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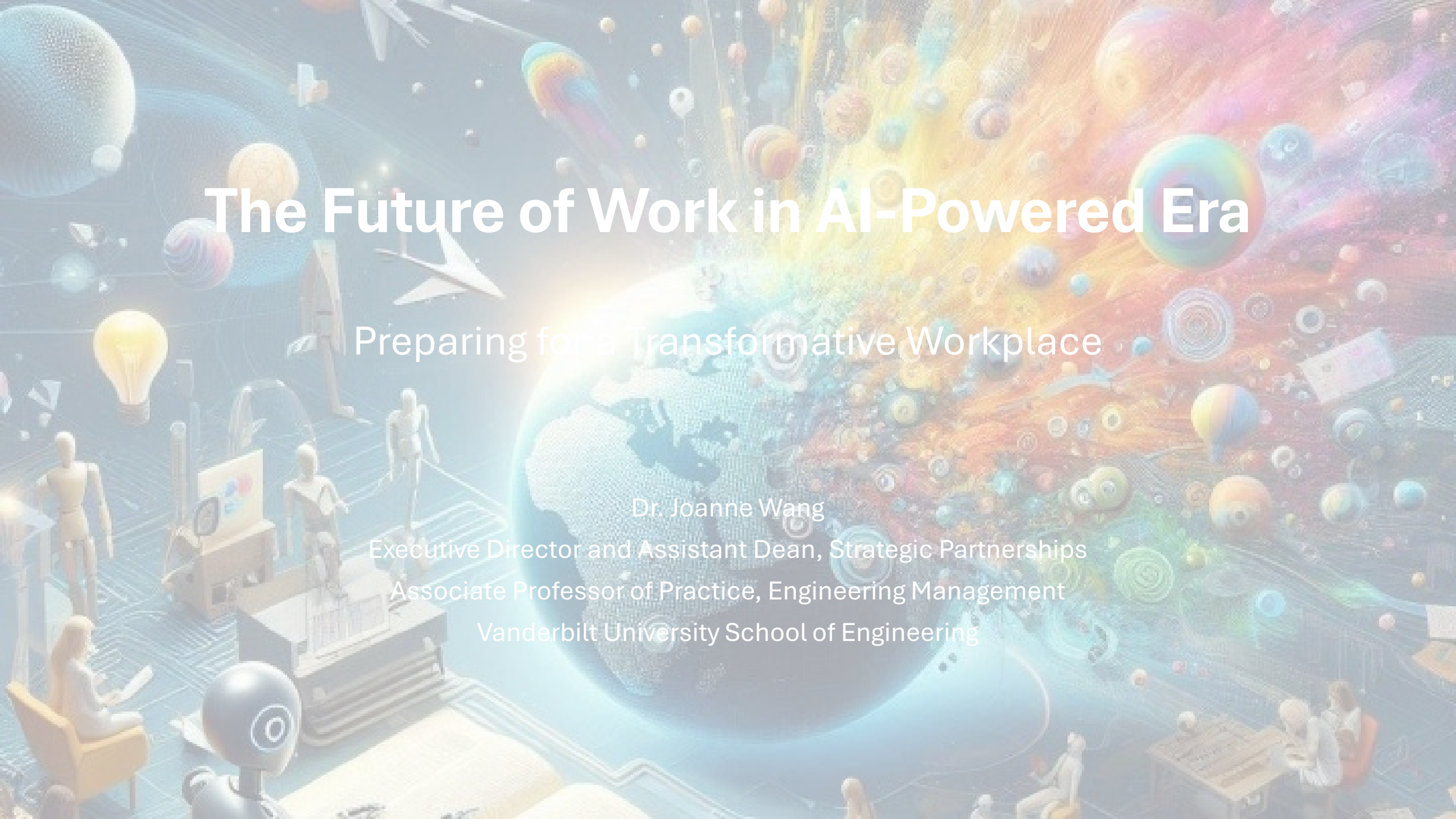
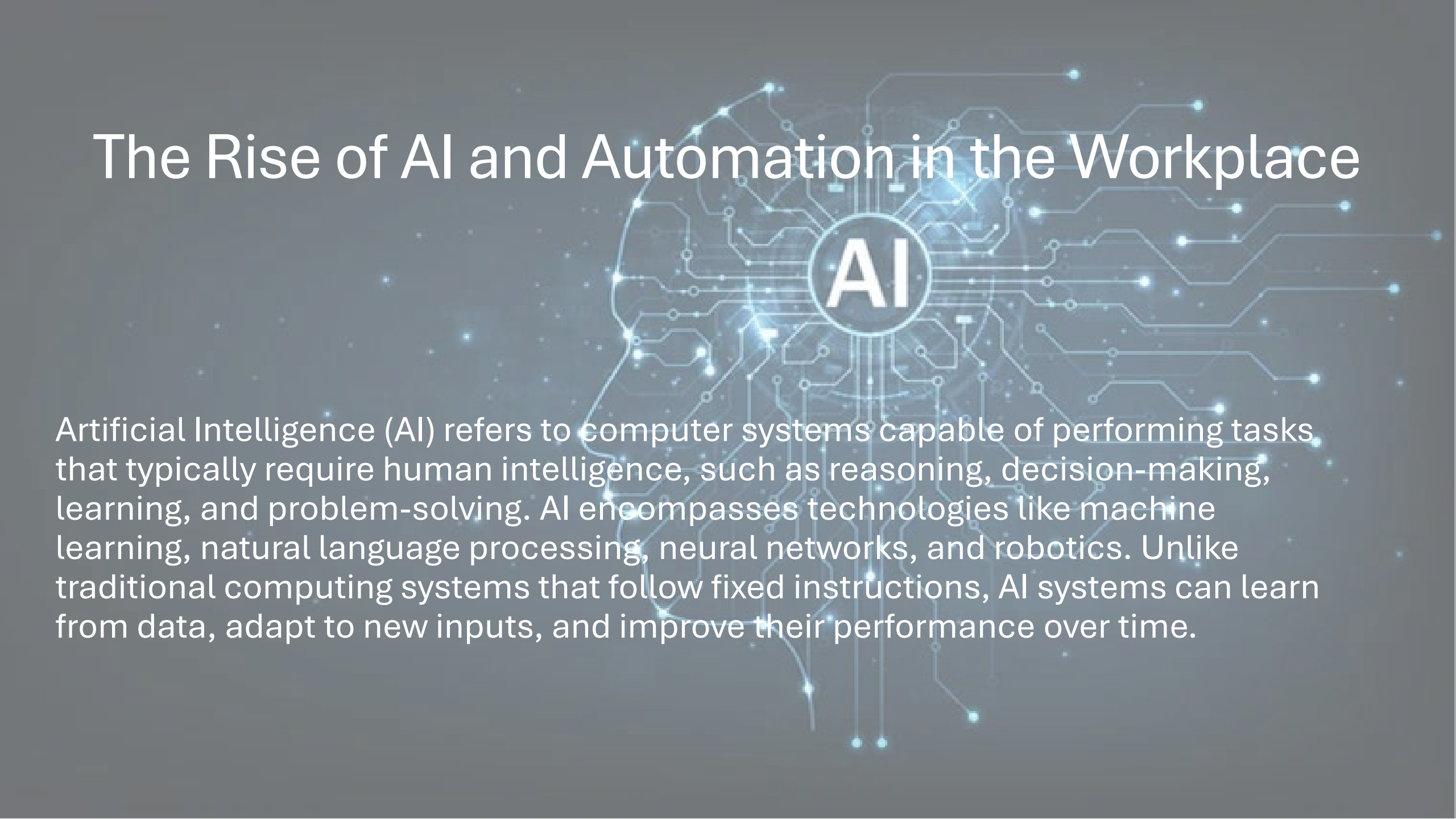


