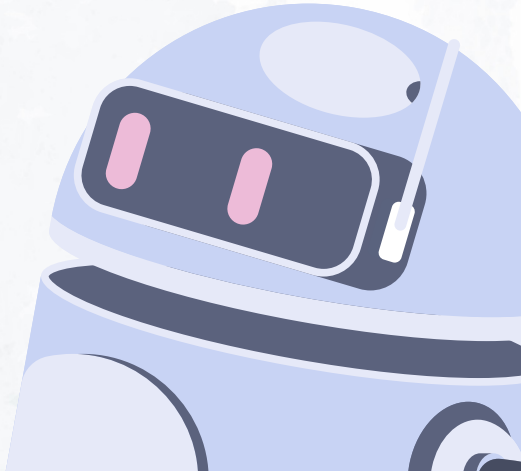
The Future of AI and California's Economy



Matthew Harding and Nick Fucci
UC Irvine

POTENTIAL

"This is a potentially transformative technology – comparable to the advent of the internet – and we're only scratching the surface of understanding what GenAI is capable of."

– **Governor Gavin Newsom**

RISK

"These things could get more intelligent than us and could decide to take over, and we need to worry now about how we prevent that happening."

– **Geoffrey Hinton, the "Godfather" of AI**

AI adoption "could drive a 7% (or almost $7 trillion) increase in global GDP and lift productivity growth by 1.5 percentage points over a 10-year period."

– **Goldman Sachs**

Nothing is inevitable

“We must recognize that there is no singular, inevitable path of development for new technology…. If we can redirect AI onto a more human-complementary path, while using it to address pressing social problems, all parts of the planet can benefit.”

– Economists Daron Acemoglu & Simon Johnson

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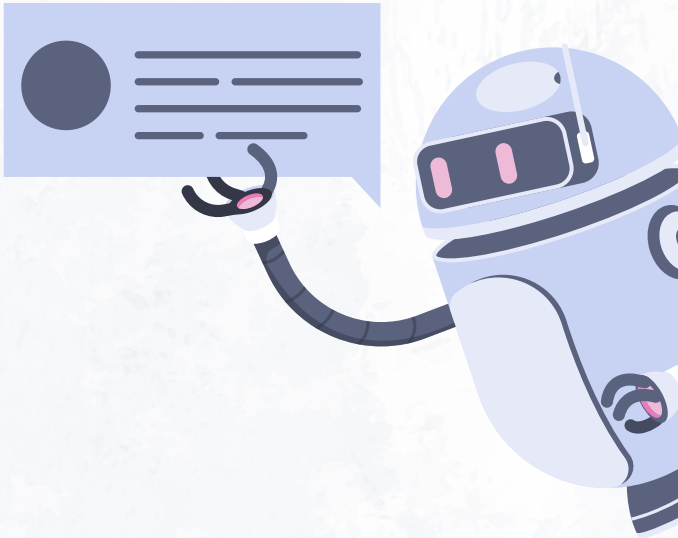
AI Today



(AI)

