Advancing AI Innovation and Education through University-Industry Collaboration

Keynote Presentation
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Pramod P. Khargonekar
University of California, Irvine

UCI University of California, Irvine

Outline

- Definition and Current State of AI
- ERVA and AI Engineering
- University-Industry Research Collaborations in AI
- Opportunities in Education and Training
- Key Questions
- Concluding Thoughts

Definition of AI

- “It is a field of fields … it holds the secrets which will reorganize the life of the world.” —National Security Commission on Artificial Intelligence quoting Thomas Edison (speaking about electricity)

- “The science and engineering of making intelligent machines, especially intelligent computer programs.” — John McCarthy

- “A machine-based system that, for explicit or implicit objectives, infers, from the input it receives, how to generate outputs such as predictions, content, recommendations, or decisions that can influence physical or virtual environments. Different AI systems vary in their levels of autonomy and adaptiveness after deployment.” — Organization for Economic Cooperation and Development

Why Now?

- AI as a field of study has been around for about 80 years.
- There have been boom-bust cycles in the past (“AI winters”)
- Rules based approaches reached limits
- 3 Keys to recent progress:
  - Massive compute power
  - Massive amounts of data
  - Architectural and algorithmic innovations for machine learning

The Age of AI has begun

Bill Gates
Chair, Gates Foundation and Founder, Breakthrough Energy

March 23, 2023

“Finally, we should keep in mind that we’re only at the beginning of what AI can accomplish. Whatever limitations it has today will be gone before we know it.”

Bill Gates, March 2023

General-Purpose Technologies

Characteristics of a General-Purpose Technology

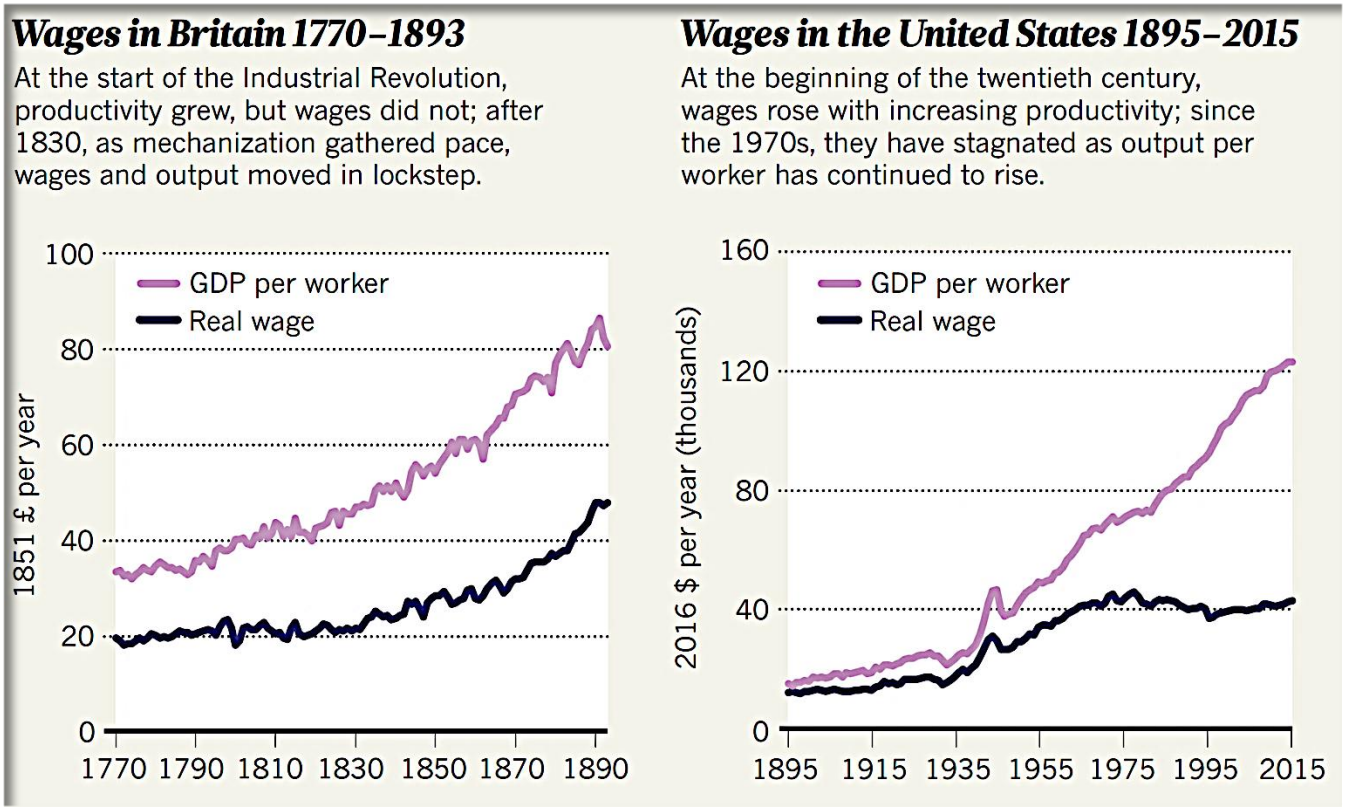
- Widespread applicability
- Continuous improvement
- No close substitutes
- Enabling complementary innovations