# The Future of Work in AI-Powered Era

## Preparing for a Transformative Workplace

Dr. Joanne Wang
Executive Director and Assistant Dean, Strategic Partnerships
Associate Professor of Practice, Engineering Management
Vanderbilt University School of Engineering

# The Rise of AI and Automation in the Workplace




Artificial Intelligence (AI) refers to computer systems capable of performing tasks that typically require human intelligence, such as reasoning, decision-making, learning, and problem-solving. AI encompasses technologies like machine learning, natural language processing, neural networks, and robotics. Unlike traditional computing systems that follow fixed instructions, AI systems can learn from data, adapt to new inputs, and improve their performance over time.

1956 | 1974 | 1980 | 1987 | 1993

The First Burst: Emergence of the first-generation robot and intelligent software.

The First Winter: No confidence on development of AI, and no more research funding.

The Second Burst: Development of expert system and breakthrough of neural network.

The Second Winter: Reduction of research funding due to lack of practical applications.

The Third Burst: Development of big data and deep learning promotes the potential economic effect.

**STAGE I: Inference Period**

**STAGE II: Knowledge Period**

**STAGE III: Learning Period**

Birth of Artificial Intelligence: *Dartmouth Conference*

**Development of Technology**

**1957** — *Perceptron* was first proposed

**Early 1970s** — *Structure learning* system and logic-based *inductive learning* system

**1986** — Combination of *multiple layer perceptron* and *back-propagation*

**1995** — *Adaptive boosting* algorithm and *support vector machines*

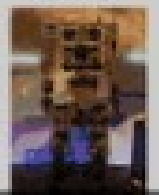
**2006** — Neural network with *deep learning* capability

**2013** — Breakthrough of deep learning in *voice and visual identification*

**Breakthrough of Applications**

**1961** — The first industrial robot *Unimate* was used in the production line of the General Motors Corporation.

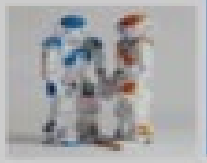
**1973** — The first humanoid robot *wabot-1* was made in Japan, which can play music.