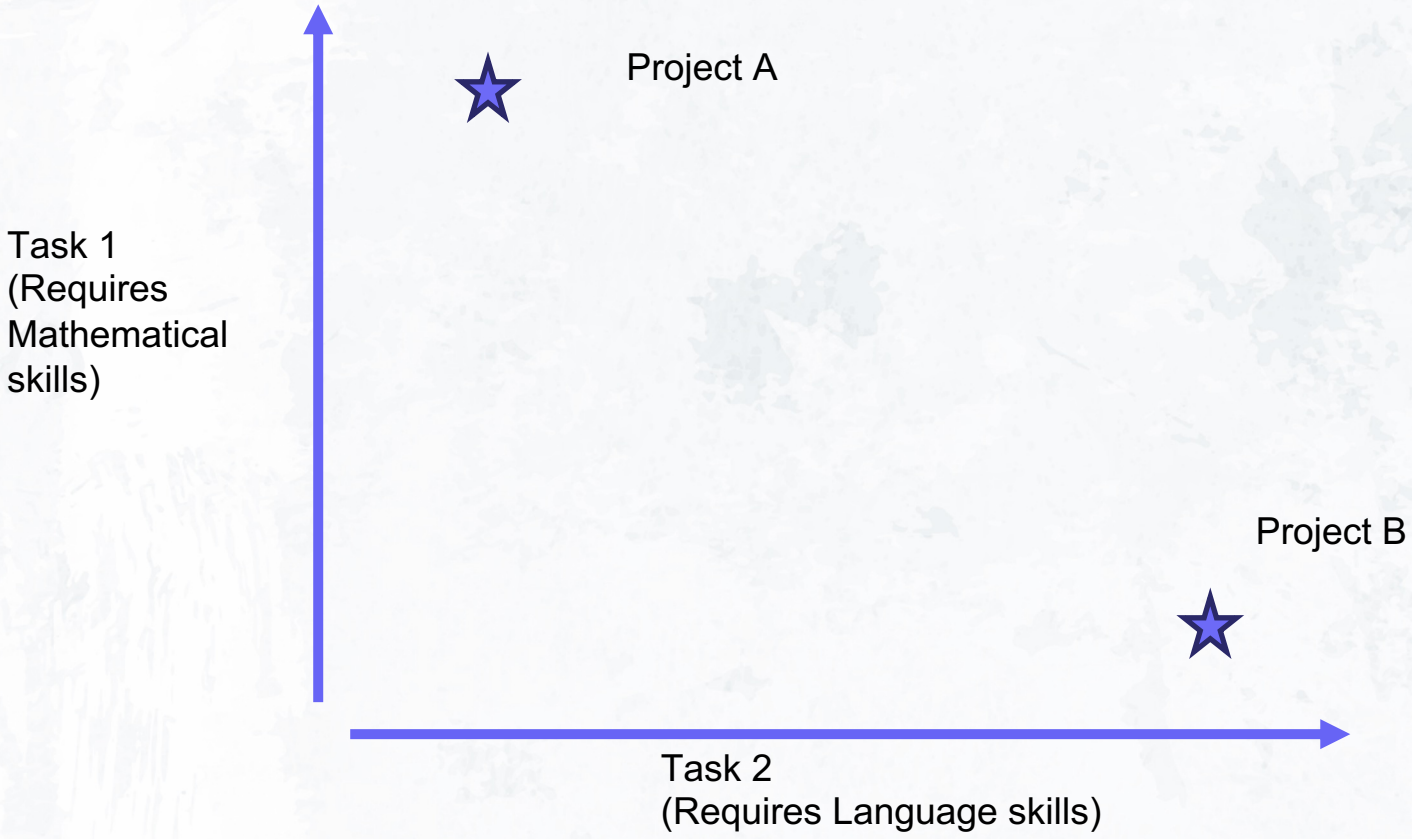
What can GenAI do?

Let’s ask an AI!

The top 5 applications of generative AI include:

1. **Content Generation**: Generative AI can automate content creation tasks, such as generating blog posts, social media captions, and marketing materials [4] [5].
2. **Art and Design**: Generative AI collaborates with artists to produce visual art, music compositions, architectural designs, and fashion creations [2] [4].
3. **Language Translation**: Generative AI has made significant advancements in breaking down language barriers by offering real-time translation services [2].
4. **Medical Imaging Analysis**: Medical professionals use generative AI to analyze complex medical images like MRIs and CT scans for disease diagnosis and anomaly detection [2].
5. **Fashion and Product Design**: In the fields of fashion and product design, generative AI is employed to create innovative and eye-catching designs by generating a range of design options based on input parameters [2].

