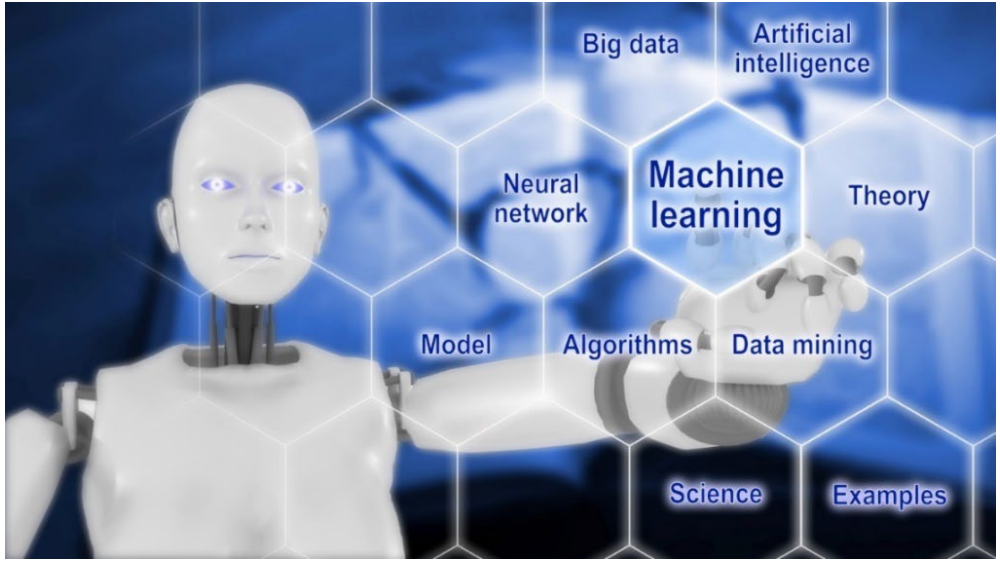
The Future of Work is Agentic and Robotic



John Howard
National Institute for Occupational Safety and Health
Centers for Disease Control and Prevention
U.S. Department of Health and Human Services

34th Annual CIHC Professional Development Seminar

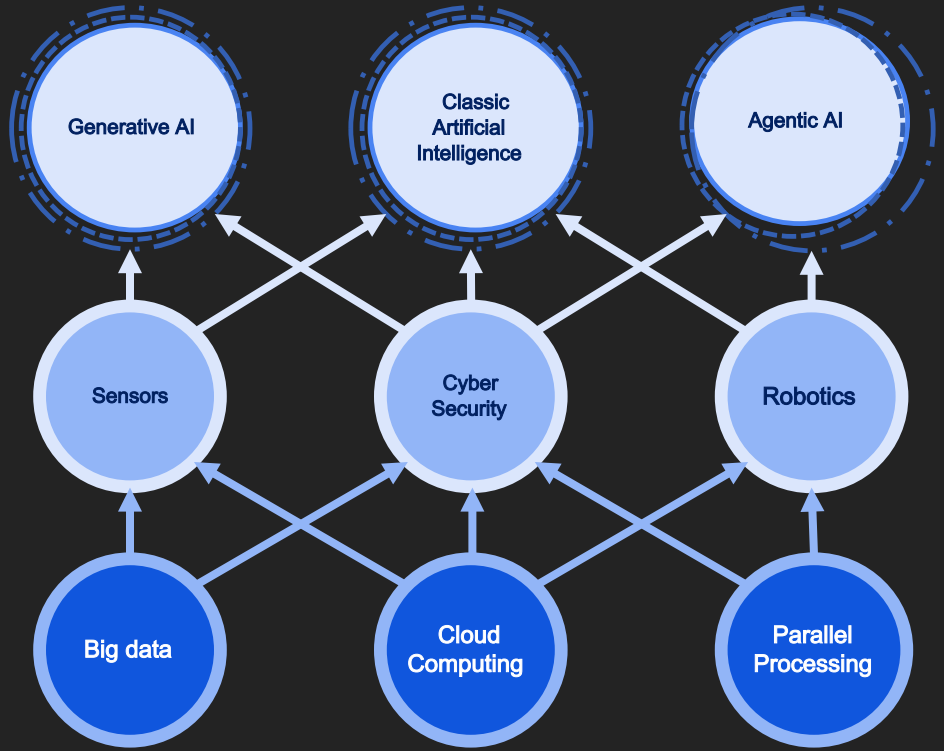
3 November 2025

Westin Hotel
Long Beach, California

“AI won’t take your job. It’s *somebody* using AI that will.”

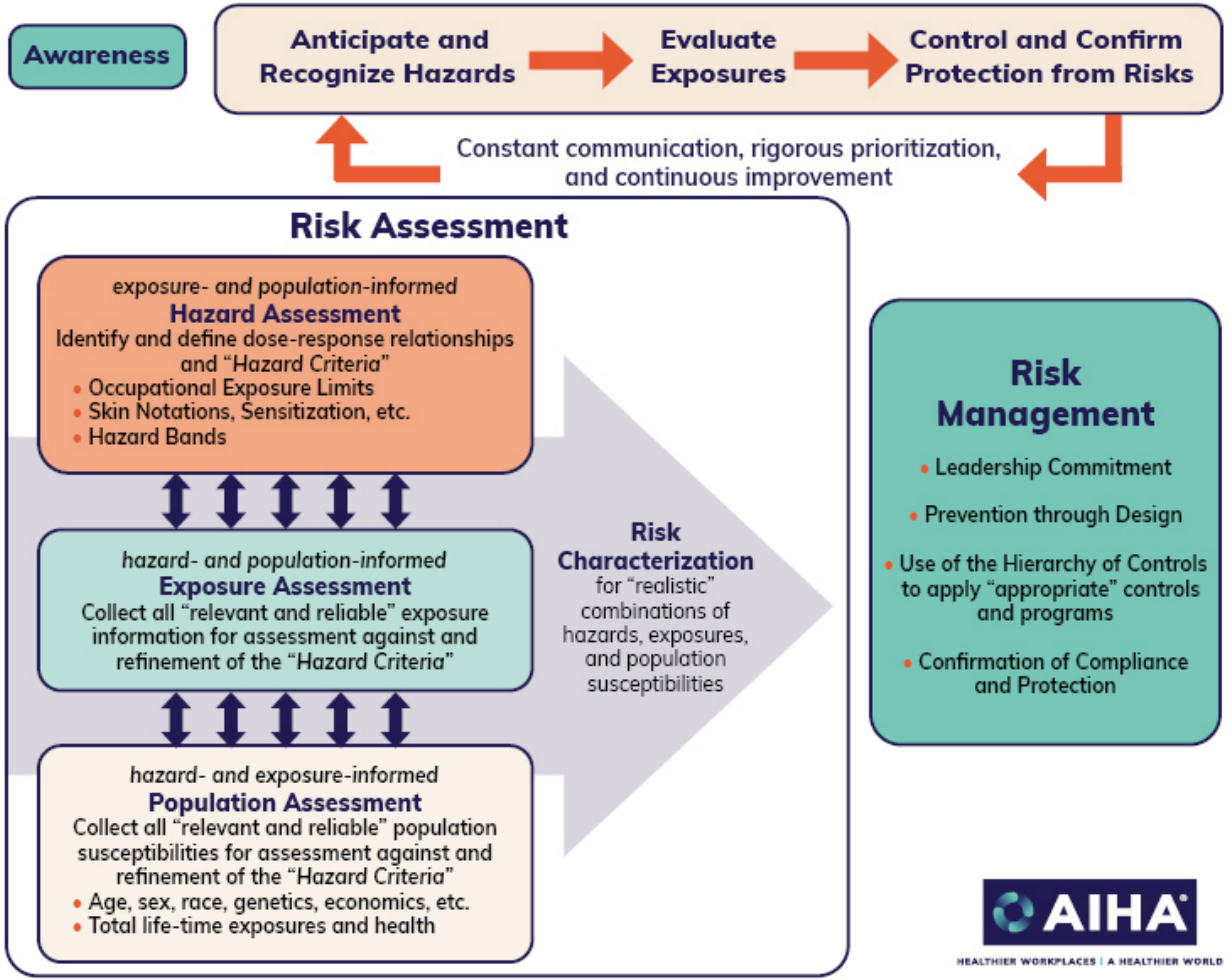
—Richard E. Baldwin, economist and IMD Business School professor, speaking at the 2023 World Economic Forum’s Growth Summit

Key Technologies Enabling the Future



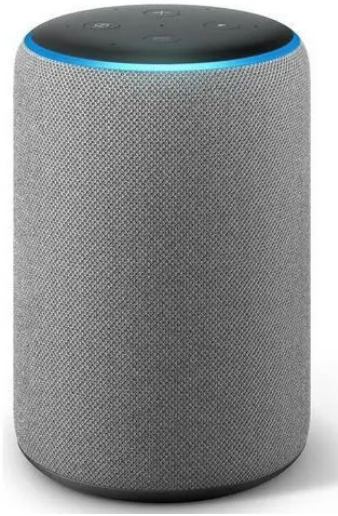
AIS 2019

- Is Your Practice of Industrial Hygiene Limited to Human Workers Only?



Model for AI Technologies

- **Sensing**
  - Data inputs
- **Thinking**
  - Classic AI
  - Generative AI
  - Agentic AI
  - Embodied AI
- **Acting**
  - *Steel-Collar* Robots
  - *White-Collar* Robots



Sensing

5 SENSES

TASTE

HEARING

SIGHT

SMELL

TOUCH

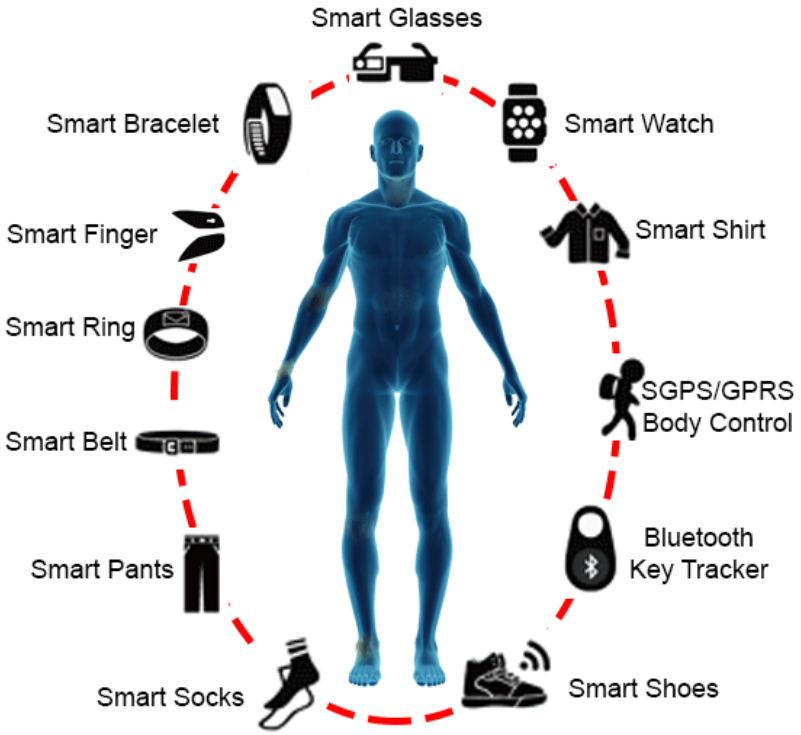
Wearable Sensor Technologies

https://doi.org/10.7759/cureus.61312

- Wearable sensor technologies encompass devices worn or attached to the body to monitor physiological parameters, track activity levels, and provide real-time health insights.

- These devices incorporate:
  - Detection of environment changes
  - Capability to process data
  - Wireless connectivity

- Enabling continuous monitoring and analysis of data.

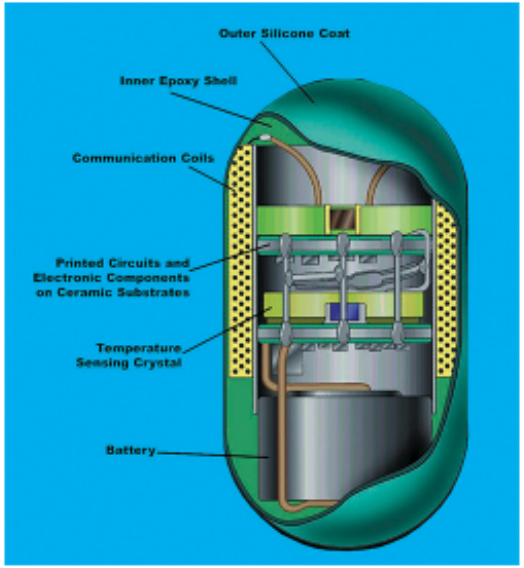


Workplace Sensors

- **Workplace Placeables**
  - Collect, store, and transmit data about the ambient work environment to a data warehouse for interpretation.