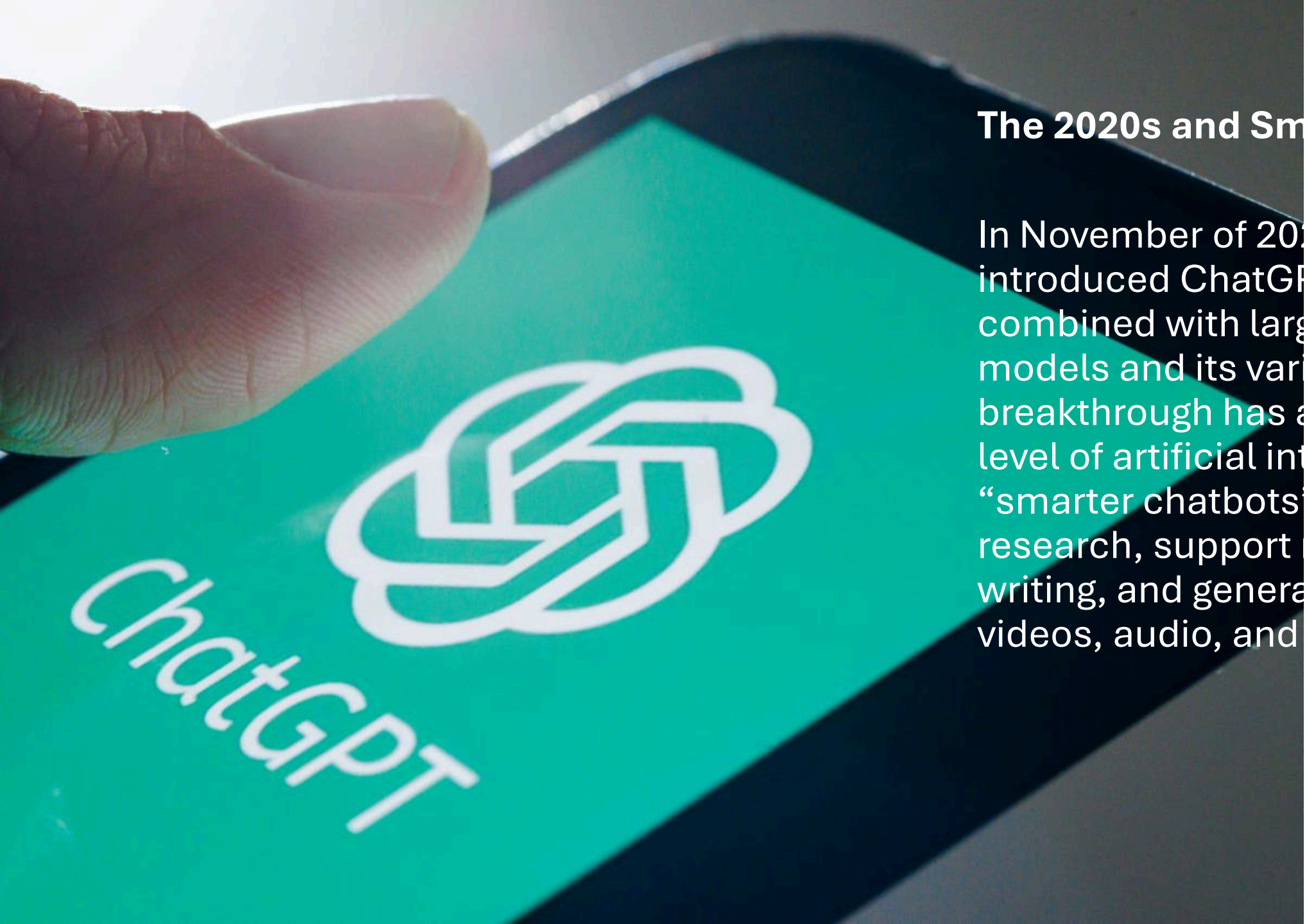
**1980** — The expert system called *XCON* was completed at CMU for the Digital Equipment Corporation

**1997** — *Deep Blue* (chess computer) from IBM beat the human champion.

**2006** — The intelligent robot NAO was developed



Apple *Siri*; Google *driverless car* and *Alpha Go*; IBM *Watson*; Massive artificial intelligence applications in daily life;




## The 2020s and Sm

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breakthrough has a
level of artificial int
“smarter chatbots”
research, support
writing, and genera
videos, audio, and