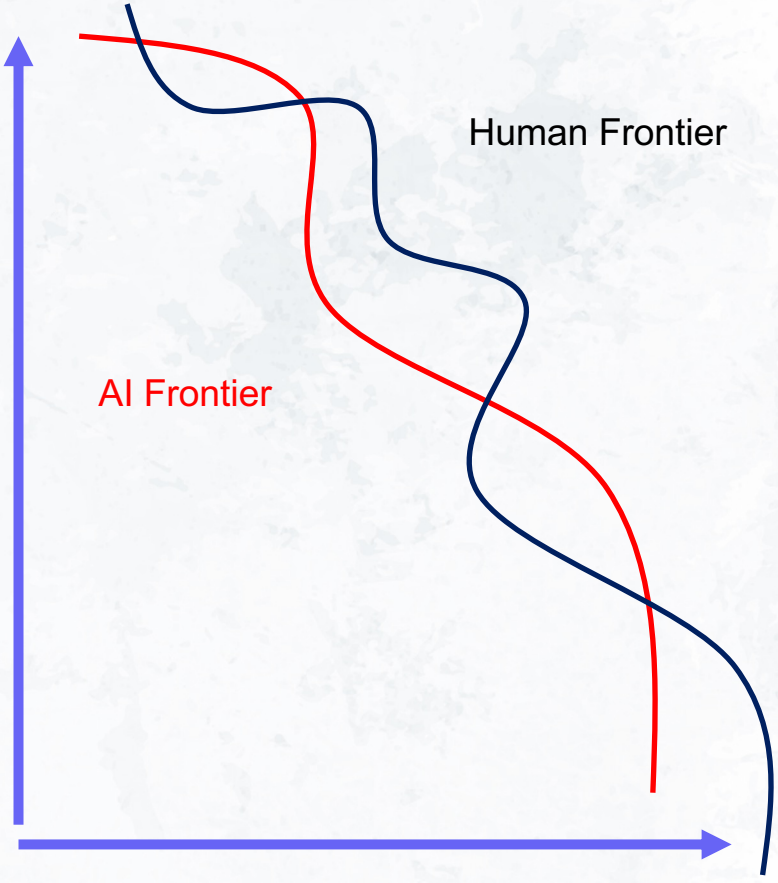
Work requires completing different tasks



What is AI’s current skillset?

Human vs AI Frontiers

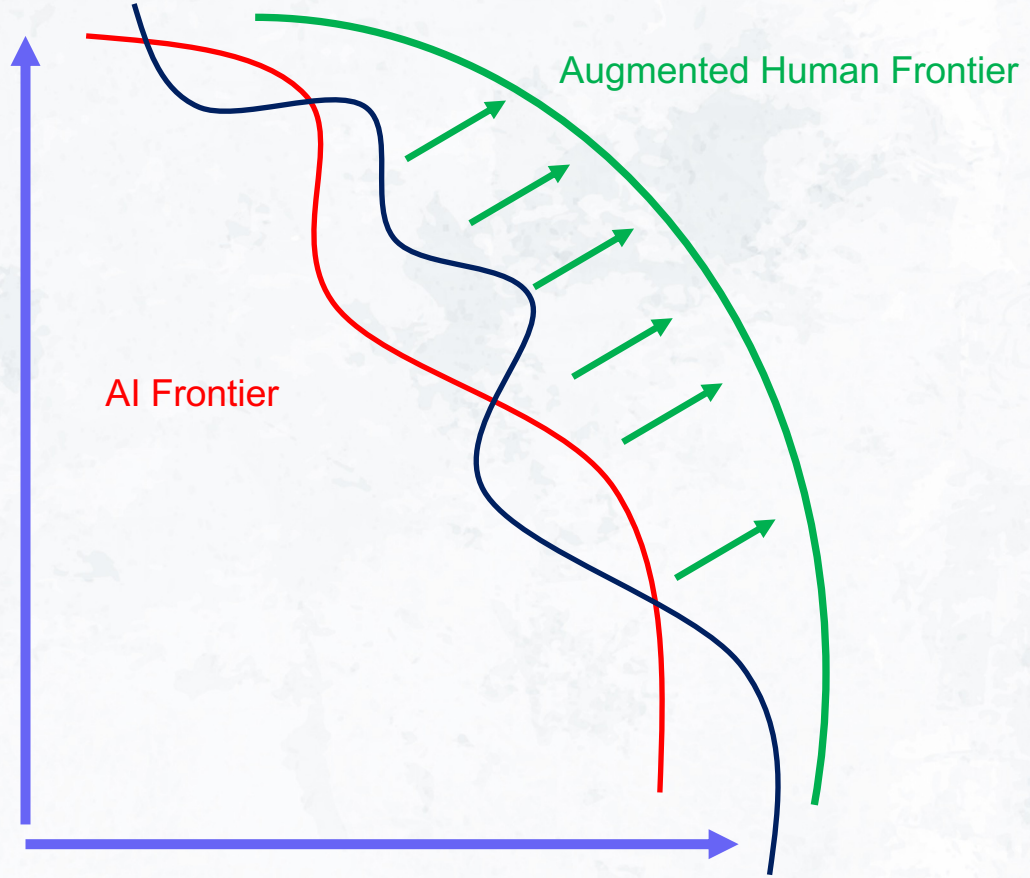
- Abilities as a jagged frontier
- AI is currently restricted to a "jagged" technological frontier (Dell'Acqua, Fabrizio, et al., 2023):
  - Some tasks are easier for AI (e.g., image generation) while others are more difficult (e.g., basic math).
- Humans also have a jagged frontier
- AI and Human frontiers don’t overlap