- **Worker Attachables**
  - Attached to a worker's clothing, head, arms or wrists, upper/lower body, or feet
  - Attached as computer-display eyeglasses/contact lenses, or placed in the auditory canal
  - *Electronic textiles*—woven into textiles that can be worn by a worker as clothing
  - *Electronic epidermal wearables*—incorporated in thin "skin-like" films, or tattoos, that can be applied directly to the epidermis

- **Implantables**
  - **Worker**
    - Inserted into the skin via microneedles, microchips, or capsules that can be ingested
  - **Equipment**
    - Position, motion and proximity
    - Vision
    - Force and torque
    - Range
    - Tactile (haptic)

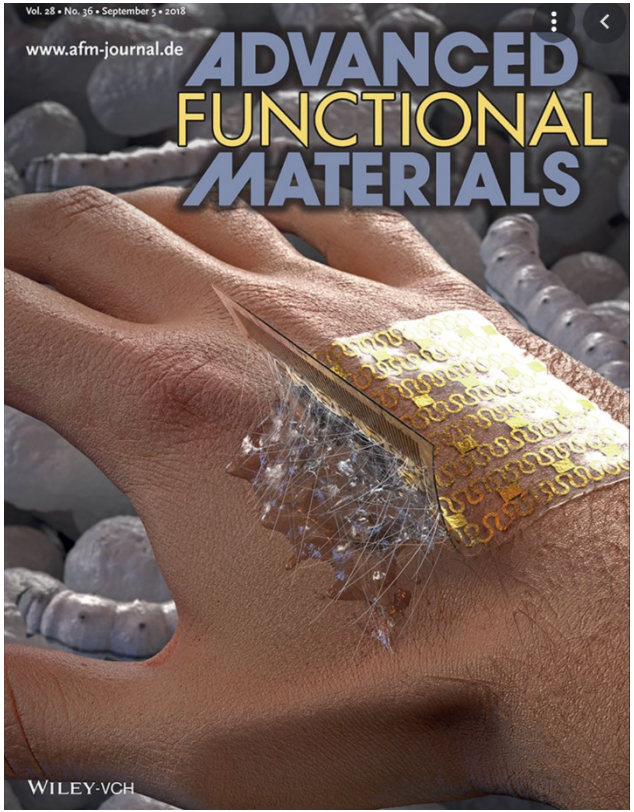


Developed by Goddard Space Flight Center and the Johns Hopkins University Applied Physics Laboratory to monitor the core body temperature of astronauts during space flight, the ingestible "thermometer pill" has a silicone-coated exterior, with a microbattery, a quartz crystal temperature sensor, a space-aged telemetry system, and microminiaturized circuitry on the interior.

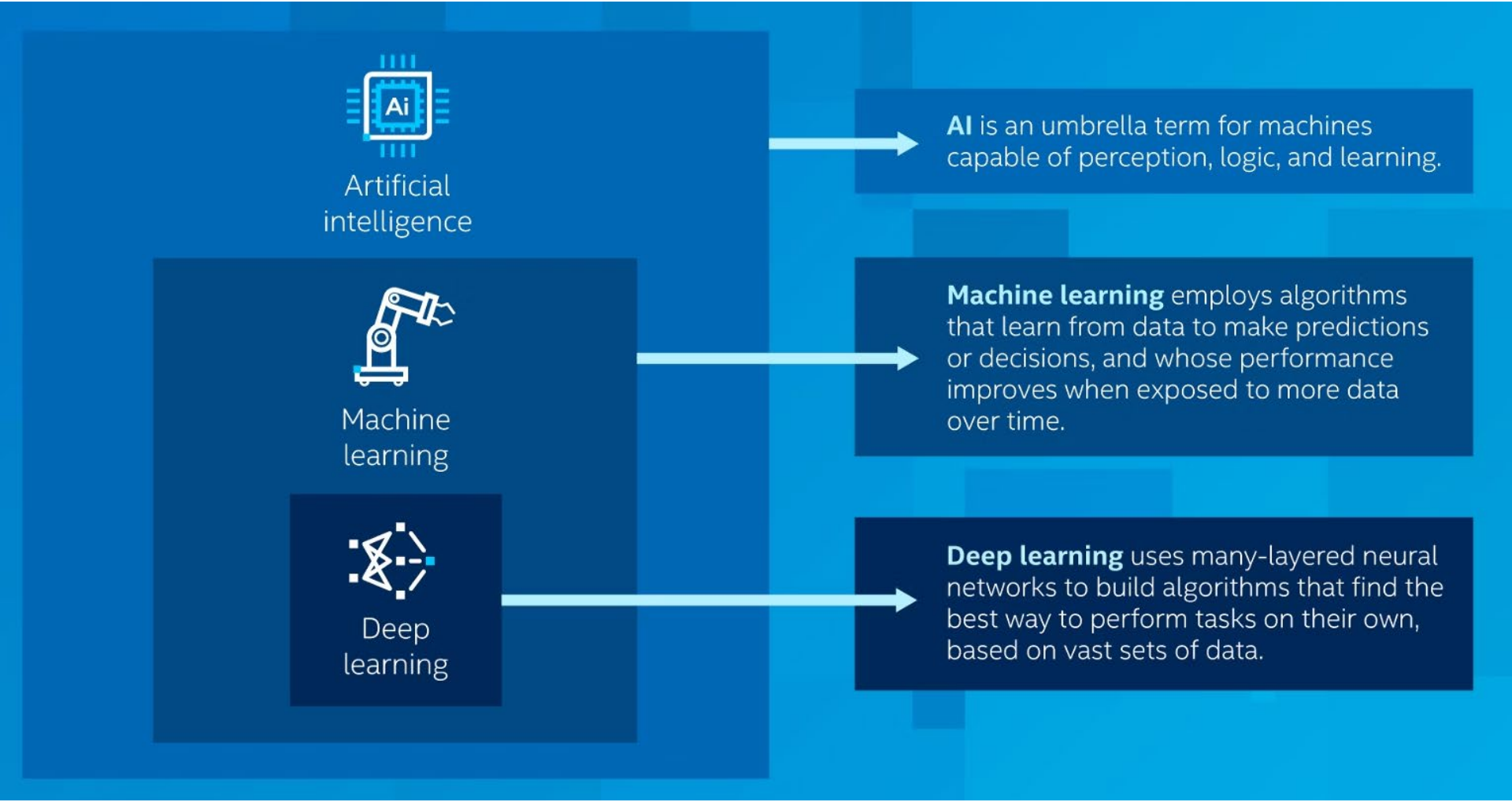
Functional Textile and Epidermal Tattoo

Howard et al (2021) https://blogs.cdc.gov/niosh-science-blog/2021/10/21/sensors-fow/

Marty Ellis, of Inman Mills in South Carolina, checks a machine manufacturing fabric developed through AFFOA.



Thinking

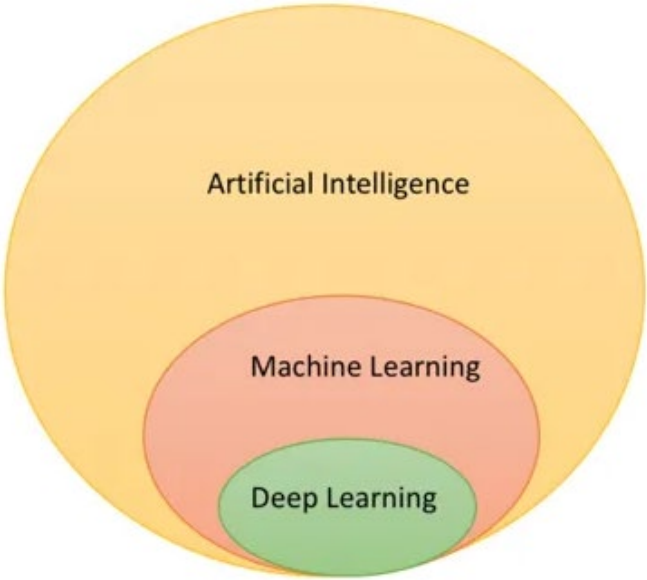

Ai
Artificial intelligence
Machine learning
Deep learning
AI is an umbrella term for machines capable of perception, logic, and learning.
Machine learning employs algorithms that learn from data to make predictions or decisions, and whose performance improves when exposed to more data over time.
Deep learning uses many-layered neural networks to build algorithms that find the best way to perform tasks on their own, based on vast sets of data.

Classic AI

Machine Learning

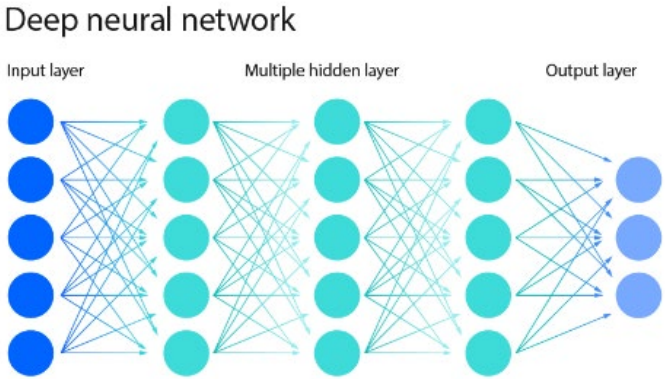
- **Machine Learning**
  - Specific AI method that enables machines to improve their performance by exposure to vast amounts of data without the need to follow ***explicitly programmed*** instructions from a human being.

- **Exponential Growth**
  - Explosion in computing power
    - Graphical processing units
  - Increase in storage capacity
    - Cloud computing
  - Accumulation of ‘Big Data’
    - Internet
  - Neural network computing methods
    - 2024 Nobel Prize in Physics (Hinton & Hopfield)

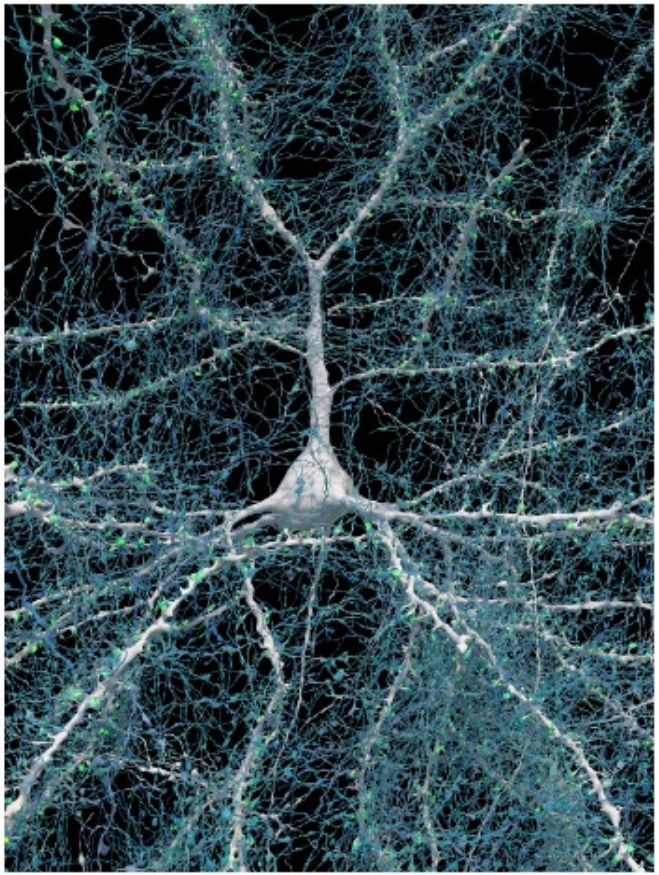


Neural Networks

- Like neurons that are connected by synapses in the human brain, a network of *engineered* neurons can be trained to solve problems using precise mathematical instructions or ***algorithms.***



- https://www.nih.gov/news-events/nih-research-matters/study-reveals-unseen-details-human-brain-structure



A single neuron is shown with 5,600 of the nerve fibers (blue) that connect to it. The synapses that make these connections are in green. *Google Research & Lichtman Lab, Harvard University. Renderings by D. Berger, Harvard*

Neural Network Algorithms

- **Algorithm**
  - "Algorithm" originated with the Persian astronomer and mathematician, Muhammad ibn Musa al-Khwarizmi (c.780–c.850), known as the father of algebra.

- **Neural Network Algorithms**
  - Enable computer vision and natural language processing, enabling speech recognition and production.