TECH

Artificial Intelligence

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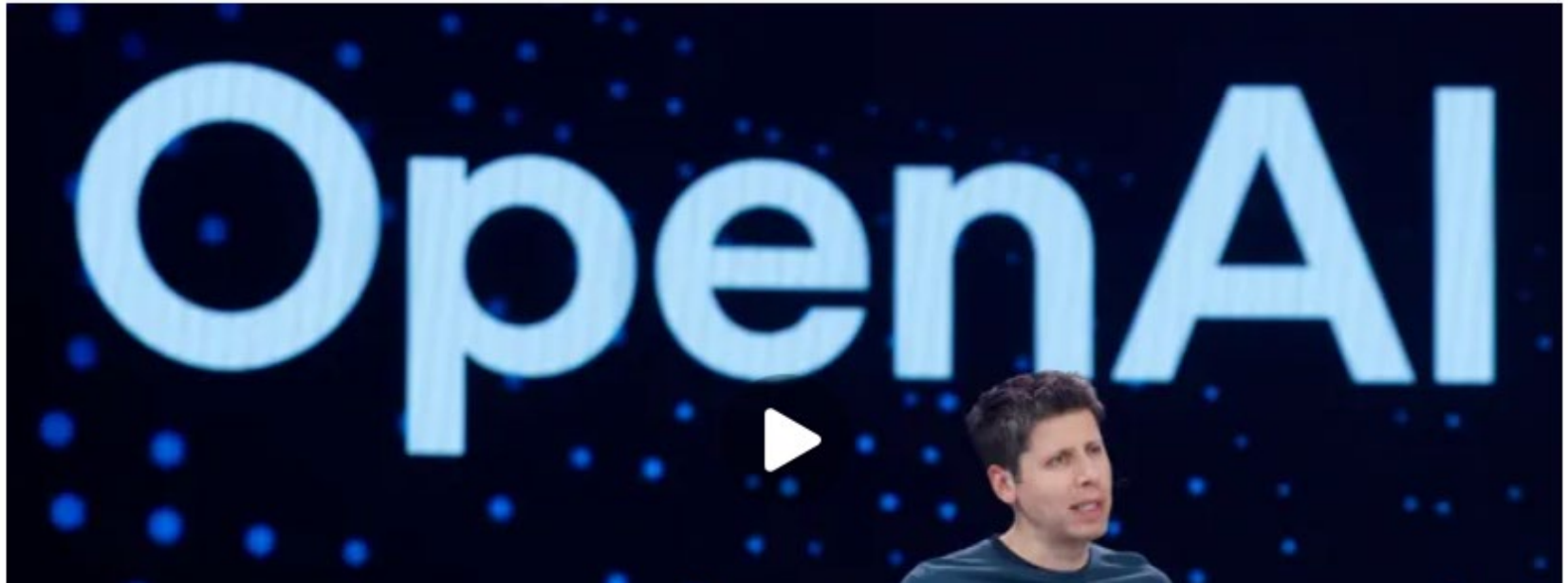
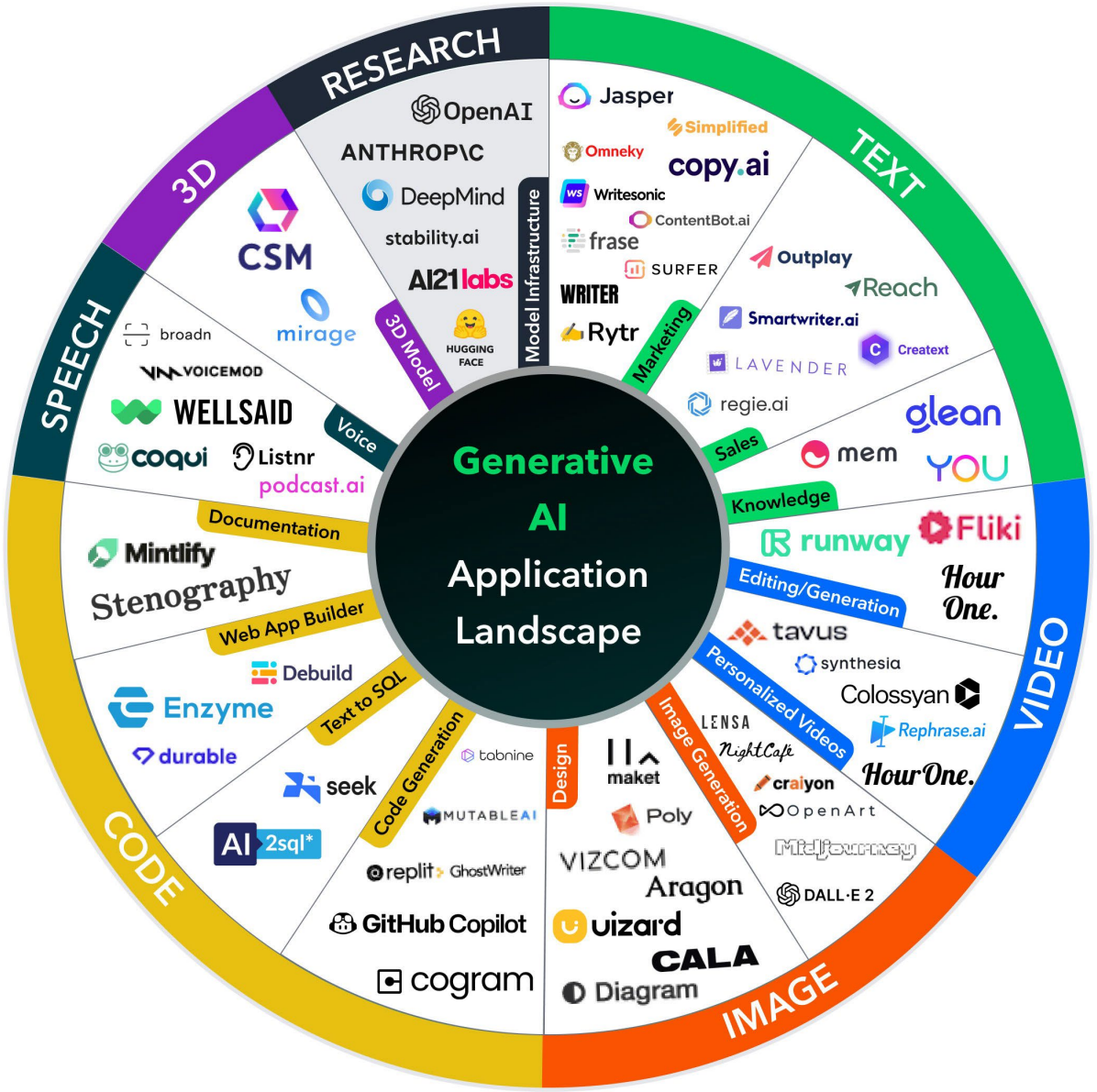
# OpenAI unveils Chat GPT-5 model with 'Ph.D level intelligence'

**Anthony Robledo** and **Natassia Paloma** USA TODAY NETWORK

Aug. 7, 2025 | Updated Aug. 8, 2025, 1:14 p.m. ET






Generative AI Application Landscape
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VIDEO
IMAGE
CODE
SPEECH
3D
Model Infrastructure
OpenAI
ANTHROP\C
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AI 2sql*
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GhostWriter
GitHub Copilot
cogram
Text to SQL
Debuild
Enzyme
durable
Web App Builder
Documentation
Mintlify
Stenography

# Formal Algorithms for Transformers

**Mary Phuong**[1] **and Marcus Hutter**[1]
[1]DeepMind

**This document aims to be a self-contained, mathematically precise overview of transformer architectures and algorithms (*not* results). It covers what transformers are, how they are trained, what they are used for, their key architectural components, and a preview of the most prominent models. The reader is assumed to be familiar with basic ML terminology and simpler neural network architectures such as MLPs.**

*Keywords: formal algorithms, pseudocode, transformers, attention, encoder, decoder, BERT, GPT, Gopher, tokenization, training, inference.*



Contents



*A famous colleague once sent an actually very well-written paper he was quite proud of to a famous complexity theorist. His answer: "I can't find a theorem in the paper. I have no idea what this paper is about."*

## 1. Introduction

Transformers are deep feed-forward artificial neural networks with a (self)attention mechanism. They have been tremendously successful in natural language processing tasks and other domains. Since their inception 5 years ago [VSP+17], many variants have been suggested [LWLQ21]. Descriptions are usually graphical, verbal, partial, or incremental. Despite their popularity, it seems no pseudocode has ever been published for any variant. Contrast this to other fields of computer science, even to "cousin" discipline reinforcement learning [MKS+13, SBB18, EMK+21].