Examples of General-Purpose Technologies as *Epochal Innovations*

- Mechanization (steam engine)
- Electricity
- Computers, internet, web (ICT)

Source: Bresnahan and Trajtenberg, 1995, Lipsey, Carlaw, Bekar, 2005

Industrial Revolution, Productivity, and

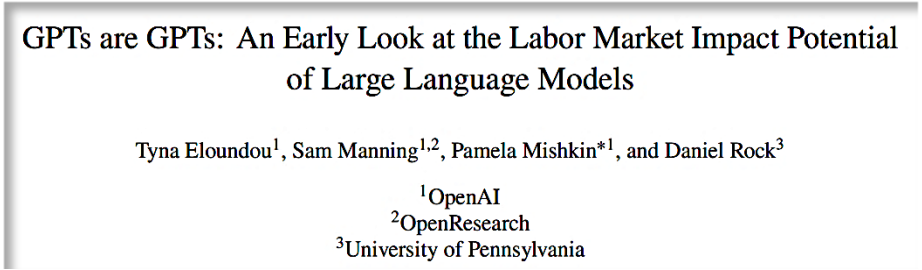


"The average real wage only began to rise in the middle of the nineteenth century, when higher-productivity factory work replaced the hand trades."

Source: R. C. Allen, Lessons from history for the future of work, 2017

Hypothesis: AI is a General-Purpose Technology

- AI technologies are continuously improving
- AI technologies are broadly applicable
- There is no close alternative to AI technologies
- AI technologies will likely cause complementary innovations



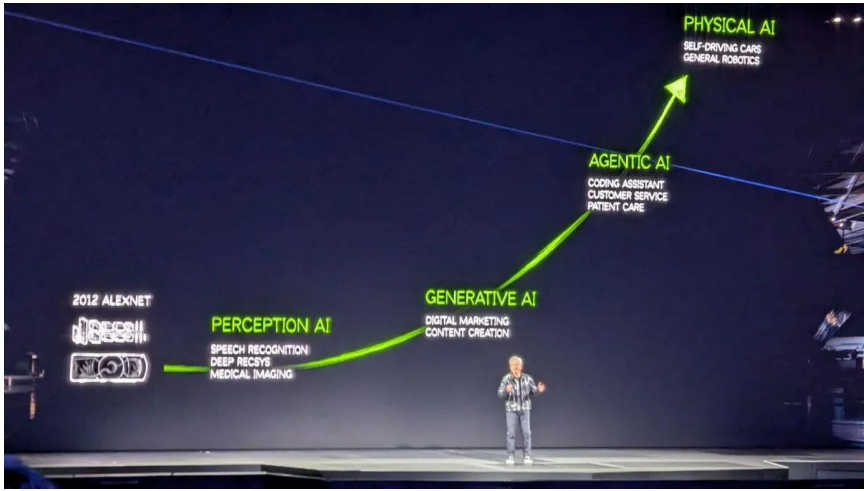
GPTs are GPTs: An Early Look at the Labor Market Impact Potential of Large Language Models

Tyna Eloundou[1], Sam Manning[1,2], Pamela Mishkin*[1], and Daniel Rock[3]

[1]OpenAI
[2]OpenResearch
[3]University of Pennsylvania

Current State of AI Technologies

- Steady progress in analytic and predictive AI
- Continuing progress in GenAI through Large Language Models (LLMs) including multi-modality
- Is this progress in LLMs plateauing? Arguably yes.
- “AI Agents” based on LLMs as the next set of technologies
- Increasing research in “Physical AI”



Source: NVIDIA

ERVA Background

- Launched in April 2021
- 5-year cooperative agreement funded by NSF
- Core Organizations: BTAA, EPSCoR/IDeA Foundation, UIDP

erVa | NSF Engineering Research Visioning Alliance

ERVA Mission

To identify and develop bold and transformative new engineering research directions and to catalyze the engineering community's pursuit of innovative, high-impact research that benefits society.