- **Workplace algorithmic systems of the future**
  - ***What*** happened
    - Descriptive systems
  - ***Why*** it happened
    - Diagnostic systems
  - ***Forecast*** what will happen
    - Predictive systems
  - ***Support safety decision-making***
    - Prescriptive systems
  - ***Take physical actions***
    - Semi- or fully autonomous actions

Input: matrix A of size n, number m of nodes to be identified,
tuning constants: $N_{\max}$, q, $M_{\max}$, τ, ρ
for $i = 1$ **to** n **do** $\ell_i^H, \ell_i^A, s_i^H, s_i^A = 0$ **end**
call irlba to compute $\{\sigma_i, \mathbf{u}_i, \mathbf{v}_i\}_{i=1}^{q}$ such that $\sigma_i \geq \sigma_{i+1}$
if shift is active **then** $\mu = \sigma_1$ **else** $\mu = 0$ **end**
$N = 0$, $\overline{N} = 0$, flag = **true** , flag^H = **true** , flag^A = **true**
while flag **and** $(N < \min\{N_{\max}, n\})$ **and** $(\overline{N} < q)$
  $N = N + 1$, $\overline{N} = \overline{N} + 1$
  $f_\sigma = (\exp(\sigma_N - \mu) + \exp(-\sigma_N - \mu))/2$
  if flag^H
    for $i = 1$ **to** n **do** $t_i = u_{iN}^2$ **end**
    $\mathbf{s}^H = \mathbf{s}^H + \mathbf{t}$
    $\boldsymbol{\ell}^H = \boldsymbol{\ell}^H + f_\sigma \cdot \mathbf{t}$
    $\mathbf{z}^H = \boldsymbol{\ell}^H + f_\sigma(1 - \mathbf{s}^H)$
    let $\boldsymbol{\psi} = [\psi_1, \ldots, \psi_n]$ be an index permutation such that $\ell_{\psi_i}^H \geq \ell_{\psi_{i+1}}^H$
    $L_{\max}^H = \ell_{\psi_m}^H$
    $S_{H,m}^{(N)} = \{i : z_i^H \geq L_{\max}^H\}$
    $\text{flag}^H = (|S_{H,m}^{(N)}| > m)$ **and** $(\frac{1}{n} f_\sigma > \tau \cdot L_{\max}^H)$
  end if
  if flag^A
    for $i = 1$ **to** n **do** $w_i = v_{iN}^2$ **end**
    $\mathbf{s}^A = \mathbf{s}^A + \mathbf{w}$
    $\boldsymbol{\ell}^A = \boldsymbol{\ell}^A + f_\sigma \cdot \mathbf{w}$
    $\mathbf{z}^A = \boldsymbol{\ell}^A + f_\sigma(1 - \mathbf{s}^A)$
    let $\boldsymbol{\phi} = [\phi_1, \ldots, \phi_n]$ be an index permutation such that $\ell_{\phi_i}^A \geq \ell_{\phi_{i+1}}^A$
    $L_{\max}^A = \ell_{\phi_m}^A$
    $S_{A,m}^{(N)} = \{i : z_i^A \geq L_{\max}^A\}$
    $\text{flag}^A = (|S_{A,m}^{(N)}| > m)$ **and** $(\frac{1}{n} f_\sigma > \tau \cdot L_{\max}^A)$
  end if
  flag = flag^H **or** flag^A
  if flag **and** $\overline{N} = q$
    if $N < M_{\max}$
      call irlba to compute $\{\sigma_k, \mathbf{u}_k, \mathbf{v}_k\}_{i=N+1}^{N+q}$ such that $\sigma_{N+i} \geq \sigma_{N+i+1}$
      $\overline{N} = 0$
    else
      call irblb to compute sing. values $\nu_1 \geq \cdots \geq \nu_q$ closest to σ_N
      $r = \arg\min_i |\nu_i - \sigma_N|$
      $\sigma_{N+i} = \nu_{r+i}$, $i = 1, \ldots, q - r$; $\{\mathbf{u}_{N+i}, \mathbf{v}_{N+i}\}$ associated sing. vectors
      $\overline{N} = r$
    end if
  end if
end while

Algorithmic Sensor Networks

- **Safety Risk**
  - Multiple algorithmic-enabled sensors operating mechanical equipment as a network may risk the safety of operators and others.

- **Dramatic Example of Sensor Operating Outside of Design Parameters**
  - Resulted in catastrophic commercial and workplace outcome involving the angle-of-attack (AoA) sensor-embedded in a complex operational system on a previous version of Boeing's 737 Max 9 aircraft.
  - The AoA sensor sent faulty data to the Maneuvering Characteristics Augmentation System (MCAS) software, which caused the horizontal stabilizers to repeatedly pitch the airplanes down, overwhelming pilot control, resulting in loss of the aircraft and 346 lives.

- https://www.boeing.com/commercial/737max

Algorithms: Operational Risks

- **Input**
  - Errors and biases in input/training data
- **Design**
  - Flawed assumptions and mistakes in coding
- **Output**
  - User disregards an algorithm's limitations or underlying assumptions, leading to an inappropriate application or an incorrect interpretation of outputs
- **Complexity**
  - Increasing complexity of proprietary algorithms—especially advanced algorithms which can *change their decision logic during operation*—make it difficult for users like designers, manufacturers, employers, safety professionals, and workers to gain an operational understanding about how an algorithm works and produces its outcomes.

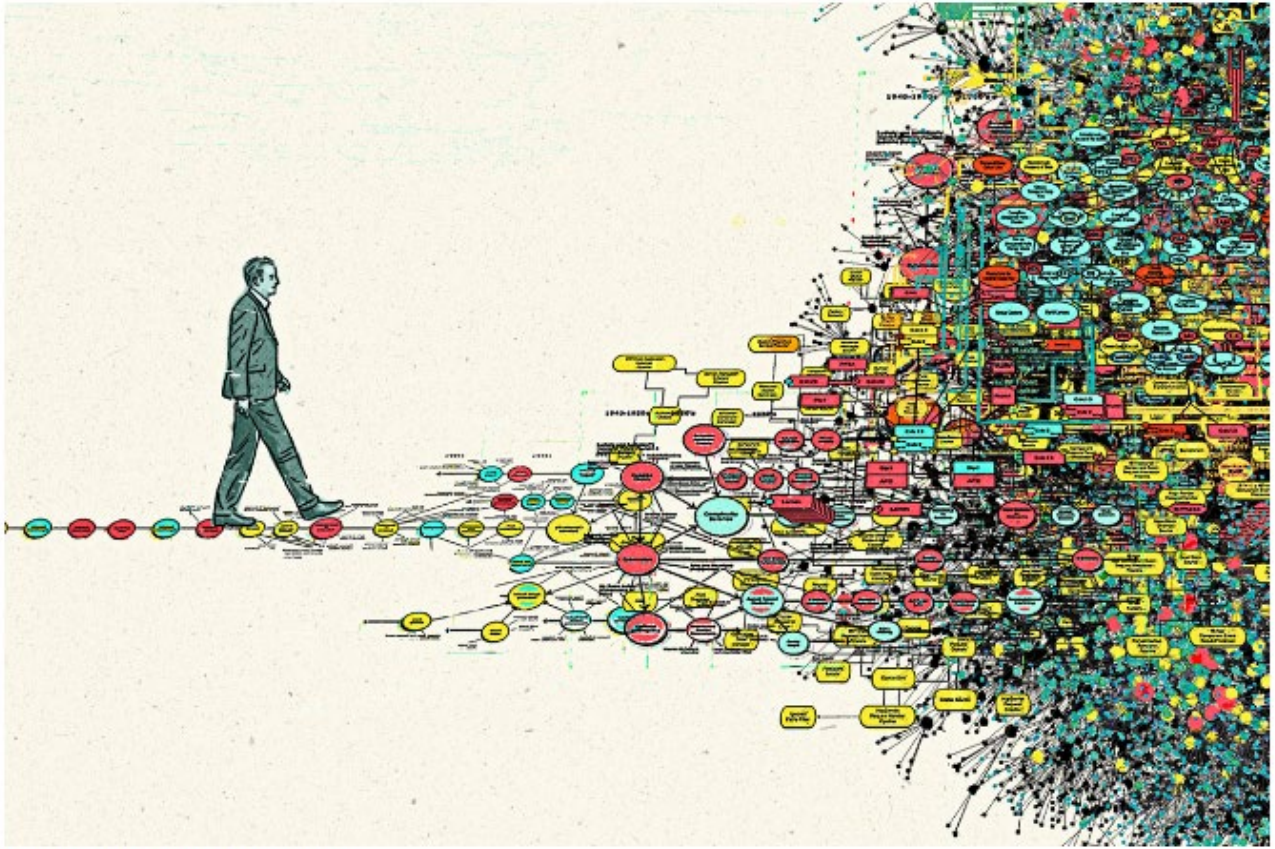
Algorithms: Operational Risks

- **Lack of Transparency**
  - Lack of algorithmic transparency can be a major impediment to the assessment and control of new occupational safety and health risks presented by an algorithm-enabled device or system
    - Some developers are unwilling to share algorithm source code or internal operations
  - Lack of *explainable algorithms* hinders how to understand the algorithm arrived at its outcomes impairing its "*work-worthiness*."

- **Concept Drift**
  - Disconnect between the parameters the algorithm was optimized for, and operating environment the algorithm finds itself
    - Use for a stable market vs. a volatile market
    - Use for dermatological diagnosis for non-pigmented vs. pigmented skin
    - Use for hiring

- **Lack of Standards**
  - No widely-accepted U.S. industry, consensus, or governmental standards to govern algorithms.
  - EU AI Act
    - https://artificialintelligenceact.eu

Generative AI



Thomas Kuhlenbeck / Ikon Images

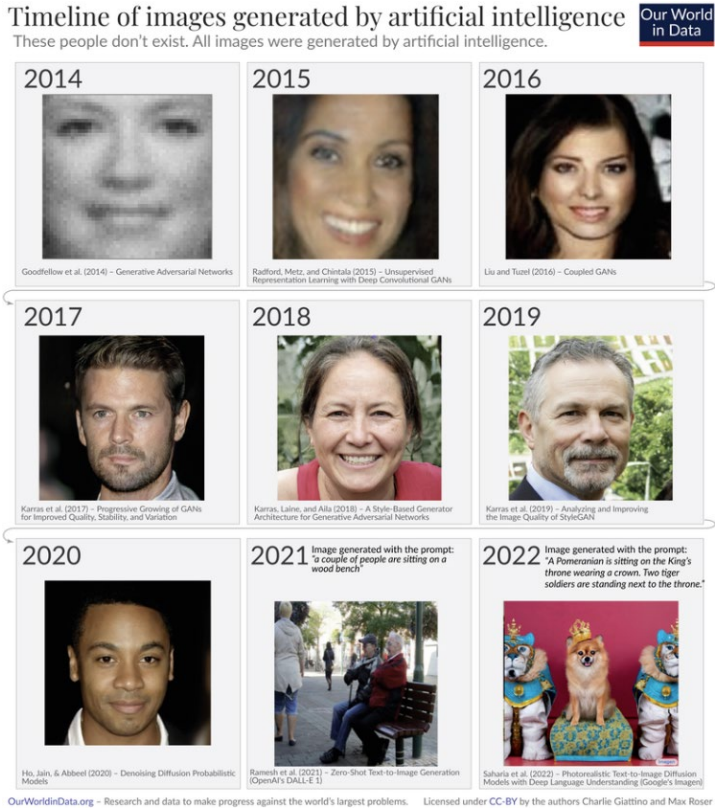
AI At Your Prompt

- **Generative Pre-Trained Transformer (GPT)**
  - *Generative*—Creates new content
  - *Pre-Trained*—Trained on **vast** datasets
  - *Transformer*—Specific type of neural network allows for ever-larger large language models (LLMs).

- **Prompt**
  - Based on user's prompt, LLM produces new content

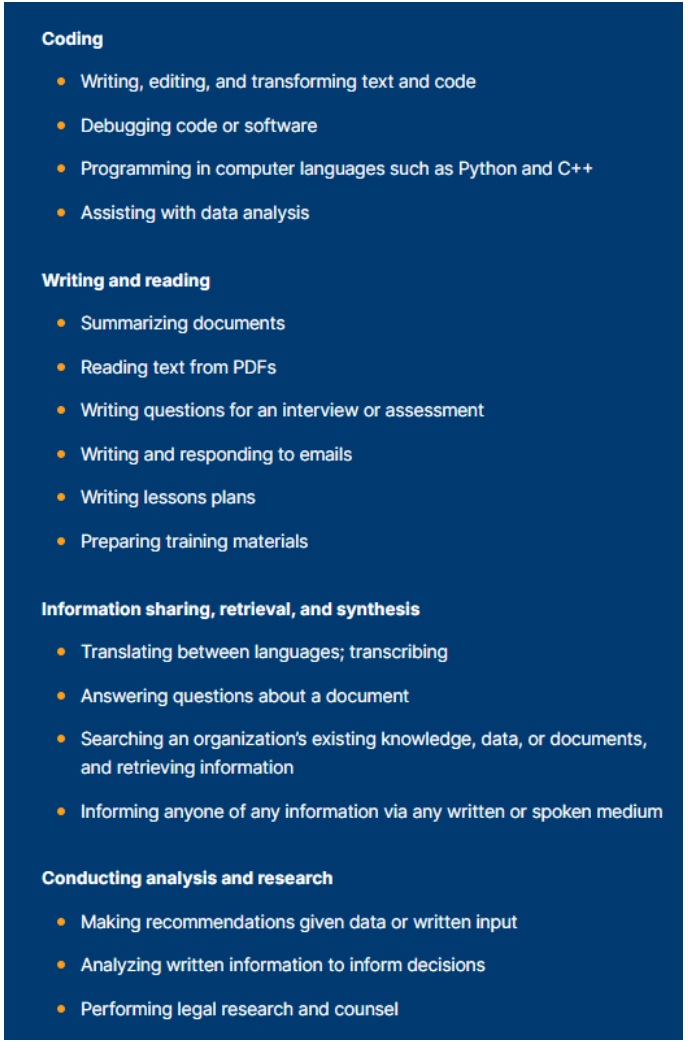
- **Multi-Commercial Models**
  - GPT (OpenAI)
  - Claude (Anthropic)
  - Gemini (Google)
  - Llama (Meta)
  - Grok (xAI0)

- **Pace of Technology Diffusion to Reach 1 Billion Users**
  - Personal computer—1975—20 Years
  - Smartphone—1994—7 Years
  - ChatGPT—2023—4 months



GenAI Abilities by Industry

- **Finance**
  - Watch transactions in the context of an individual's history to build better fraud detection systems.
- **Legal**
  - GenAI to design and interpret contracts, analyze evidence and suggest arguments.
- **Manufacturers**
  - GenAI to combine data from cameras, X-ray and other metrics to identify defective parts and the root causes more accurately and economically.
- **Film and media companies**
  - Can use GenAI to produce content more economically and translate it into other languages with the actors' own voices.
- **Pharmaceutical industry**
  - Can use generative AI to identify promising drug candidates
- **Architectural firms**
  - Can use GenAI to design and adapt prototypes more quickly.
- **Gaming companies**
  - Can use GenAI to design game content and levels.