This report intends to rectify the situation for Transformers. It aims to be a self-contained, complete, precise and compact overview of transformer architectures and formal algorithms (but *not* results). It covers what Transformers are (Section 6), how they are trained (Section 7), what they're used for (Section 3), their key architectural components (Section 5), tokenization (Section 4), and a preview of practical considerations (Section 8) and the most prominent models.

The essentially complete pseudocode is about 50 lines, compared to thousands of lines of actual real source code. We believe these formal algorithms will be useful for theoreticians who require compact, complete, and precise formulations, experimental researchers interested in implementing a Transformer from scratch, and encourage authors to augment their paper or text book with formal Transformer algorithms (Section 2).

The reader is assumed to be familiar with basic ML terminology and simpler neural network architectures such as MLPs.

In short, a (formally inclined) reader, upon understanding the contents of this document, will have a solid grasp of transformers: they will be ready to read and contribute to the literature on the topic as well as implement their own Transformer using the pseudocode as templates.

## 2. Motivation

The true story above the introduction describes quite well the feeling we have when browsing

*Corresponding author(s): {buiphuong,mhutter}@deepmind.com*


**Algorithm 4:** $\tilde{V} \leftarrow \texttt{Attention}(X, Z|\mathcal{W}_{qkv}, \text{Mask})$

```
/* Computes a single (masked) self- or
   cross- attention head.                */
```

**Input:** $X \in \mathbb{R}^{d_x \times \ell_x}$, $Z \in \mathbb{R}^{d_z \times \ell_z}$, vector representations of primary and context sequence.

**Output:** $\tilde{V} \in \mathbb{R}^{d_{out} \times \ell_x}$, updated representations of tokens in $X$, folding in information from tokens in $Z$.

**Parameters:** $\mathcal{W}_{qkv}$ consisting of:
$W_q \in \mathbb{R}^{d_{attn} \times d_x}$, $b_q \in \mathbb{R}^{d_{attn}}$
$W_k \in \mathbb{R}^{d_{attn} \times d_z}$, $b_k \in \mathbb{R}^{d_{attn}}$
$W_v \in \mathbb{R}^{d_{out} \times d_z}$, $b_v \in \mathbb{R}^{d_{out}}$.

**Hyperparameters:** $\text{Mask} \in \{0,1\}^{\ell_z \times \ell_x}$, $\uparrow(3)$

$Q \leftarrow W_q X + b_q \mathbf{1}^\top$ $\quad [\![Q\text{uery} \in \mathbb{R}^{d_{attn} \times \ell_x}]\!]$
$K \leftarrow W_k Z + b_k \mathbf{1}^\top$ $\quad [\![K\text{ey} \in \mathbb{R}^{d_{attn} \times \ell_z}]\!]$
$V \leftarrow W_v Z + b_v \mathbf{1}^\top$ $\quad [\![V\text{alue} \in \mathbb{R}^{d_{out} \times \ell_z}]\!]$
$S \leftarrow K^\top Q$ $\quad [\![S\text{core} \in \mathbb{R}^{\ell_z \times \ell_x}]\!]$
$\forall t_z, t_x$, if $\neg\text{Mask}[t_z, t_x]$ then $S[t_z, t_x] \leftarrow -\infty$
**return** $\tilde{V} = V \cdot \text{softmax}\left(S/\sqrt{d_{attn}}\right)$

# Key Trends of AI in Transforming the Workplace

- Economic Impact: AI is projected to contribute up to $15.7 trillion to the global economy by 2030, driving innovation and efficiency across industries. 70% of the skills required in jobs will change, emphasizing the need for continuous learning and adaptability

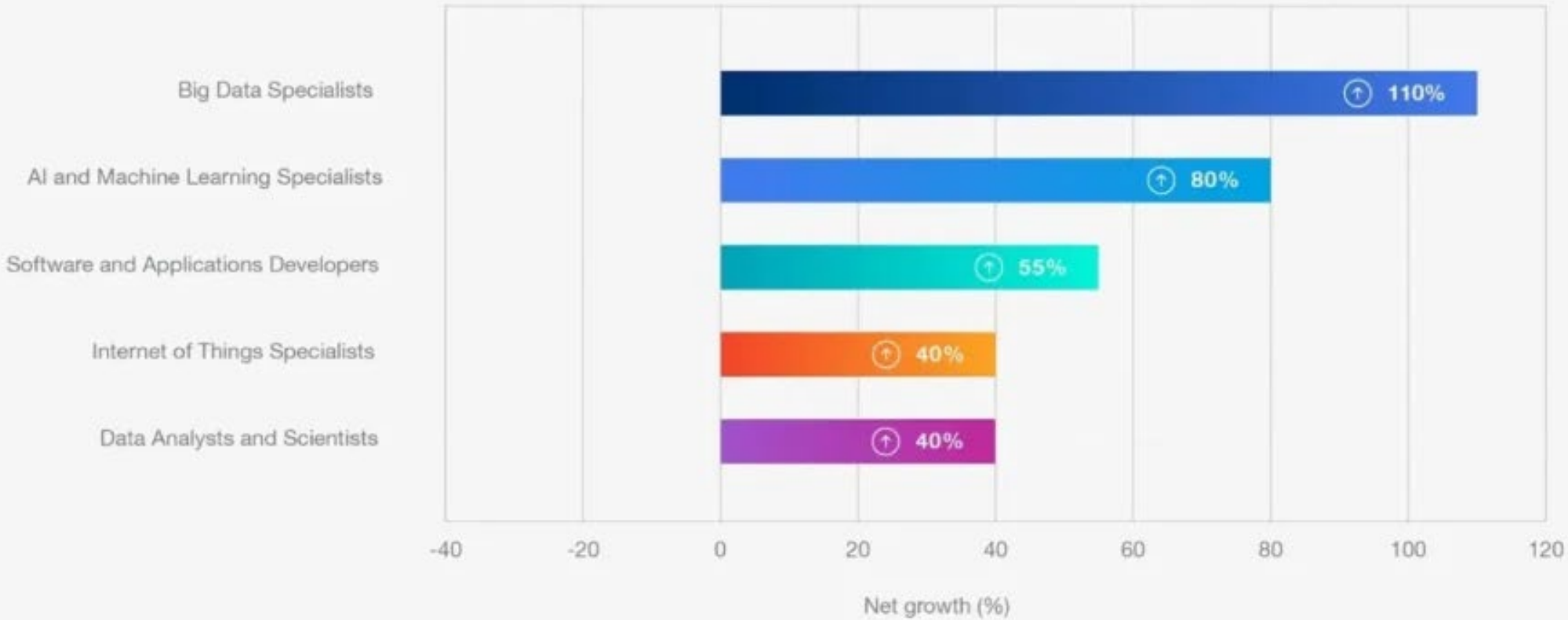
- Job Creation and Transformation: AI is expected to create 19 million jobs while displacing 9 million by 2025, reshaping workforce dynamics