Dell'Acqua, Fabrizio, et al. "Navigating the jagged technological frontier: Field experimental evidence of the effects of AI on knowledge worker productivity and quality." *Harvard Business School Technology & Operations Mgt. Unit Working Paper* 24-013 (2023).

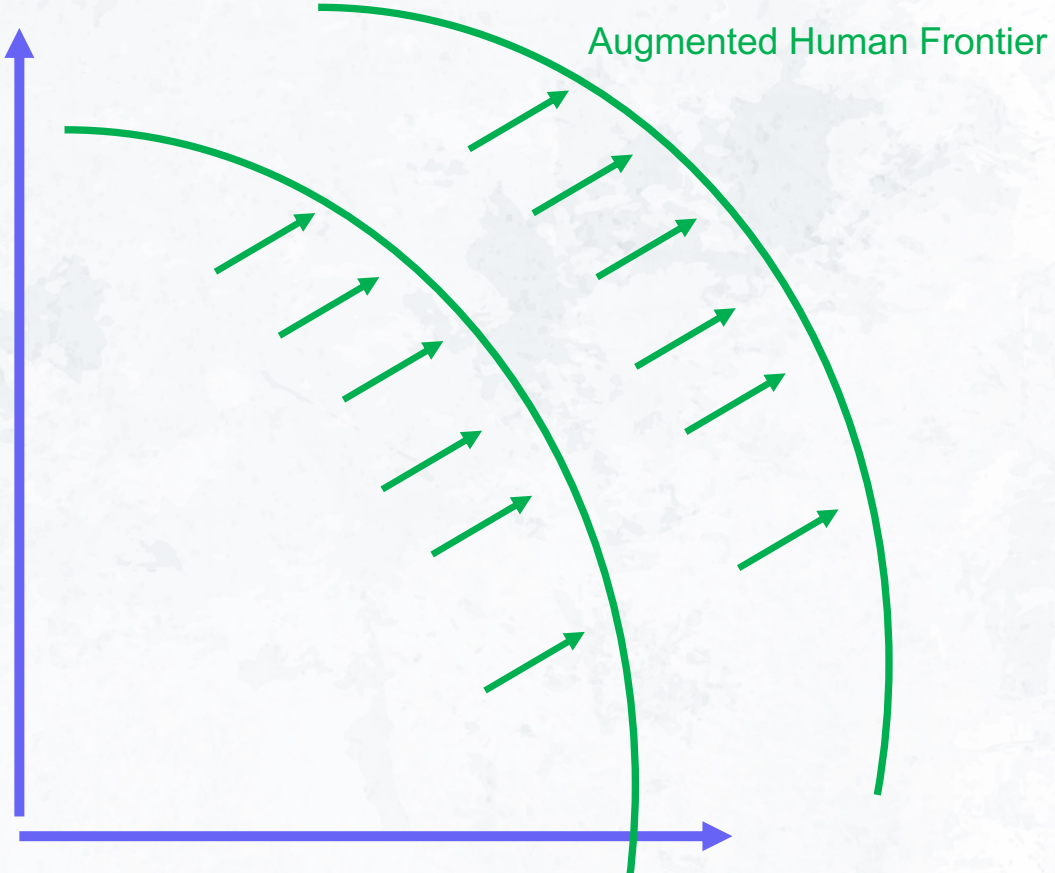
AI Augmented Human Workers

- Combining tasks performed by AI and humans can lead to improved performance for humans
- Humans relying on AI may increase overall productivity



Future Innovation?

- Can this process continue and lead to an ongoing process of innovation?
- Many scenarios to consider:
  - Limits of AI technology
  - AI expands in scope and replaces human contributions
  - Growth is limited by human ability to utilize these tools
  - Risk of AI technology and limiting expansion



02 →

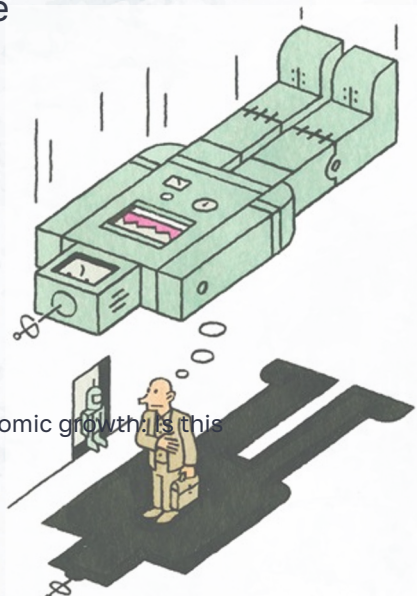
Technological Transitions & the Labor Market