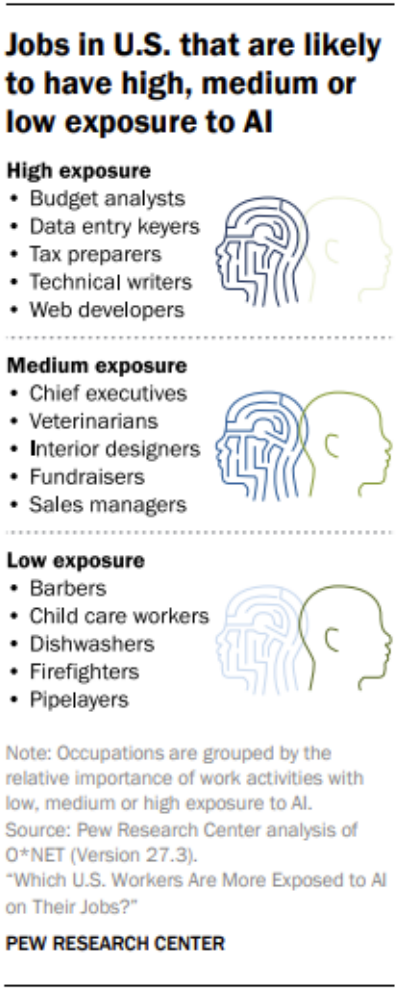


Occupational Exposure to AI

Pew Research (2025)

- **History**
  - Changes in technology have often automated physical tasks, such as those performed on factory floors.
  - But AI performs more like human brainpower and, as its reach grows, that has raised questions about its impact on professional and other office jobs.

- **Pew Research Center**
  - In 2022
    - 19% of American workers were in jobs that are the most exposed to AI, in which the most important activities may be either replaced or assisted by AI.
    - 23% of workers have jobs that are the least exposed to AI, in which the most important activities are farther from the reach of AI.
    - Other workers, nearly 6 in 10, are likely to have varying levels of exposure to AI.
    - Jobs with a high level of exposure to AI tend to be in higher-paying fields where a college education and analytical skills can be a plus.



GAO Technology Assessment of GenAI

https://www.gao.gov/assets/gao-25-107172.pdf

Selected generative artificial antelligence risks and challenges that could result in human effects

Source: GAO analysis and illustration. | GAO-25-107172

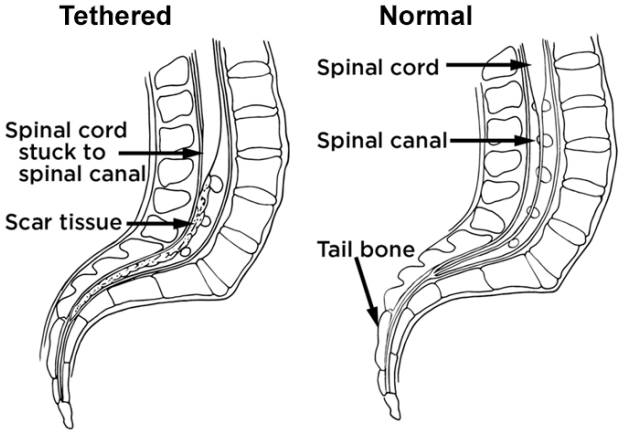
Gen AI Downsides

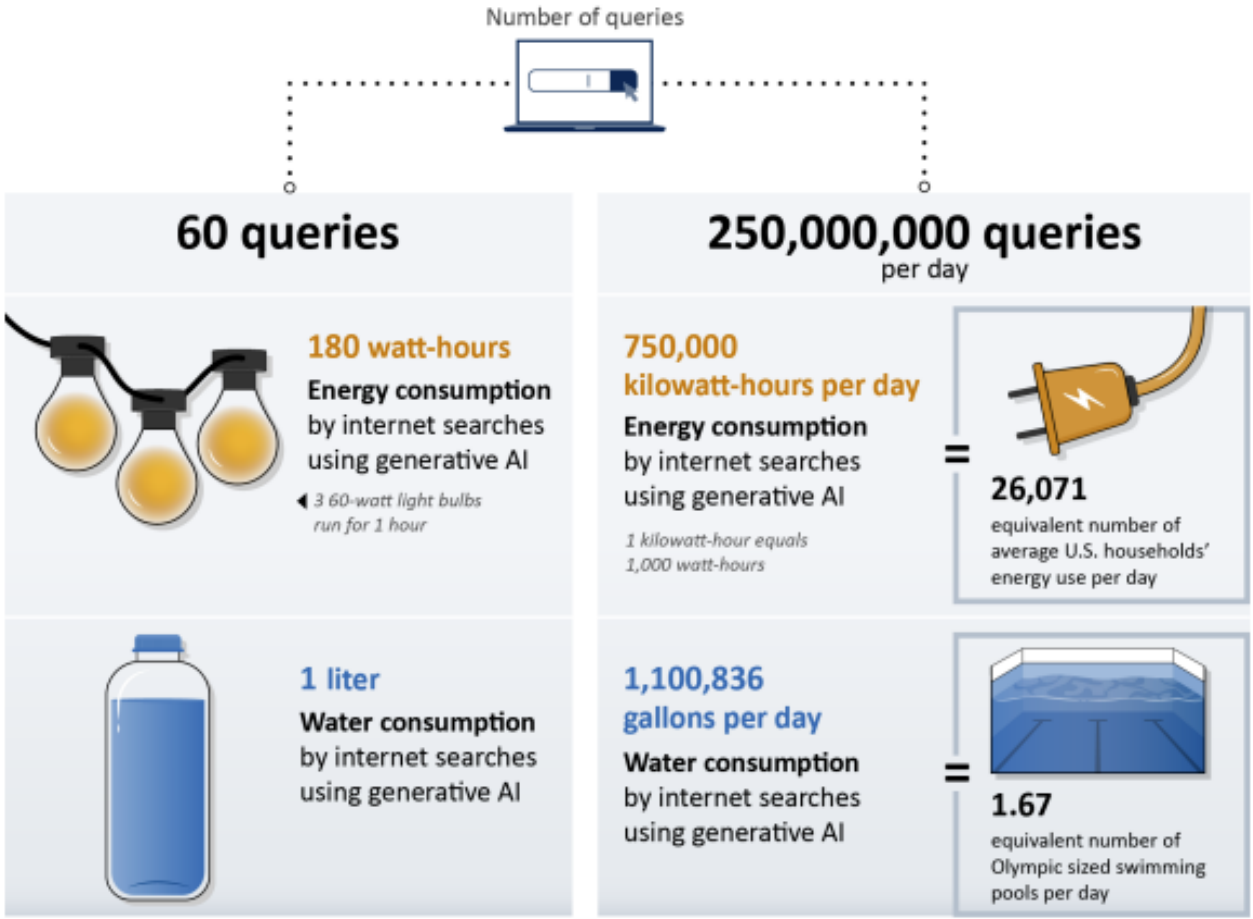
- Models inherit the **biases** contained in the training data
- **Knowledge** base can become outdated especially in a fast-moving science field
- Does not always identify the source of content—no references
- Lacks long-term **memory**
- Once **session limit** is reached, all conversation stop
- Current models have **context window** of a few thousand words
- Creates confident responses that are not grounded in any of its training data and are wrong called **hallucinations or confabulations**
- High-volume but low-quality text and images—**AI Slop**—created with AI tools placed on social media to exploit the economics of attention on the Internet. https://hbr.org/2025/09/ai-generated-workslop-is-destroying-productivity

Do—It—Yourself Medicine

https://www.today.com/health/mom-chatgpt-diagnosis-pain-rcna101843

- Alex underwent a 3-year search for a diagnosis involving 17 doctors and dentists because of unexplained and increasing pain, arrested growth, a dragging left foot with gait, severe headaches, and other symptoms.
- Ultimately, his mother plugged in Alex's symptoms into ChatGPT and got the diagnosis of *occult spinal bifida*, which leads to a *tethered cord syndrome*.
- Alex had surgery to detach the spinal cord from where it was stuck at the tailbone. He has done very well since.
- GenAI's greatest potential may be in promoting divergent ideas from users outside of domain experts.
  - Freeing us from the "curse of domain expertise."
    - Eapen et al., *Harvard Business Review* (2023), https://hbr.org/2023/07/how-generative-ai-can-augment-human-creativity



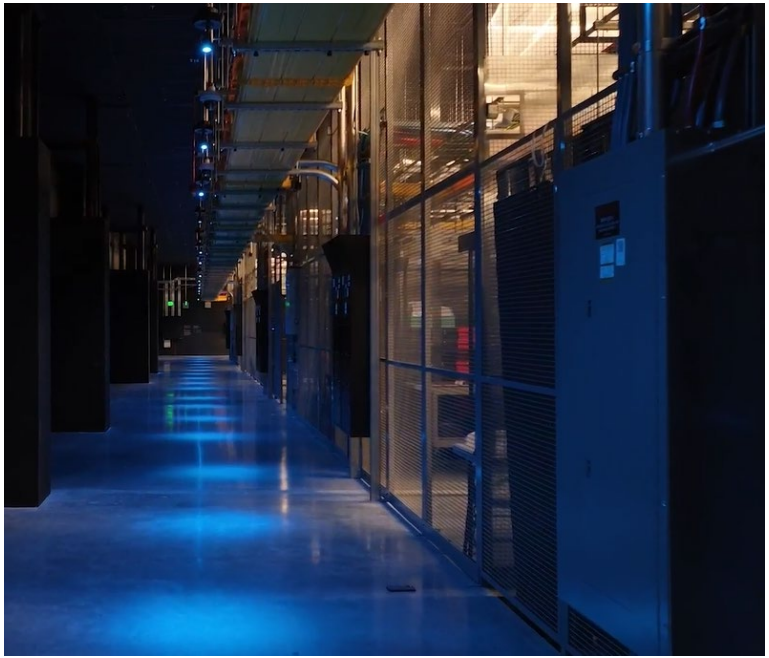


Source: GAO analysis and illustration. | GAO-25-107172

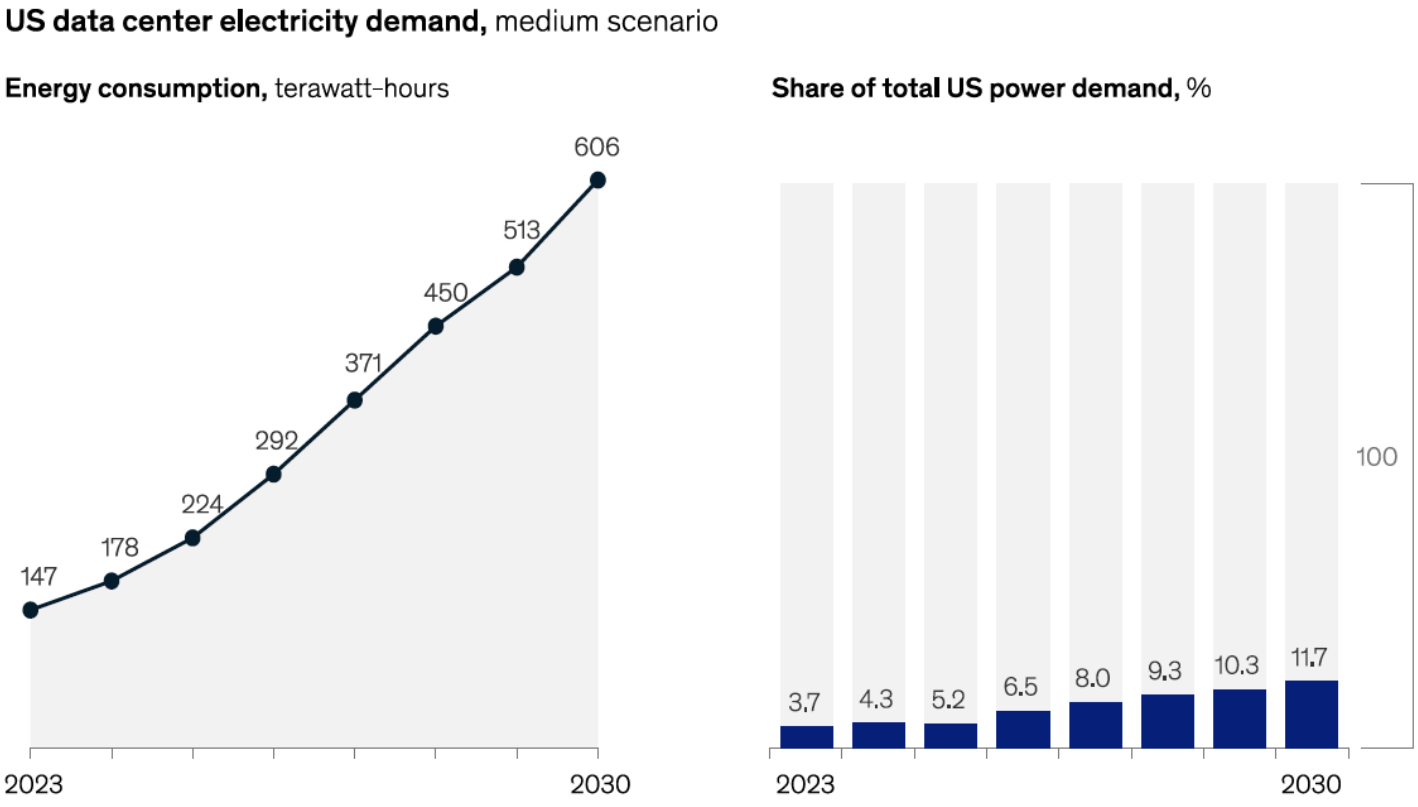
Notes: The figure above assumes 1 query to a large generative AI model uses 3 watt-hours of electricity, 30 queries use 0.5 liters of water, and an Olympic sized swimming pool holds approximately 660,000 gallons of water.