- Human-Machine Collaboration: By 2030, work tasks will be evenly divided between humans, machines, and hybrid approaches, underscoring the importance of designing systems that augment human capabilities rather than replace them

https://www.weforum.org/stories/2025/01/ai-2025-workplace/
https://www.sandtech.com/insight/ai-and-the-future-of-work/

## Fastest Growing Jobs, 2025–2030

by net growth, projected by surveyed employers

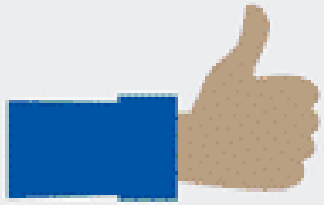



Source

# AI and Business

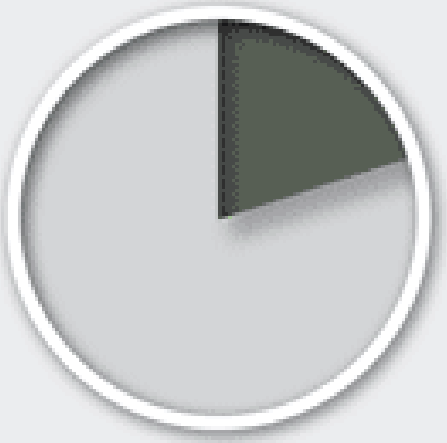

**300%**

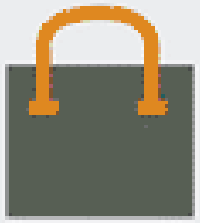
increase investment in AI methodology this year across all businesses



**57%**

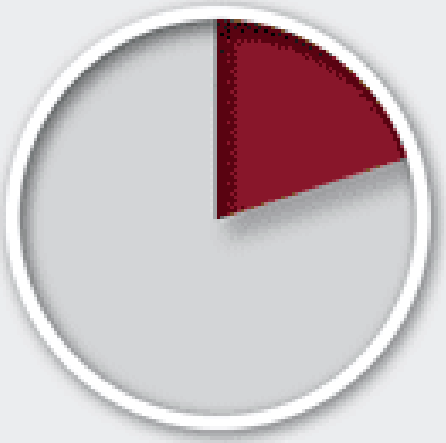
of businesses expect it to help improve customer experience and support

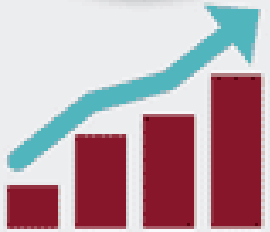




**20%**

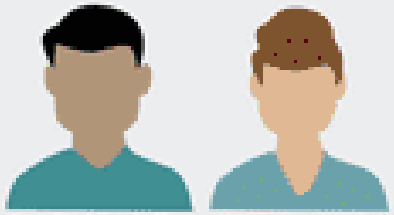
of major retailers will use AI to personalize the brand experience from awareness through purchase





**20%**

of all workers will use automated assistance technologies to make decisions and get work



**80%**

of executives say AI boosts productivity and creates new positions

# How UPS Uses AI to Save $200 Million a Year


CHIPOTLE

INSIDER MONKEY

# The Coca-Cola Company's (KO) Digital Transformation Pays Off in Operating-Margin Boost

By Habib Ur Rehman | July 08, 2025, 5:38 AM

Share

KO -1.08%
Coca-Cola Co

The Coca-Cola Company (NYSE:KO) is one of the Best Stagflation Stocks to Buy Now. Now, the company is undergoing a quiet digital transformation — one that's already paying off. Roughly 65% of its marketing spend has shifted to digital channels, supported by AI-driven personalization at scale. On the operational side, AI tools have helped cut downtime by 20% through predictive maintenance, while route optimization has shaved off 8% in fuel use.

These digital efficiencies contributed to a 140 basis point boost in operating margin last quarter, generating over $550 million in free cash flow, clear signs that Coca-Cola is adapting its legacy machinery to the 21st century.

SOUTHWEST
FarmPress.