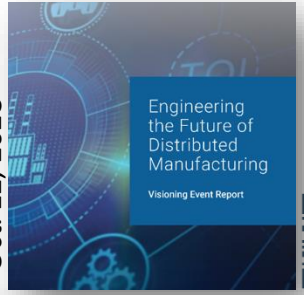
ERVA Published Reports

Dec. 9, 2024

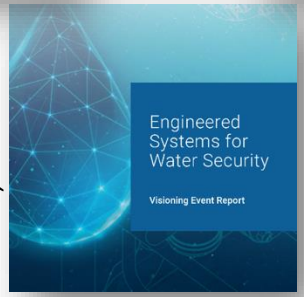
May 23, 2024

Feb. 21, 2024

Oct. 12, 2023

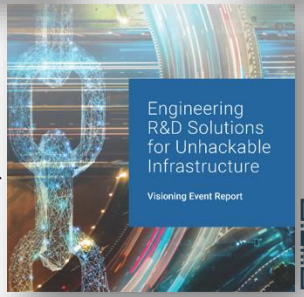


Jul. 13, 2023



Apr. 26, 2023

Feb. 16, 2023



Oct. 27, 2022

Aug. 17, 2022

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Motivating Question:

What is the Future of Engineering in the AI Era?

Visioning Report: AI Engineering

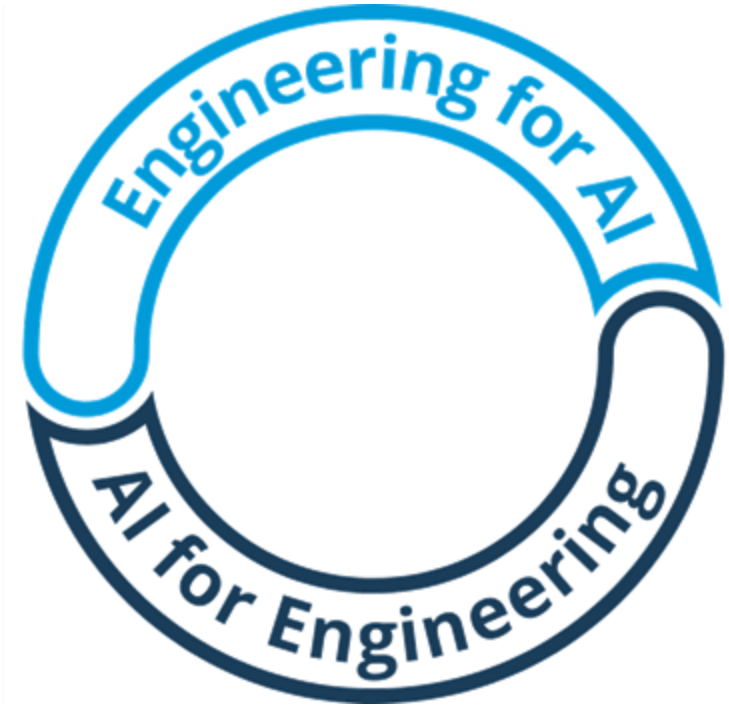
Download the report at
ervacommunity.org

AI Engineering Event Participants

Our Emergent Vision: *AI Engineering*

AI Engineering: Convergence of AI and Engineering as a bi-directional flow leading to a virtuous cycle:

- **Engineering for AI:** Engineering disciplines enabling safer, more reliable, and trustworthy AI-enabled cyber-physical systems
- **AI for Engineering:** AI technology and advances impacting engineering across engineering disciplines



Grand Challenge Areas and Multi-Sector Collaboration

Three grand challenges areas:

- Design, Manufacturing, and Operations
- AI Engineering for Humans and Society
- National Initiatives for AI Engineering

Multi-Sector Collaboration:

- Government (National Labs)
- Industry
- Academia
- Nonprofits

Transform Manufacturing through Industrial AI Engineering

- Accelerate the way engineers design products
- Optimize manufacturing operations
- Create value for service systems