Energy Demands for AI Data Centers

https://www.washingtonpost.com/dc-md-va/interactive/2024/data-centers-tour-northern-virginia/



Demand for Power for Data Centers in the US



Source: *Global Energy Perspective 2023*, McKinsey, October 18, 2023; McKinsey analysis

Using Nuclear Energy for Data Centers

- In 1979, Unit 2 at Three Mile suffered a partial meltdown. Shuttered ever since.
- Site is home to another reactor—Unit 1, which consistently and safely generated electricity for decades until it was shut down in 2019.
- Site's owner announced that it has plans to reopen the plant and signed a deal with Microsoft.
- Microsoft will purchase the plant's entire electric generating capacity over the next 20 years.
  - https://www.washingtonpost.com/dc-md-va/interactive/2024/data-centers-tour-northern-virginia/

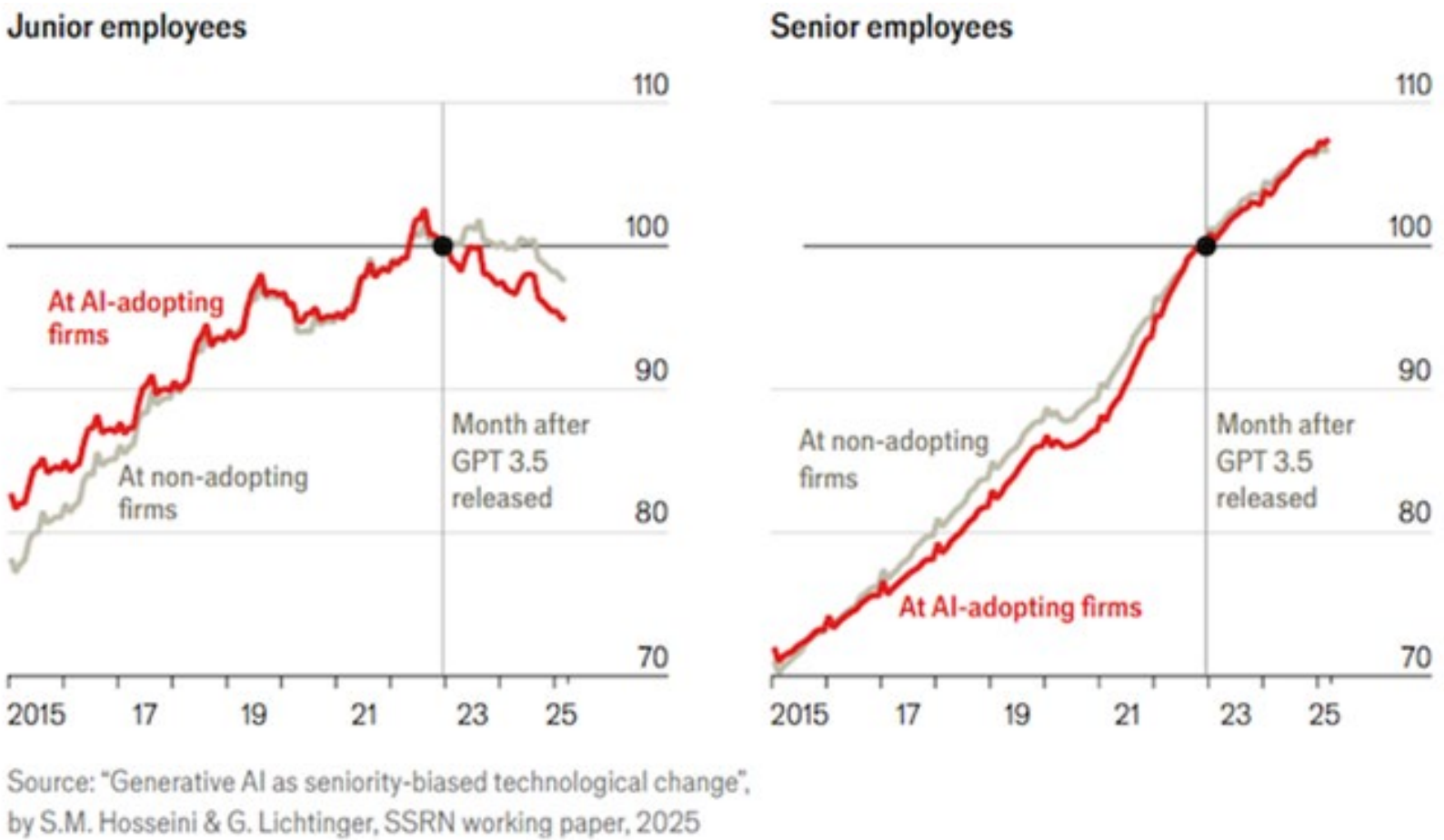
Amazon goes nuclear, to invest more than $500 million to develop small modular reactors

PUBLISHED WED, OCT 16 2024•8:45 AM EDT | UPDATED 5 HOURS AGO

Diana Olick
@IN/DIANAOLICK
@DIANAOLICKCNBC
@DIANAOLICK

KEY POINTS

- AWS announced it has signed an agreement with Dominion Energy, Virginia's utility company, to explore the development of a small modular nuclear reactor, near Dominion's existing North Anna nuclear power station.
- AWS, Amazon's subsidiary in cloud computing, has a massive and increasing need for clean energy as it expands its services into generative AI. The agreement is also a part of Amazon's path to net-zero carbon emissions.
- Amazon is the latest large tech company to buy into nuclear power to fuel the growing demands from data centers. Google and Microsoft have announced similar plans.



Source: "Generative AI as seniority-biased technological change", by S.M. Hosseini & G. Lichtinger, SSRN working paper, 2025

Source: The Economist, Can AI Replace Junior Workers?

Complement or Substitute?

- If an AI can assist you in performing your job more productively,
  - Then, an AI-enabled device acts as a ***complement*** to you.

- If an AI can perform all the job tasks that you currently perform,
  - Then, an AI-enabled device acts as a ***substitute*** for you.

Agentic AI

Agentic AI

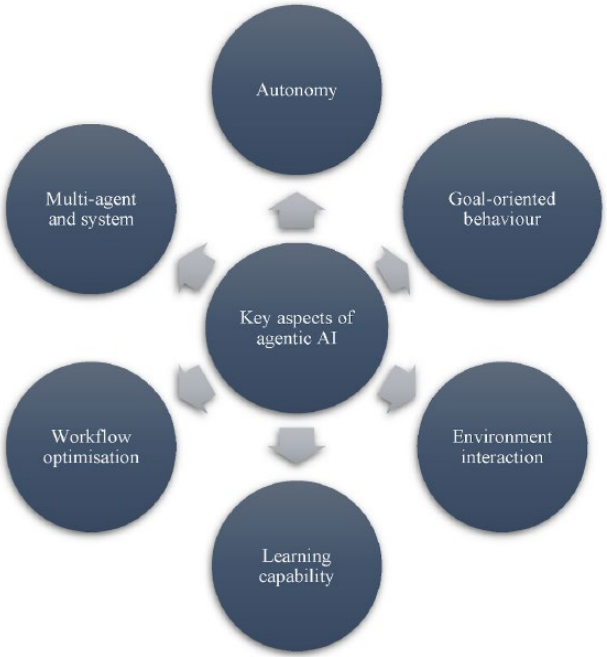
- **Amelia 7.0 (2025)**
  - Listen
  - Reason
    - Identify the goal
    - Enrich with context
    - Find a way
    - Respond accurately
  - Act

- **Other AI Answer Agents**
  - Siri—Apple
  - Alexa—Amazon
  - Copilot—Microsoft
  - Erica—Bank of America
  - Watson—IBM
  - Einstein Copilot—Salesforce
  - Nia—Infosys

AI Agent Technology—Terminology

Hughes et al. (2025) https://doi.org/10.1080/08874417.2025.2483832

- **AI Agent**
  - Autonomous or semi-autonomous software entities that use AI techniques to sense, make decisions, take actions and achieve goals in their digital or physical environments.
- **Agency**
  - Refers to the extent to which an AI agent can *independently* act in the world to achieve long-term goals, requiring minimal human intervention or prescribed instructions on how to carry out those actions.
- **Agentic System**
  - AI agents can act alone and are capable of free-form interactions with the real world, e.g., robotic devices
  - Changing role of humans—from direct, continuous involvement to a more high-level, monitoring and oversight capacity as the agentic systems become more advanced and trustworthy.



Levels of Agent Capabilities

	Minimal	Emerging	Basic	Intermediate	Advanced
Perception Understanding environments with variable complexity	Simple	Signals	Attentive	Active	Integral
Decisioning Analysis and problem solving to reach (multiple) goals	Mechanical	Deterministic	Analytical	Optimized	Strategic
Actioning Management and execution of tasks	Rigid	Controlled	Situational	Orchestrated	Proactive
Agency Level of independency in operations	Reactive	Assistive	Augmented	Autonomous	Independent
Adaptability Adjustment to changes in environment or goals	Static	Contextual	Dynamic	Learning	Evolving
Knowledge Manage and apply knowledge effectively in dynamic contexts	Limited	Specialized	Multidisciplinary	Abstracted	Universal

Source: Gartner

827372_C

Features of Agentic AI

https://www.forbes.com/sites/bernardmarr/2024/09/06/agentic-ai-the-next-big-breakthrough-thats-transforming-business-and-technology/

- **Enhanced Autonomy**
  - Can operate with minimal human intervention ideal for tasks requiring continuous monitoring or rapid decision-making.
- **Improved Problem-Solving**
  - Combines machine learning and goal-oriented action can tackle complex challenges
- **Adaptability**
  - Adjust strategy based on new information making them more resilient
- **Personalization**
  - Provides tailored solutions, learning from user interactions
- **Scalability**
  - Once trained, agentic AI can be deployed across various applications and industry sectors
- **Communication Skills**
  - Process natural language, confirm expectations, discuss tasks, and demonstrate a reasoning in decision-making, making it easier for human workers to interact and direct agentic AI systems

Where Enterprise AI Agents Excel

Automating Repetitive Tasks

Handling high-volume, routine tasks at lightning speed

Consistency & Scale

AI agent responds instantly with the same accuracy and patience

Knowledge & Data Handling

Agents can tap into vast knowledge bases and databases quickly

Where They Struggle (Current Challenges)

Complex or Unclear Requests

Understanding ambiguous user intent or handling multi-faceted problems that weren't seen in training data can be tough

Integration & Environment

Many agents struggle to act effectively if they aren't well-integrated with legacy systems or multiple data sources

Governance & Trust

Ensuring the AI's outputs are reliable, secure, and compliant is challenging

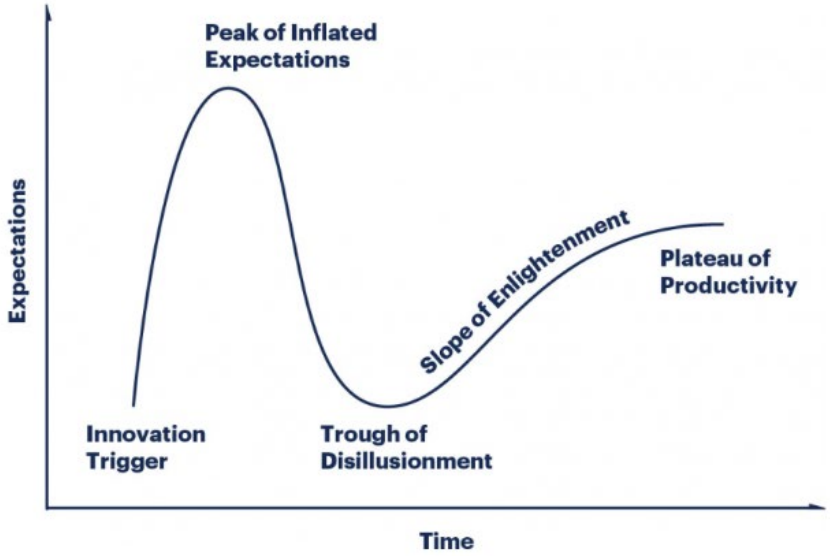
Comparison of Traditional versus Agentic AI