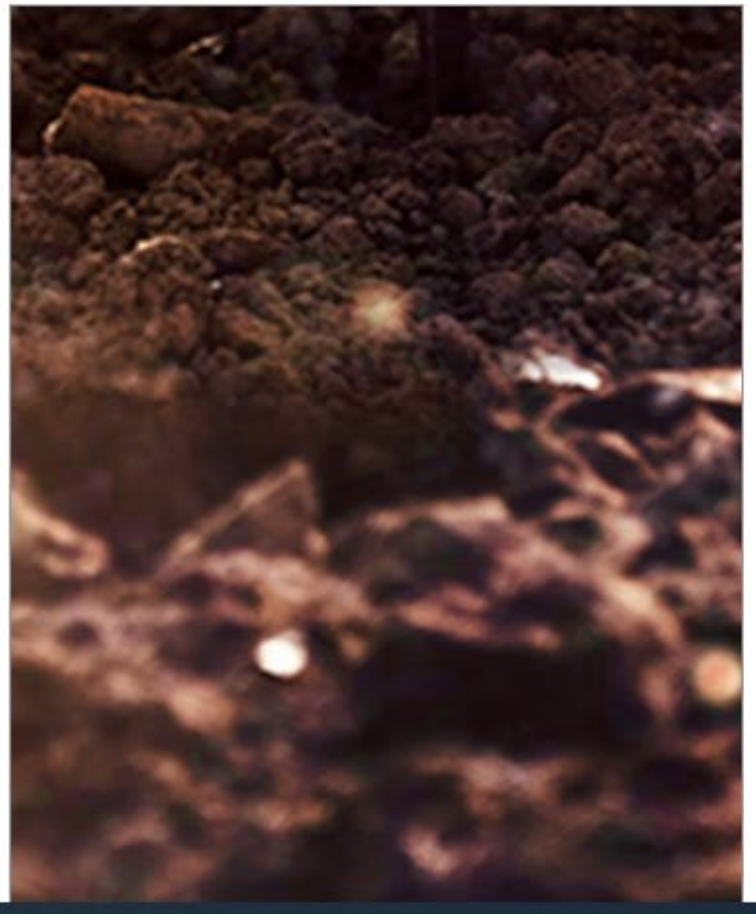
# AI is the future of agriculture

Juan Landivar, Texas A&M AgriLife Center director, discusses three areas where innovation has increased the reliability and efficacy of artificial intelligence.

**Ron Smith**, Contributing Writer

December 12, 2024

3 Min Read

| Industry | AI Applications |
| --- | --- |
| **Healthcare** | Diagnosing diseases, analyzing medical images, predicting patient outcomes |
| **Finance** | Fraud detection, market forecasting, credit scoring |
| **Retail & E-commerce** | Personalized marketing, improving customer experience |
| **Manufacturing** | Predictive maintenance systems and supply chain optimization |
| **Transportation** | Autonomous vehicles and traffic management systems |
| **Education** | Adaptive learning platforms tailored to individual student needs |

# Key takeaways from the global survey of over 7,000 full-time employees

**24**

number of business days a year freed up with AI

**85%**

of IT departments use AI at least once a week

**70%**

of workers want to develop their AI skill sets to stay marketable

**72%**

of workers trust AI to bring value to their work processes

**80%**

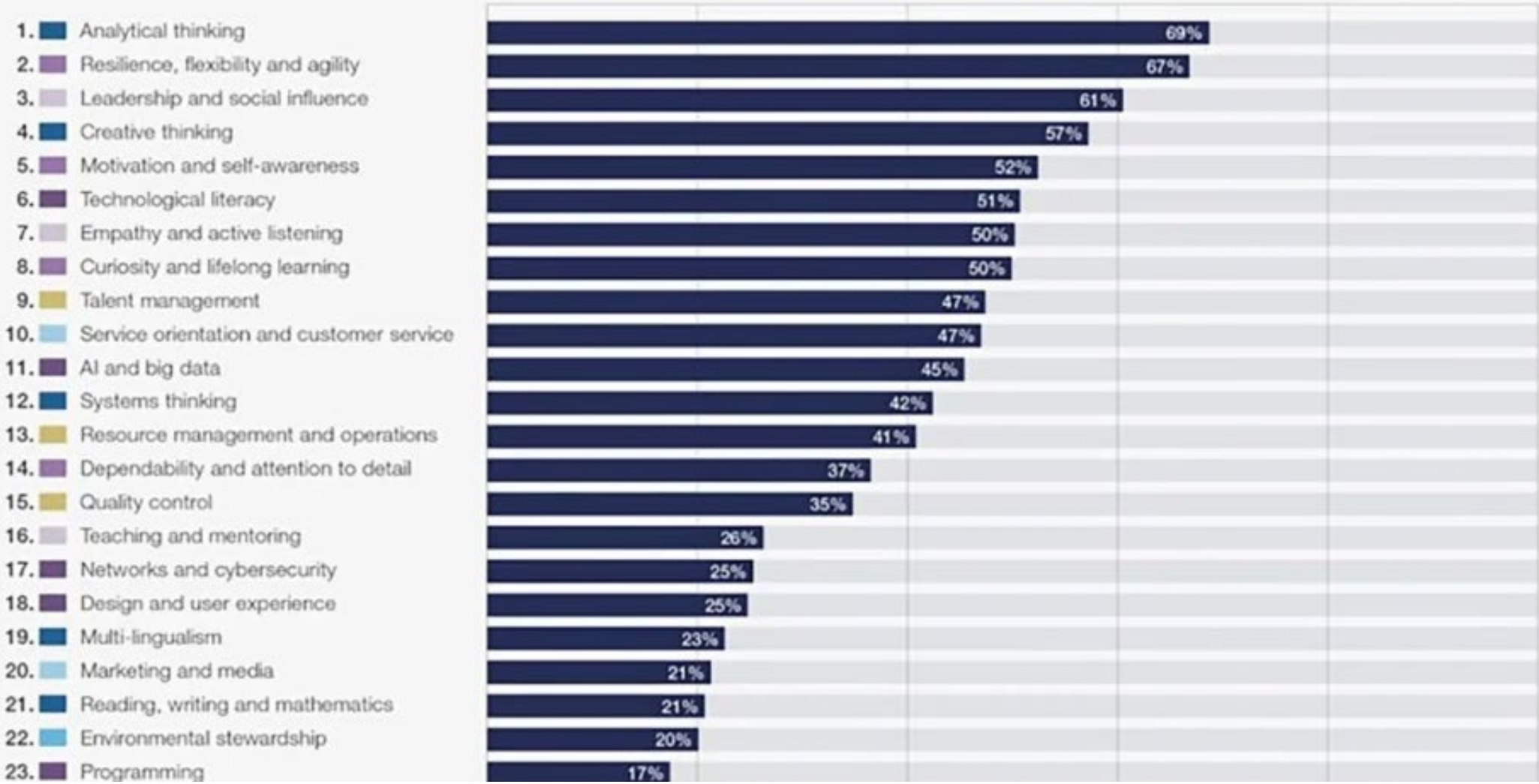
of senior employees believe AI will prove its business impact within two years