Design Safe, Secure, Reliable, and Trustworthy AI Systems

- Understanding complex systems
- Data management
- Secure, trusted, and AI-optimized EDA
- Testing and certification of AI Systems
- Regulatory considerations

Education and Training Opportunity

Education and training needs not primary focus of this report:

- Dedicated workshop for deep dive into education and training opportunity
- For engineering undergrads: AI fundamentals requirement
- Different curricula for academic research-bound and industry-bound grad students
- Experiential learning in industry
- Professional education short courses and certificate programs

University-Industry Collaborations

Three fundamental motivations for *industry to engage with universities*:

- Access to leading edge research
- Access to valuable intellectual property
- Access to talent

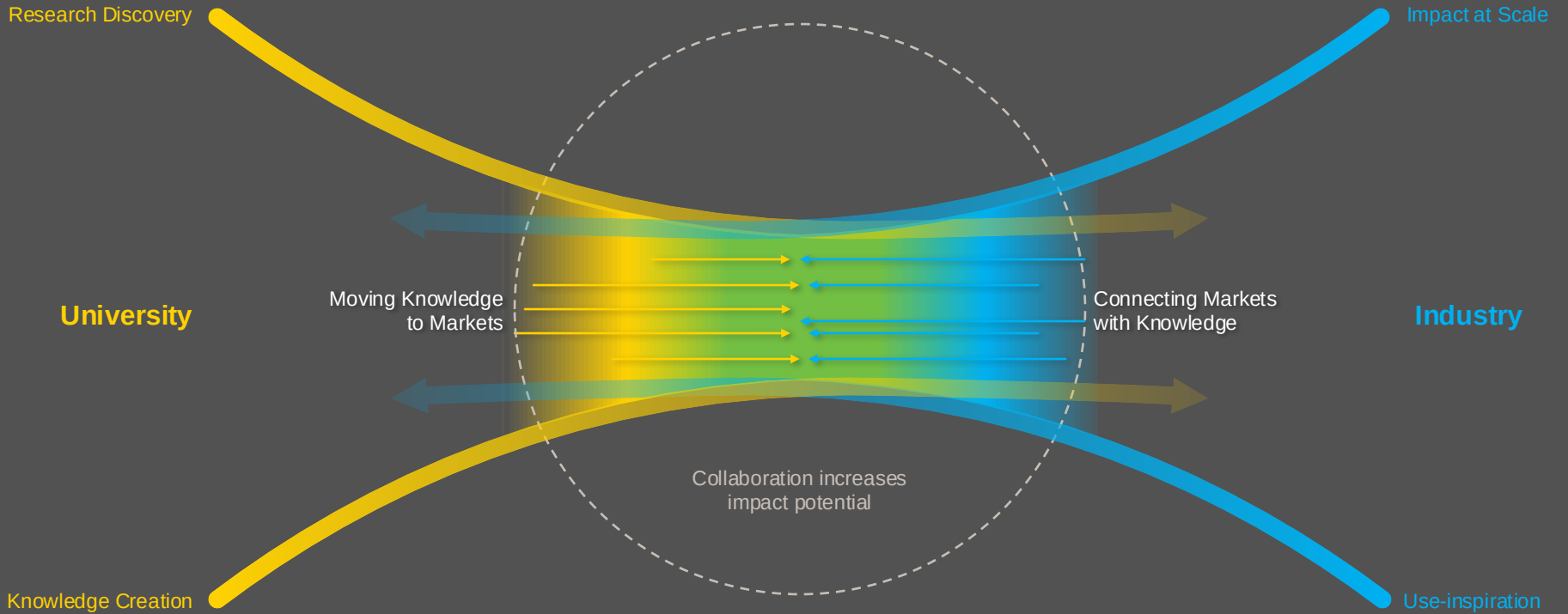
University-Industry Collaborations

Three fundamental motivations for *universities to engage with industry*:

- Potential pathways to translation of research
- Access to critical insights to motivate high impact research
- Employment for graduates

UCI Beall Applied Innovation

Maximizing Impact Potential



Key to Success in University-Industry Collaborations

- Deep understanding of motivations of partners
- Mutual respect for differences in cultures and values
- Medium term commitments
- Removing barriers and frictions