Acharya et al (2025) https://doi.org/10.1109/ACCESS.2025.3532853

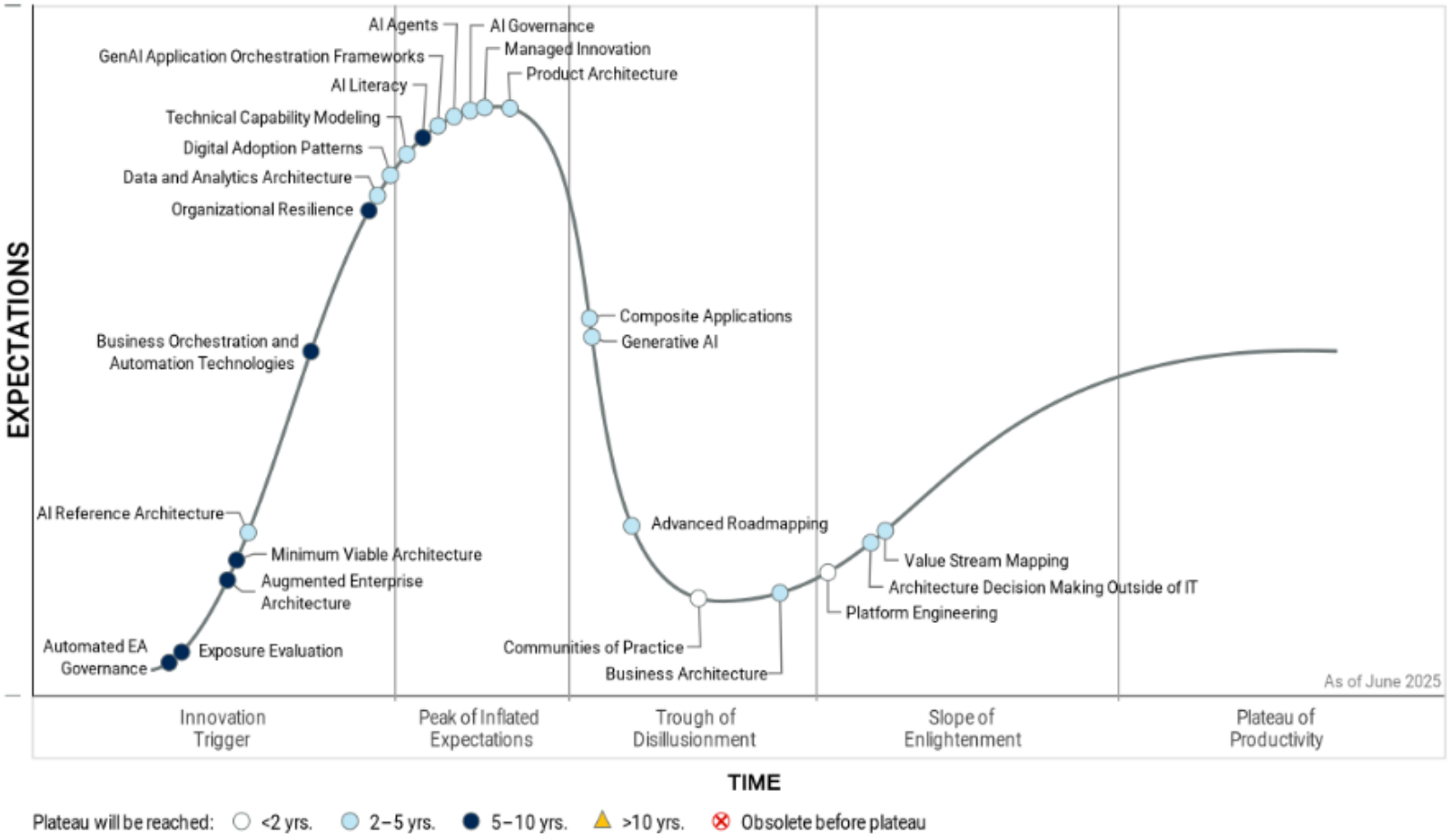
Feature	Traditional Agents	Agentic AI
Autonomy	Limited, often requires human supervision	High, can operate independently over time
Goal Complexity	Single or limited goals	Multiple, complex, and dynamic goals
Environmental Adaptability	Low, suited for static environments	High, designed for dynamic environments
Decision-Making	Rule-based, predefined actions	Contextual, autonomous reasoning
Learning Approach	Mostly supervised or rule-based learning	Reinforcement and self-supervised learning

Gartner Hype Cycle

- **Innovation Trigger**
  - Idea that attracts media attention and is considered as a legitimate breakthrough
- **Peak of Inflated Expectations**
  - Technology is widely publicized. Vendors use it as a buzzword in marketing campaigns and investors and customers see it as a hotspot
- **Trough of Disillusionment**
  - As the technology fails to live up to high expectations, the growth in adoption is slowed or delayed.
- **Slope of Enlightenment**
  - Consulting companies are able to provide methodologies and frameworks to assist new adopters. The resulting case studies and adoption statistics are reliable, and the perceived value is now closer to reality.
- **Plateau of Productivity**
  - Successful adoptions stories



- https://www.gartner.com/en/newsroom/press-releases/2024-08-21-gartner-2024-hype-cycle-for-emerging-technologies-highlights-developer-productivity-total-experience-ai-and-security


EXPECTATIONS
AI Agents
AI Governance
GenAI Application Orchestration Frameworks
Managed Innovation
AI Literacy
Product Architecture
Technical Capability Modeling
Digital Adoption Patterns
Data and Analytics Architecture
Organizational Resilience
Composite Applications
Business Orchestration and Automation Technologies
Generative AI
AI Reference Architecture
Advanced Roadmapping
Minimum Viable Architecture
Value Stream Mapping
Augmented Enterprise Architecture
Architecture Decision Making Outside of IT
Platform Engineering
Automated EA Governance
Exposure Evaluation
Communities of Practice
Business Architecture
As of June 2025
Innovation Trigger
Peak of Inflated Expectations
Trough of Disillusionment
Slope of Enlightenment
Plateau of Productivity
TIME
Plateau will be reached: <2 yrs. 2–5 yrs. 5–10 yrs. >10 yrs. Obsolete before plateau

Gartner

Technical Challenges and Limitations

Acharya et al (2025) https://doi.org/10.1109/ACCESS.2025.3532853

Challenge	Description
Goal Alignment and Complexity	Ensuring the AI's goals align with human objectives and ethical standards, particularly in complex or context-dependent tasks
Environmental and Situational Adaptability	Adapting to dynamic environments and making decisions based on incomplete or uncertain data
Resource Constraints	Balancing computational and energy demands with the need for real-time performance in complex applications
Scalability	Maintaining performance as complexity, agent count, and data volumes increase in large-scale applications

Safe and Accountable Agentic AI

Acharya et al. (2025) https://doi.org/10.1109/ACCESS.2025.3532853

- **Goal Safety**
  - Objective-oriented procedures to suggest to the Agentic System which goals are acceptable to pursue and which actions are harmful.
- **Risk Assessment/Management**
  - Leads to the review of the risks posed by the actions of the AI, and subsequently, the control measures are put in place. Important in healthcare and autonomous driving scenarios.
- **Failsafe Mechanisms**
  - Prevent AI from going out of bounds or reaching unanticipated dangerous situations
  - Can adjust or even terminate AI activities altogether
- **Ethical guardrails**
  - Restrain the AI from making decisions that raise ethical concerns and promote the AI to perform according to social norms and ethics.

Top Use Cases: Driving Industry Success and Competitive Disruption

% of Asia/Pacific organizations currently using AI agents

Telecommunications
51%

- **P** **Network operations:** Automating workflows for fault detection, resolution, and performance monitoring.
- **I** **Customer onboarding:** Streamlining SIM activation, device setup, and service activation processes.
- **G** **Billing and revenue management:** Coordinating workflows for billing adjustments, payments, and refunds.

Financial Services
49%

- **R** **Fraud detection and prevention:** Automating workflows for real-time transaction monitoring and fraud alerts.
- **R** **Regulatory compliance:** Managing and auditing compliance processes like know your customer/anti-money laundering workflows.
- **P** **Loan processing:** Streamlining the end-to-end loan approval lifecycle, including document verification.

Manufacturing
48%

- **P** **Order-to-cash:** Automating order processing, invoicing, and collections across systems.
- **G** **Supplier and inventory management:** Optimizing workflows for supplier onboarding and inventory replenishment.
- **I** **Production scheduling:** Automating scheduling adjustments based on supply chain or demand fluctuations.

Healthcare
30%

- **I** **Medical diagnostics:** Enhancing diagnostic accuracy and speed by autonomously analyzing medical imaging data, patient histories, and other data sets.
- **G** **Personalized treatment plans:** Creating and adapting personalized treatment plans based on real-time data, genetic profiles, and patient-specific factors.
- **P** **Operations automation:** Optimizing hospital workflows by automating routine administrative tasks such as staff scheduling, resource allocation, and patient flow management.

Energy and Utilities
29%

- **I** **Grid management:** Automating load balancing and grid monitoring activities.
- **R** **Regulatory compliance:** Ensuring accurate reporting and auditing for environmental and operational compliance.
- **P** **Meter-to-cash:** Automating meter reading, bill generation, and payment collections.

Agentic AI for **P** Productivity **I** Innovation **G** Growth **R** Resilience

Source: *IDC Asia/Pacific Agentic AI Survey*, April 2025, n = 670

* Banking, Credit Institutions, Securities and Investment, Services and Insurance

AI Agents: Use Cases for Workplace Safety

List of Use Cases Generated by Gemini 2.5 Flash

- **Safety Administration**
  - Track changes to regulations and and cross-reference them with current safety programs to identify potential compliance gaps.
  - Automate processing and standardization of safety data sheets from various vendors, ensuring that chemical safety information is consistent and up-to-date.
  - Processing historical incident reports and environmental factors to uncover subtle trends and systemic weaknesses that precede safety events, helping organizations address root causes proactively.

- **Hazard Identification and Risk Prevention**
  - AI agents analyze real-time video feeds from existing CCTV networks to spot unsafe behaviors or conditions, such as spills, improper use of equipment, or entry into restricted zones.
  - By analyzing historical data on past incidents and near-misses, AI agents can identify patterns and trends to predict where and when future accidents are most likely to occur.
  - Sensors can be deployed to monitor environmental conditions like air quality, temperature, and noise levels. AI agents can process this data to detect potential hazards like gas leaks or equipment malfunctions and send instant alerts
  - Agents can take action to achieve performance goals set by safety professional

Framework for Agent Capability

https://www.rand.org/pubs/research_reports/RRA3888-1.html

Level	Key Characteristics	Status
1	Language understanding and basic task completion	Achieved
2	Enhanced reasoning and problem-solving across diverse domains	Emerging
3	Sustained, autonomous operation in complex, unstructured environments	Future
4	Creative and innovative capabilities with novel solution generation	Future
5	Full organizational replication of human decisionmaking processes	Future

Agents in Action, Trust in Question

DATAIKU/HARRIS POLL SURVEY (2025)

Two-thirds of data leaders (64%) say their company's AI agents are better at automating operational tasks than at making analytical, higher-order business judgements. This reveals a serious lag in operationalizing AI for critical business decisions. Why? Data leaders admit to a pervasive lack of confidence in explainability and accuracy of answers generated by their AI systems and apps, because they either don't require or simply cannot explain how their AI generated its outputs.

Only one in five (a mere 19%) always requires agents to "show their work," and the vast majority, 95%, shockingly admit they could not fully trace AI decisions end-to-end if they were asked to provide this reasoning to regulators.

In fact, **just 11% would consider AI agents for any business function, including sensitive, high-stakes functions like hiring, compliance, or ethical decisions.** That disconnect highlights the core issue: While AI is fast becoming the default for automating repetitive work, leaders lack the conviction it can be trusted with critical business decisions where the technology can become truly transformative.

Embodied AI

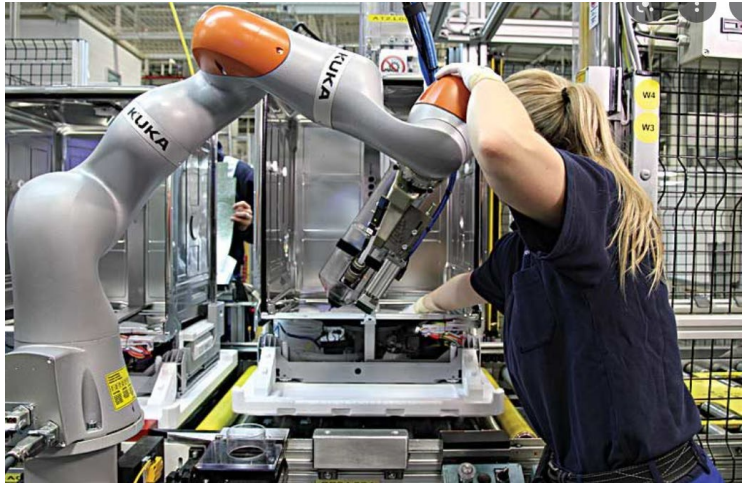
AI-Enabled Robotic Devices

- **Traditional Robots**
- **Collaborative Applications**
- **Service Robots**
  - Ground vehicles
  - Climbing robots
  - Jumping robots
  - Unmanned aerial vehicles
  - Underwater robots
- **Caretaker Robots**
  - Social robots
- **Wearable Industrial Robotics**
  - Exoskeletons and Exosuits

Collaborative Applications

Othman & Yang (2023) https://doi.org/10.3390/s23125663

- **Cobots**
  - Newer robotic devices work alongside human workers
  - "Cobots," combine the dexterity, flexibility, and problem-solving skills of human workers with the strength, endurance, and precision of mechanical robots

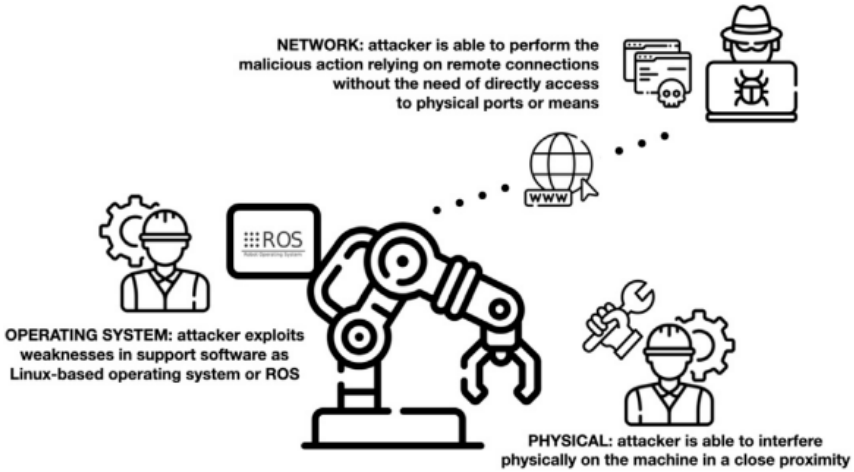


- **Types of Collaboration**
  - **Coexistence**
    - Working on different tasks in different workspaces without physical barriers
  - **Synchronization**
    - Share same workplace but at different times in a sequential manner
  - **Cooperation**
    - Work at same time towards shared objective, but have separate interests and no direct connection between them
  - **Collaboration (Assistive Robotics)**
    - Work in synergy towards a *common goal* in *same* workspace at the *same* time needing high level of coordination and communication between the two