# Preparing for Workforce Transformation

- Reskilling and Upskilling: Developing Technical Competencies
- Hybrid Leadership: Human-AI collaboration
- Ethical Considerations: Transparency in AI deployment and privacy concern

## Core skills in 2025

Share of employers who consider the stated skills to be core skills for their workforce.



ADAPTING TO CHANGE

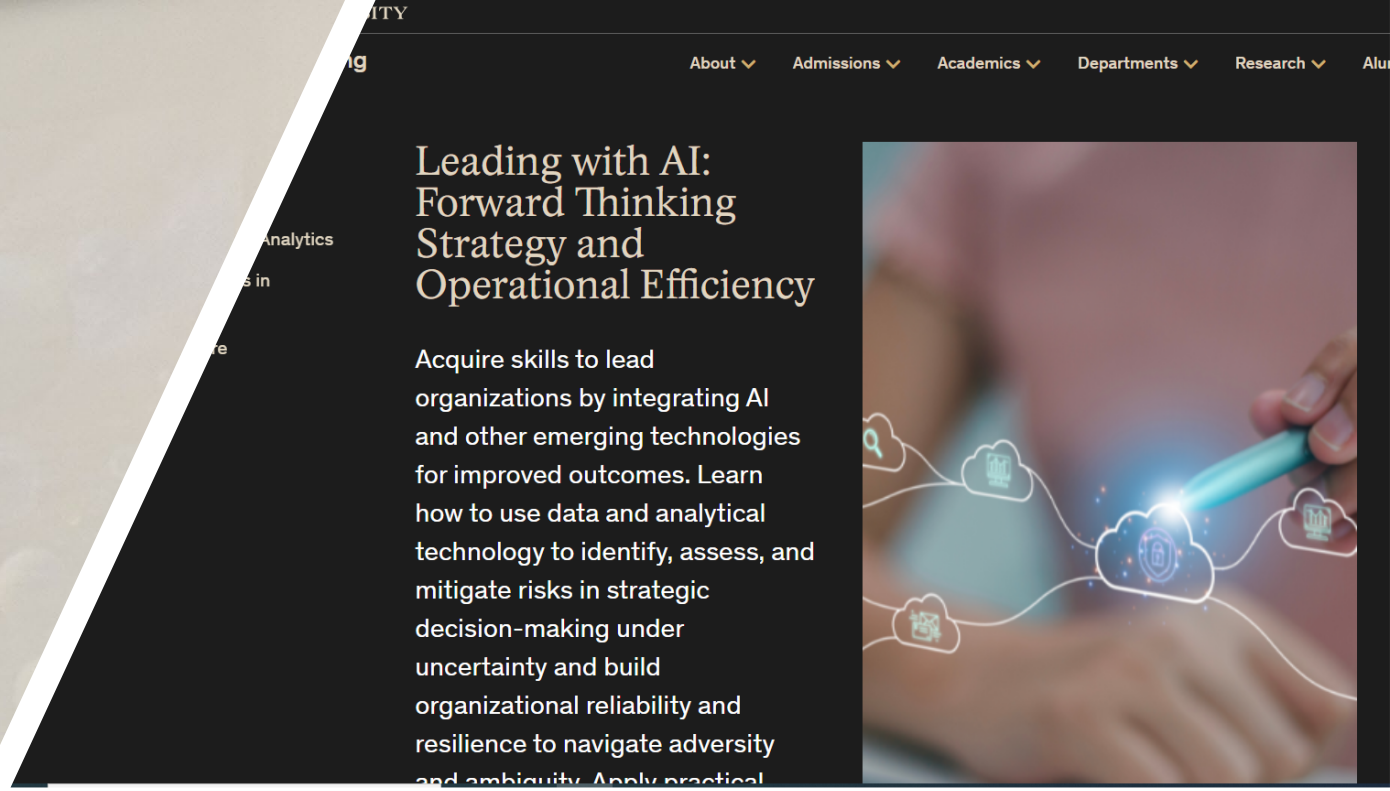
AI ETHICS AND RESPONSIBILITY

WORKPLACE TRANSFORMATION

PRACTICAL ACTION PLAN

AI isn't a replacement for human leadership - it complements our capabilities. Emotional intelligence, empathy, and ethical decision-making remain essential for navigating this transformative era successfully. We should embrace these changes boldly to unlock the full potential of AI-driven workplaces.


The Future of Work
Building Strategic Leade
wered Era
Joanne
Executive Director,
Associate Professor of Prac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Leading with AI: Forward Thinking Strategy and Operational Efficiency
Acquire skills to lead organizations by integrating AI and other emerging technologies for improved outcomes. Learn how to use data and analytical technology to identify, assess, and mitigate risks in strategic decision-making under uncertainty and build organizational reliability and resilience to navigate adversity and ambiguity. Apply practical


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Joanne.wang@vanderbilt.edu