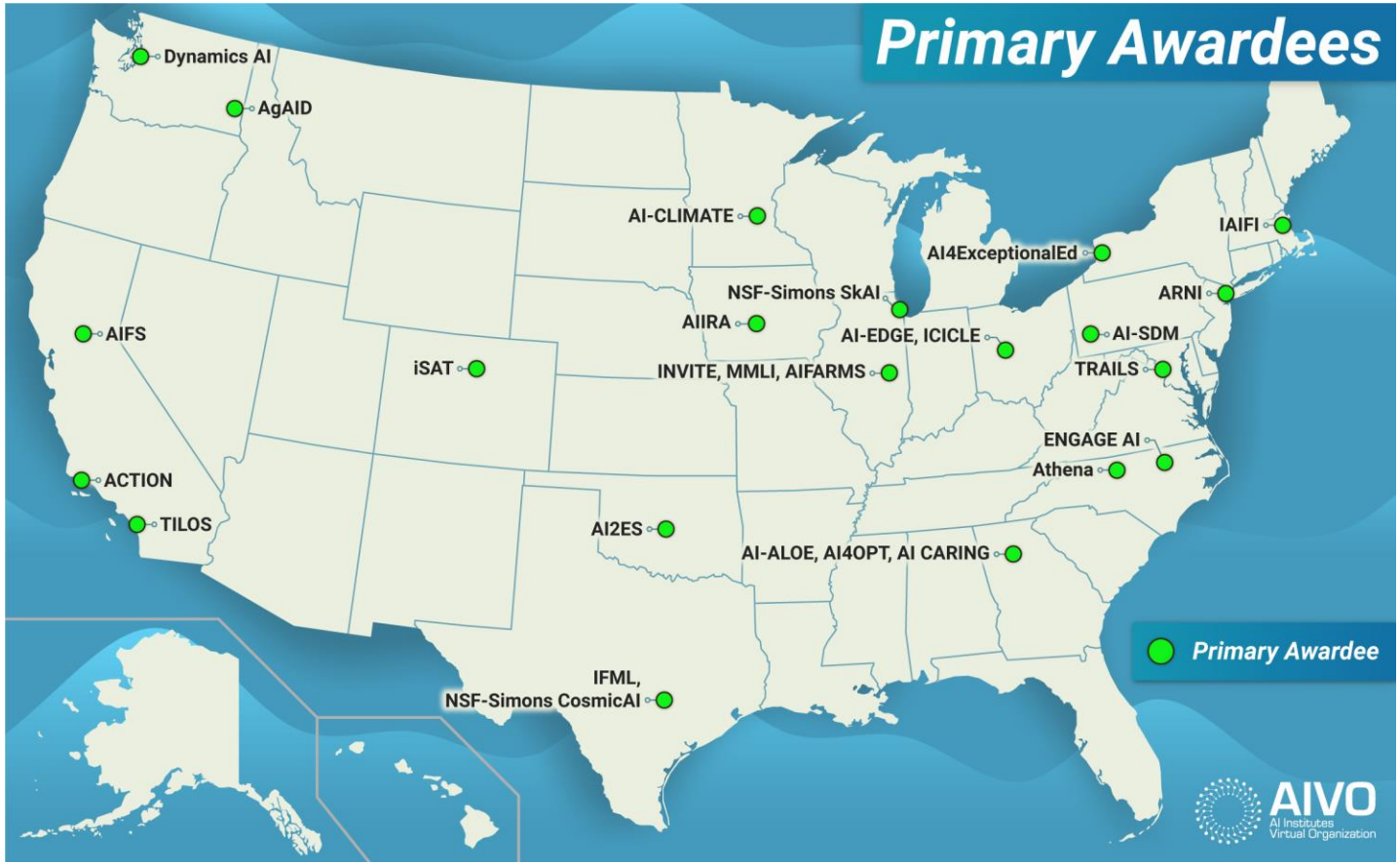
University-Industry Collaborations in AI

- Universities bring cutting edge faculty expertise and motivated students
- Universities can bring multi-disciplinary teams
- Universities are lagging industry in computational resources
- Industry brings data and computational resources
- Industry brings knowledge in key application domains

Great Challenges and Opportunities

- AI is fueling science and engineering research
- AI is driving innovations across many industry sectors
- AI will create new industries and businesses
- AI is creating new levels of uncertainty
- AI will transform work and workers

NSF AI Institutes



25 Active Institutes

2020: First cohort of Institutes (5 NSF, 2 NIFA)

2021: Second cohort of Institutes (9 NSF, 2 NIFA)