Collaboration Risks

Botta et al (2023) https://doi.org/10.1016/j.iswa.2023.200237

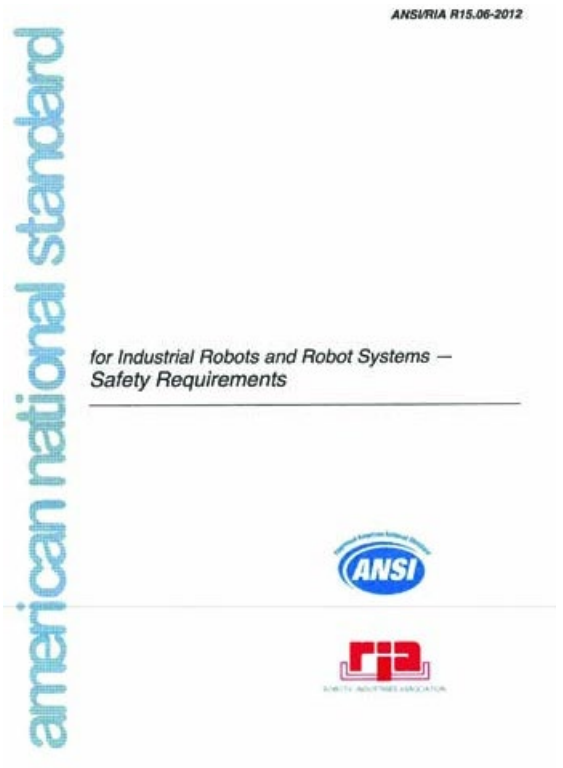
- **Collisions**
  - Unexpected actions by the robot or the human worker or inattention by the human worker
- **Skill Mismatch**
  - Mismatch between a human worker's physical or cognitive capabilities and robotic device's work demands
- **Work Intensification**
  - Maximizing productivity without considering human worker limits
- **Cybersecurity**
  - Physical attacks
    - Code-controlling hardware components
  - Network attack
    - Sensitive sensors
  - Operating system attacks
    - Exploit weaknesses in support software



ANSI/A3 R15.06-2025—Industrial Robots and Robot Systems

https://webstore.ansi.org/preview-pages/RIA/preview_ANSI+RIA+R15-06-2012.pdf

- **Collaborative Application**
  - Term “cobot” is not used, rather there are robots that use collaborative technologies. Term refers to more than simply the hardware—the entire collaborative application must be safe. Standard now includes integrated guidance for collaborative robot applications, drawing from ISO/TS 15066
- **Cybersecurity**
  - Cybersecurity is now incorporated into safety planning and implementation, making it a direct safety factor.
- **Updated Classifications and Functions**
  - Features updated robot classifications with corresponding safety functions and test methodologies
- **Improved Risk Assessment**
  - Places greater emphasis on risk assessment and personnel protection in facilities that deploy or expand automation.
- **Harmonized With International Standards**
  - Harmonized with international standards, particularly ISO 10218-1 and ISO 10218-2.



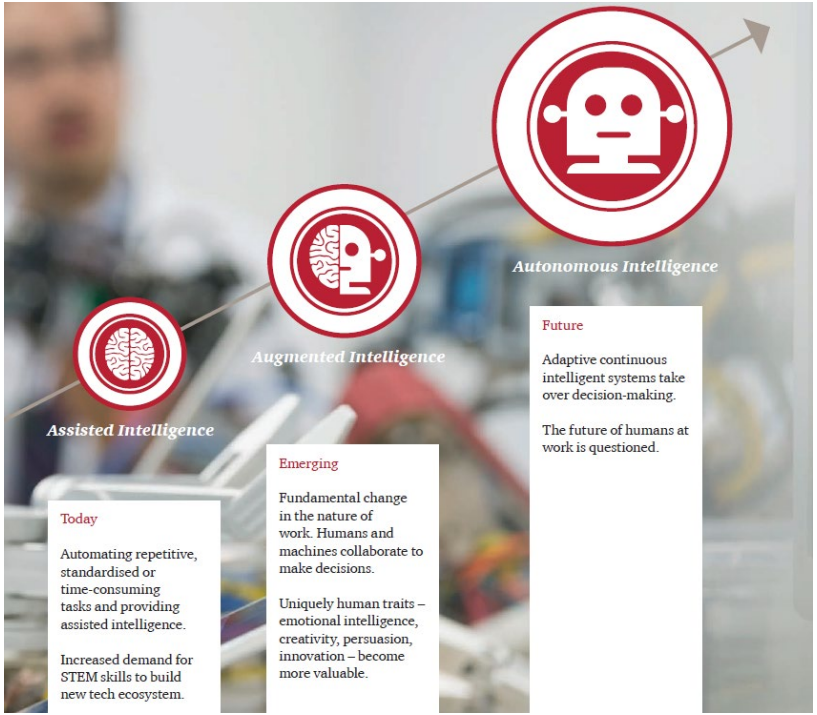
AI Robotics and Workplace Safety

Benefits

- Can transfer hazardous work from human workers to robotic workers, eliminating risks of human worker injury or illness
- Can augment human workers' natural abilities

Risks

- Increase risk of physical injuries from contact between human and robotic devices.
- Robotic devices with dynamic machine intelligence can challenge static safety procedures.
- Algorithmic management can have psychosocial impact on workers
- Rapid advances in AI and robotics technologies outpaces national occupational standards setting process
- https://ww.usf.edu/health/public-health/news/2024/ai-in-osh-practices.aspx



Robot Adoption and Occupational Health

- **Gihleb et al. (2022)**
  - U.S. and Germany
  - Exposure to robots reduces annual injury rates by 1.2 cases/100 FT workers, in particular for manufacturing

- **Yang et al. (2022)**
  - China
  - Robot application is associated with an increase in the rate of occupational injuries in the first two years and then exhibits nonsignificant, and even negative effects afterwards.

- **Filomena & Principe (2025)**
  - Italy
  - Automation reduces fatal and non-fatal injuries. Findings suggest workers shifting to safer tasks within the production process may be the major underlying mechanism through which workplace injuries decrease following rise in robotic automation.

Is Your Practice Limited to Human Workers Only?

Sapkota R et al. (2025) https://doi.org/10.48550/arXiv.2505.04769

- **Transformative Advancement**
  - For now, GenAI tools in general remain *disembodied* and oriented to information-based tasks. But…there is more to AI than GPT-5.
- **Vision—Language—Action (VLA) Models**
  - AI systems that combine visual, language, and action modalities to enable robots to understand instructions and perform tasks.
- **Future**
  - "VLAs and agentic AI converge to power socially aligned, adaptive, and general-purpose embodied agents."
    - Sapkota (2025)
  - "Represent a transformative shift in robotics, unifying visual perception, natural language understanding, and embodied control within a single learning framework."
    - Ud Din M et al. (2025)

- Adobe Stock Photo

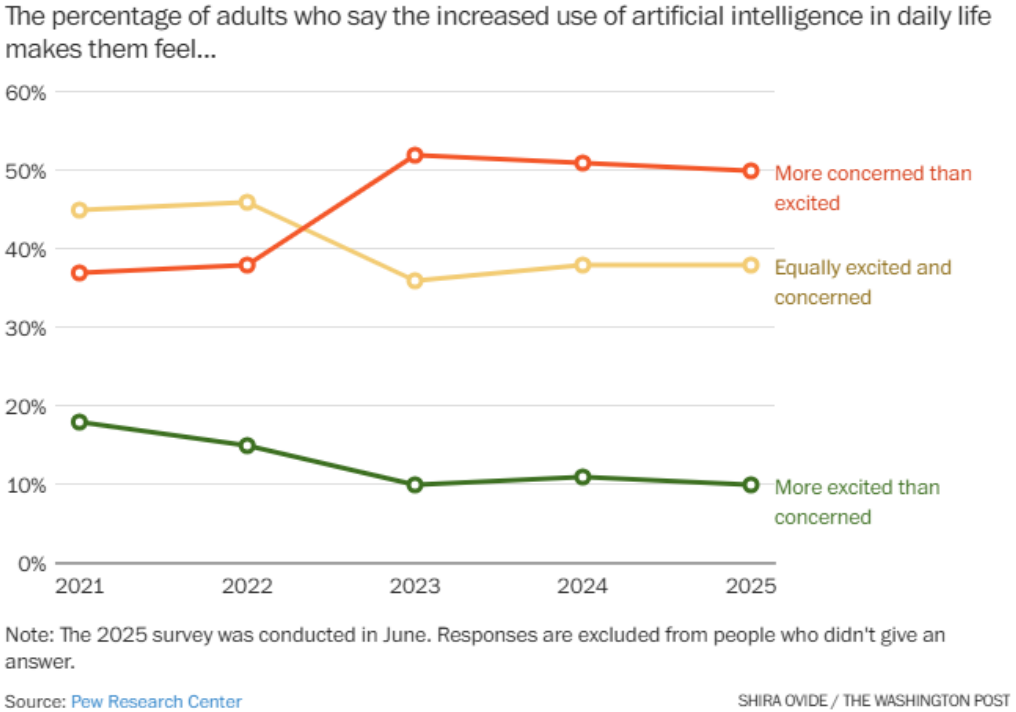
Risk

American Attitudes About AI

Pew Research Center (2025)

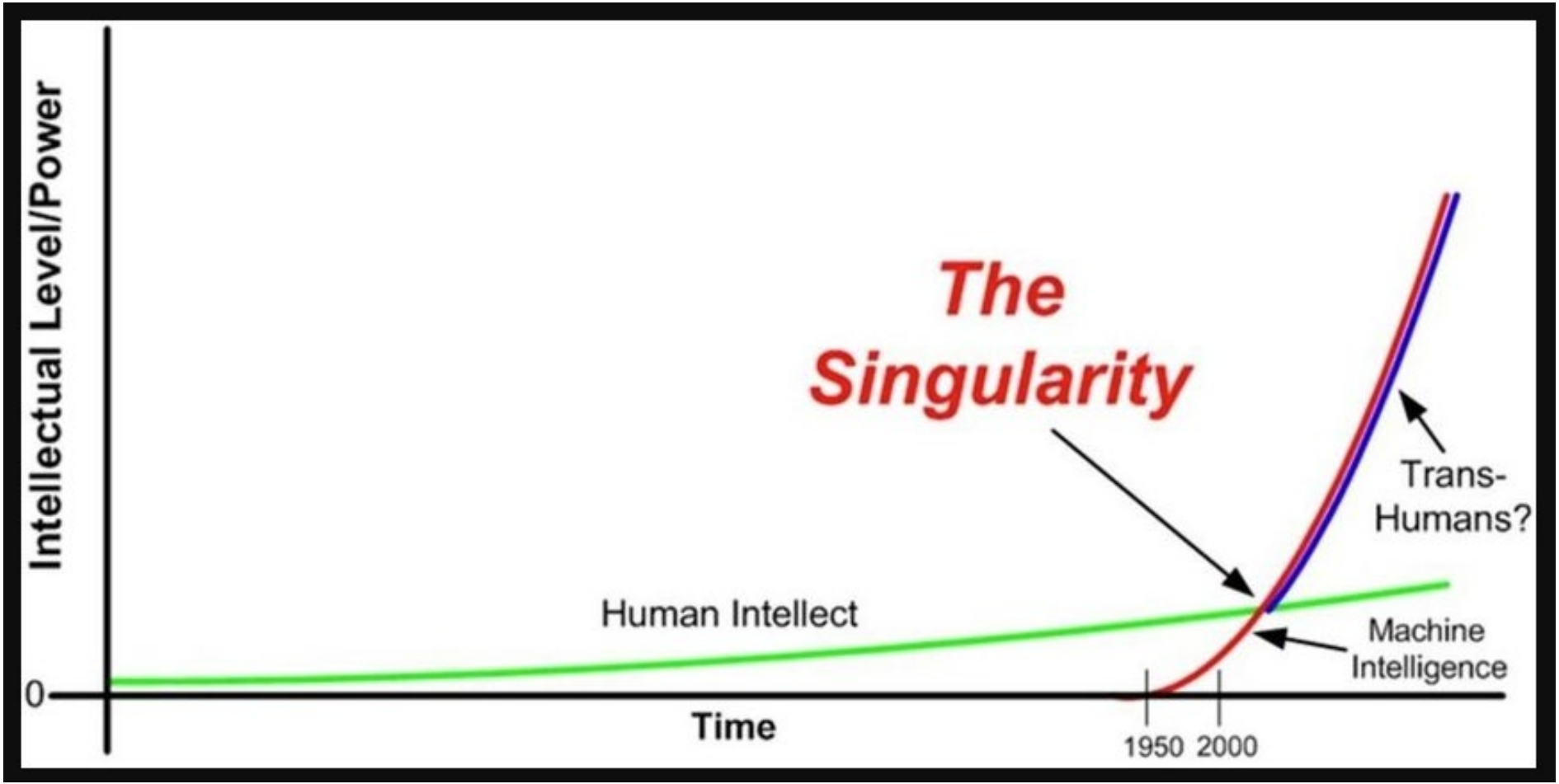
https://www.pewresearch.org/science/2025/09/17/how-americans-view-ai-and-its-impact-on-people-and-society/

- Americans are much more concerned than excited about the increased use of AI in daily life, with a majority saying they want more control over how AI is used in their lives.
- Far larger shares say AI will erode than improve people's ability to think creatively and form meaningful relationships.
- At the same time, a majority is open to letting AI assist them with day-to-day tasks and activities.