2022: AI Institutes Virtual Organization established

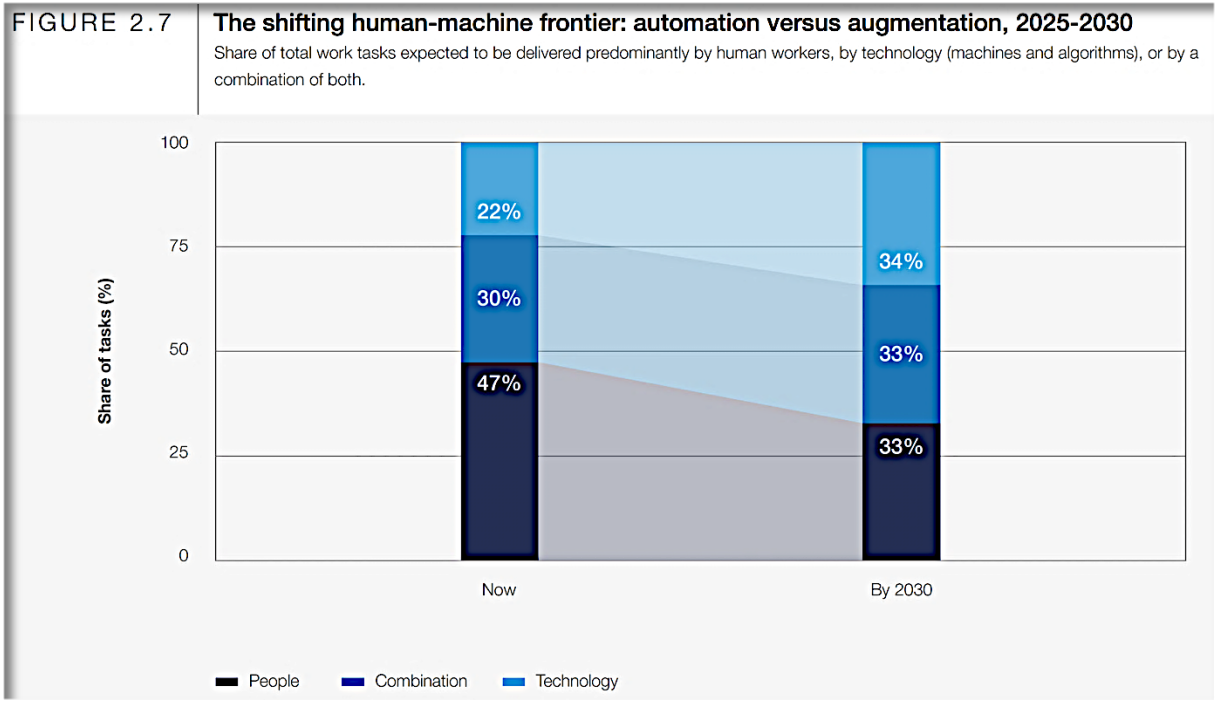
2023: Third cohort of Institutes (6 NSF, 1 NIFA)

AIVO AI Institutes Virtual Organization

AI Institutes directory and news: https://aiinstitutes.org

Source: NSF

Augmentation vs Automation



"You can think of automation as a machine that takes a job's inputs and does it for the worker," says David Autor, Massachusetts Institute of Technology economist, and "augmentation as a technology that increases the variety of things that people can do, the quality of things people can do, or their productivity".

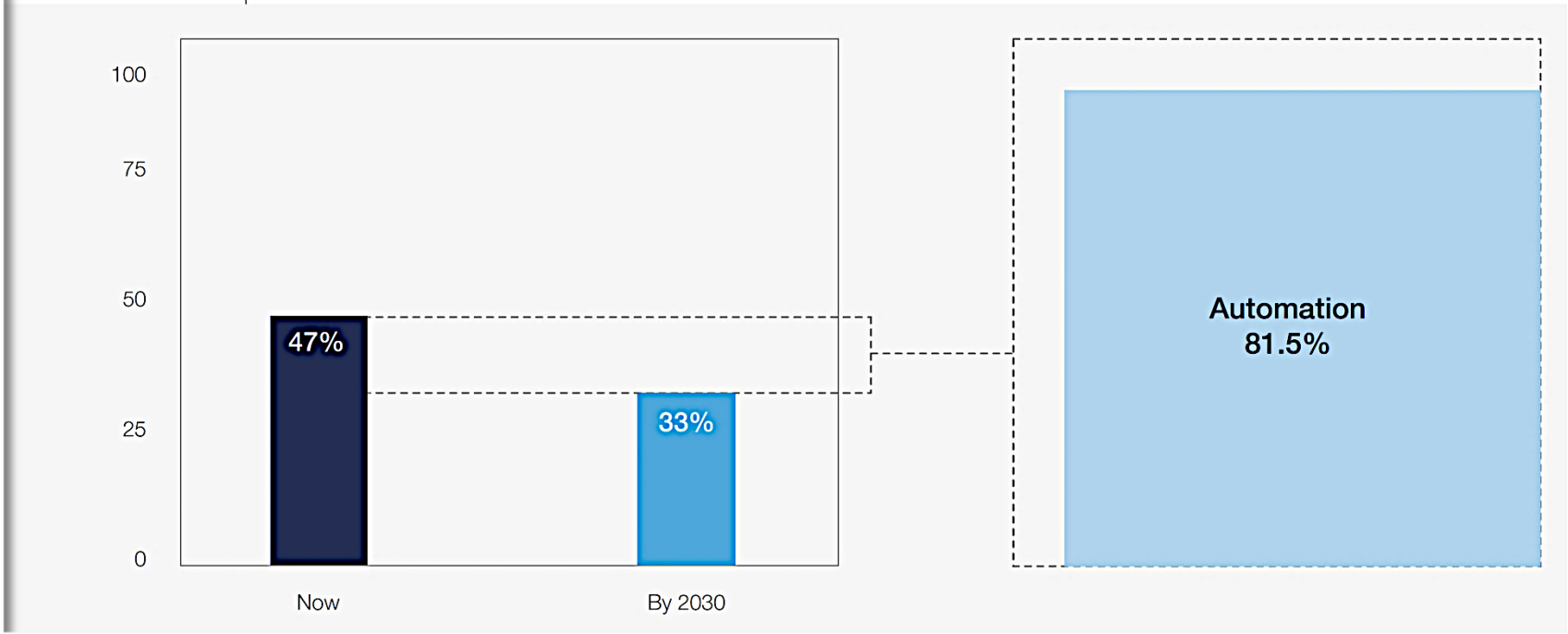
FT, 3/16/25

Source: World Economic Forum, 2025

Human Share of Work is Projected to Decline

FIGURE 2.8 **Expected shift in the human share of work task delivery in total firm output driven by automation versus augmentation, 2025-2030, global average**

Change in proportion of human-performed tasks attributable to increasing automation.