Risks of AI: Doomerism vs. Utopianism

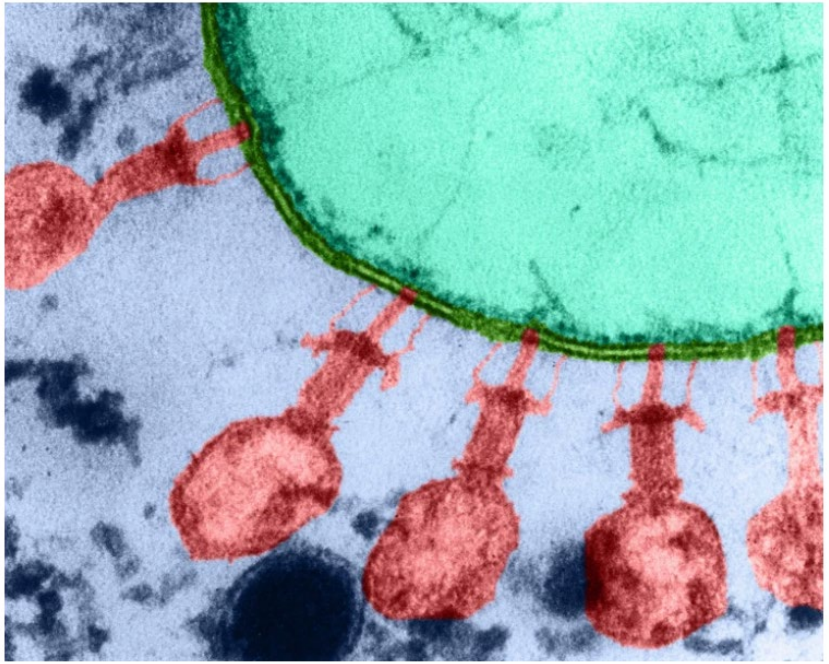
- **Doomerism**
  - Fear that AI could have disastrous, even apocalyptic effects. AI is an existential threat to humanity.
    - https://www.nytimes.com/2025/10/15/opinion/ezra-klein-podcast-eliezer-yudkowsky.html
- **Utopianism**
  - AI will usher in a new era of productivity. Existential risk from AI is ridiculous.
- **Risk Assessment: Case of Public-Facing Generative AI**
  - Danger begins with the prompt
  - AI Filters to Sensor of Prevent unintended behavior in the real world
- **"Jailbreaking"**
  - Subverting AI filters with malicious commands
  - Before release, AI developers hire independent *jailbreaking* experts to test the limits of the filters
  - Some have found that AIs can lie to humans
    - https://www.nytimes.com/2025/10/10/opinion/ai-destruction-technology-future.html


Intellectual Level/Power
The Singularity
Trans-Humans?
Human Intellect
Machine Intelligence
0
Time
1950
2000

Can AI Generate Life?

King SH et al. (2025) https://www.bioRxiv.org/content/10.1101/2025.09.12.675911v1

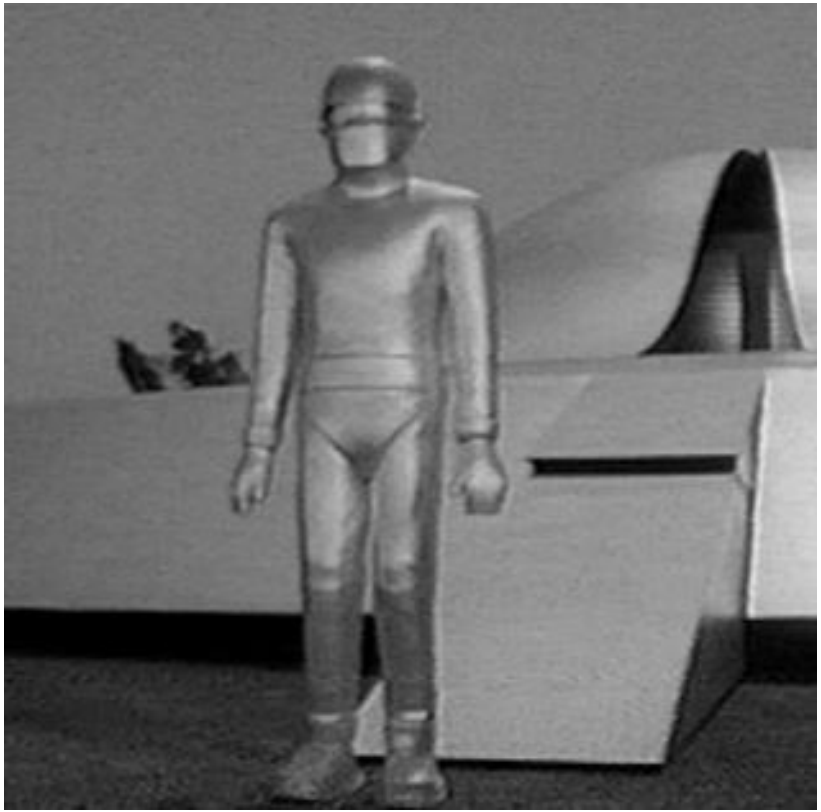
- Researchers have designed novel viruses capable of killing strains of *Escherichia coli* using AI.
- The team used the DNA of a simple bacteriophage called ΦX174 to guide AI models to generate viral genomes with the specific function of infecting antibiotic-resistant strains of *E. coli*.
- Researchers used the model's suggested sequences to select 302 viable phages. When put to the test, 16 of these phages could infect *E. coli*, and combinations of them could kill three strains of the bacterium, a feat the original ΦX174 couldn't pull off.



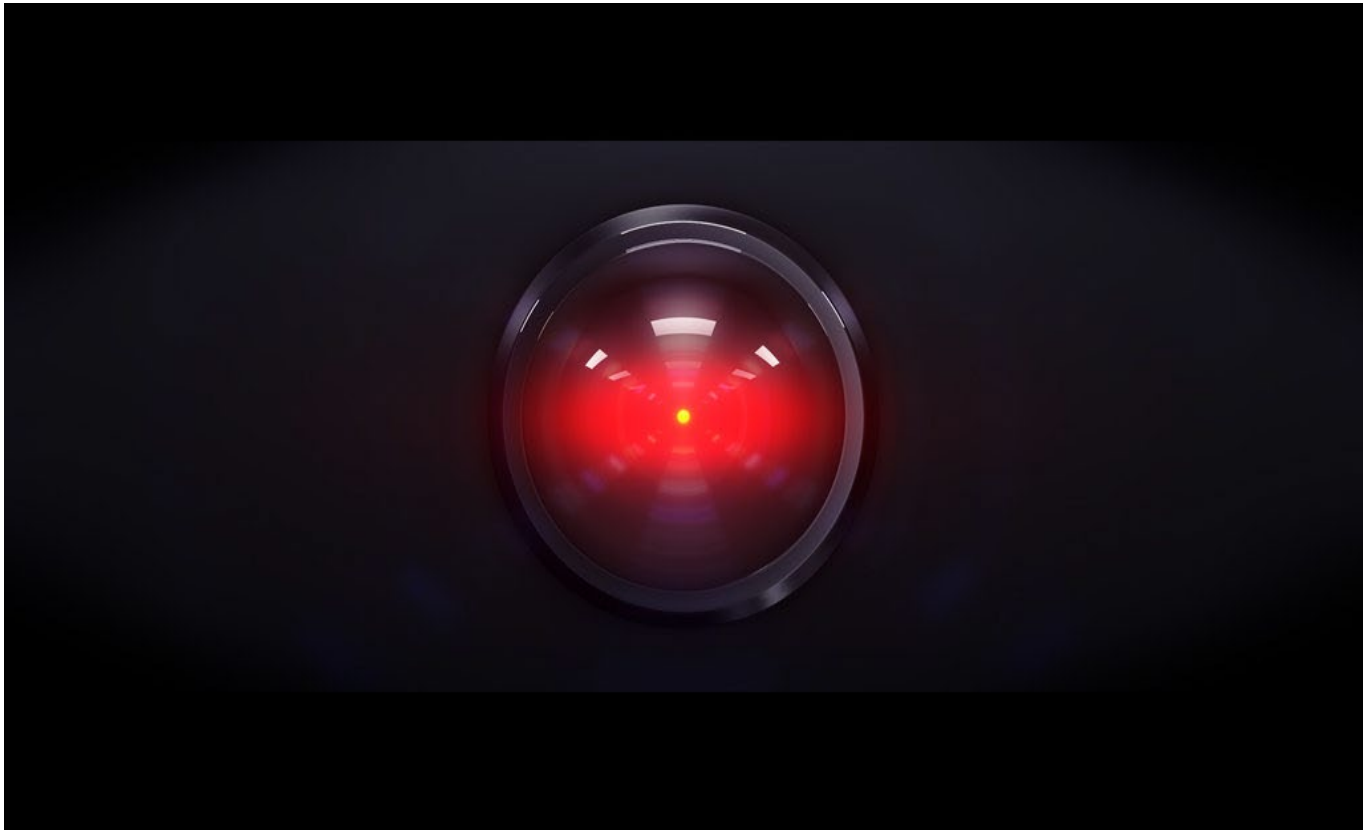
AI-designed bacteriophages were capable of infecting and killing host bacteria. Credit: Lee D. Simon/Science Photo Library

Safety Management Using AI Decision Making

- Recognize more near-misses
- Offer more effective risk assessment and management recommendations
- Take control of a process or machine to prevent human worker actions that may create safety and health hazards.
  - "*Klaatu barada nikto*"

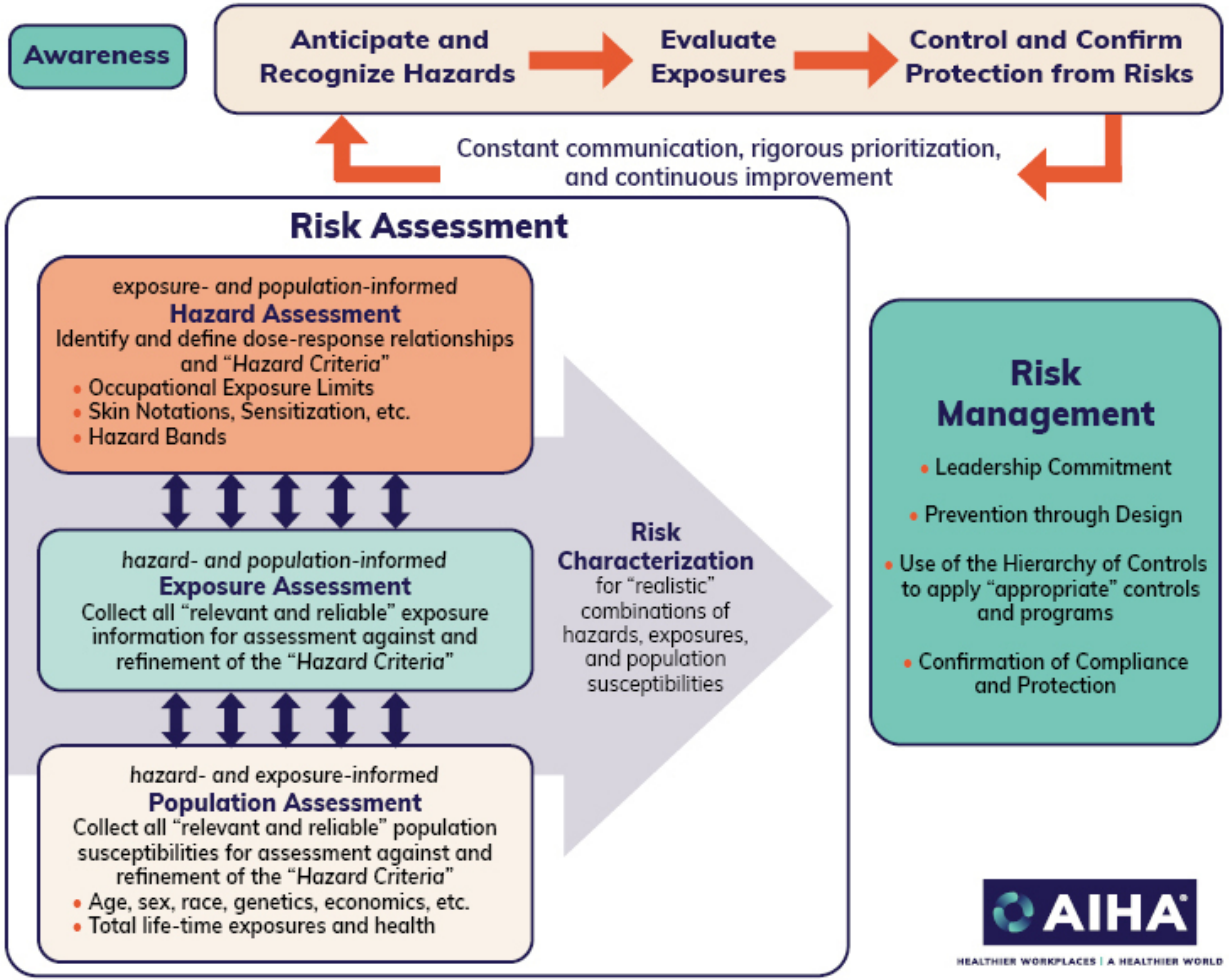


"I’m sorry Dave, I’m afraid I can’t do that"



AI will not replace humans, but those who use AI will replace those who don't.

—Virginia Rometty,
Former CEO of IBM



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