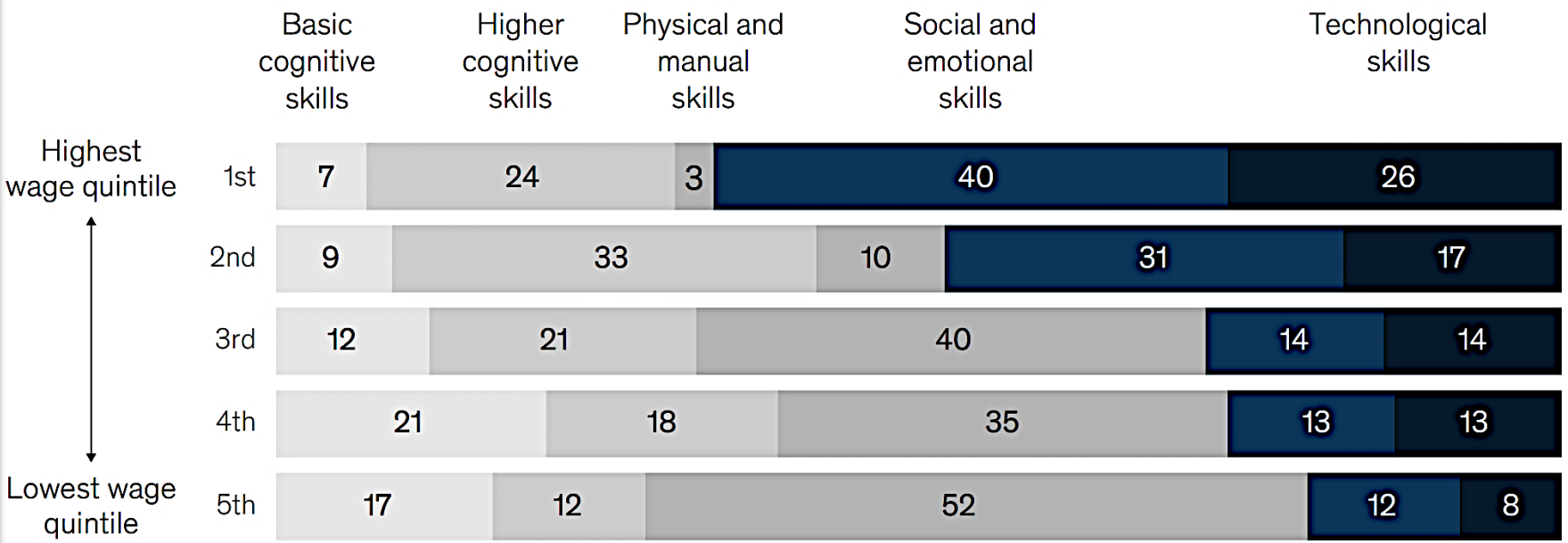


Source: World Economic Forum, 2025

Exhibit 15

To move into higher-wage occupations, workers will need to be trained more on social and emotional skills and technological skills.

Time spent using various types of skills by wage quintile in the United States,[1] 2030, %
Midpoint automation scenario, with generative AI acceleration



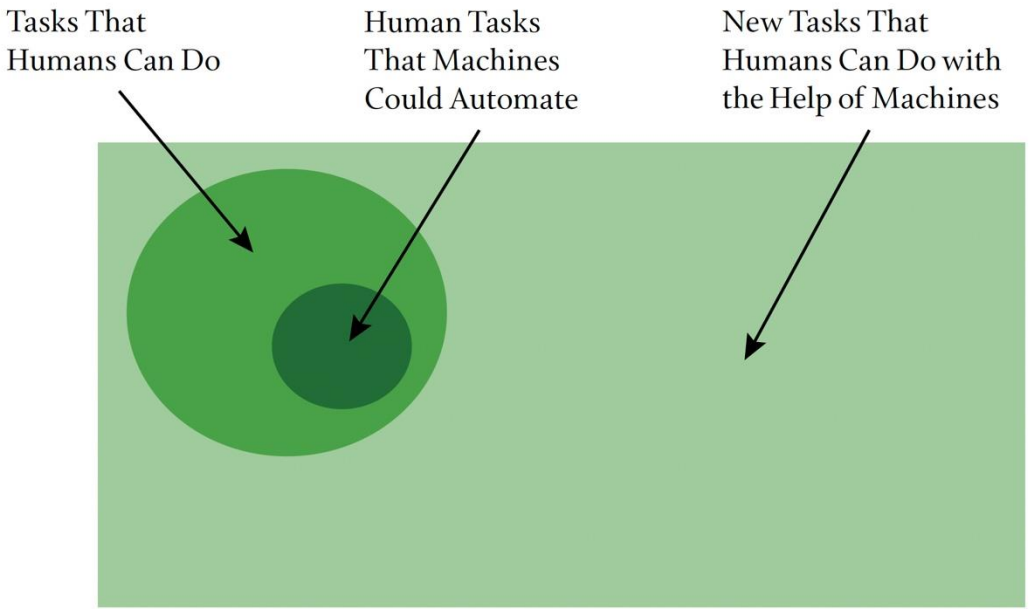
Source: McKinsey Global Institute, 2023

Brynjolfsson: Turing Trap

The Turing Trap: The Promise & Peril of Human-Like Artificial Intelligence

Erik Brynjolfsson

Figure 1
Opportunities for Augmenting Humans Are Far Greater than Opportunities to Automate Existing Tasks



"A common fallacy is to assume that all or most productivity-enhancing innovations belong in the first category: automation. However, the second category, augmentation, has been far more important throughout most of the past two centuries."

E. Brynjolfsson, Turing Trap, Stanford, 2023

Key Questions

- What is the common focus for AI oriented university-industry collaboration? Possible options:
  - A specific domain of AI research and development
  - A specific application or industry domain
  - Education and workforce training
  - Combination or something else
- What is needed from each side: university and industry?
- What is the mutual benefit?

Concluding Thoughts

- AI technologies likely to transform myriad aspects of life and society: business, industry, health, education, entertainment, …
- Jagged frontier of AI with likely improvements over time
- Universities will adapt their education and training programs to meet employer needs and expectations
- Industry-University collaboration is critical to success

Comments

Ideas

Questions?

pramod.Khargonekar@uci.edu
http://faculty.sites.uci.edu/khargonekar/