(AI)

Past as prologue?

Prior technological upheaval

- AI is the “next big thing” in a long history of technological advancement and economic anxiety
- 19th century artisans and domestic workers saw their livelihoods threatened by the rise of factories, but workers were ultimately complemented by these advancements in production technology (Mokyr, 2015).
- As a **general purpose technology** (GPT), AI’s historical peers include steam, electricity, and information technology.
    - GPTs provide a platform for future invention.



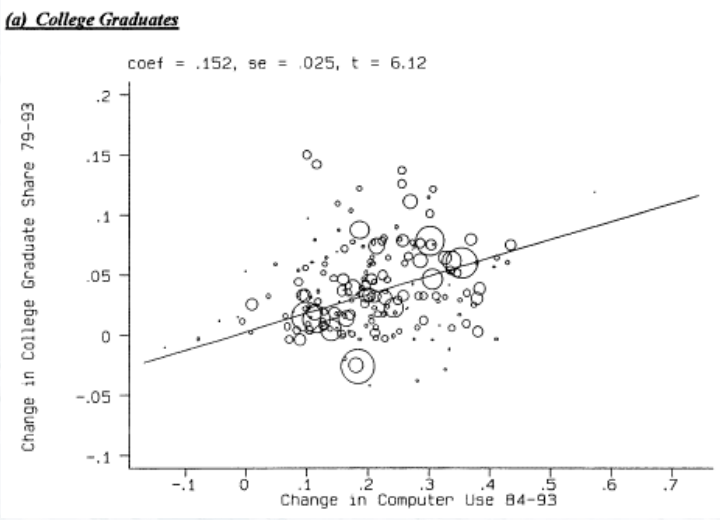
Source: *MIT Technology Review*

https://www.technologyreview.com/2015/06/16/11184/who-will-own-the-robots/

Mokyr, J., Vickers, C., & Ziebarth, N. L. (2015). The history of technological anxiety and the future of economic growth: Is this time different?. *Journal of economic perspectives*, 29(3), 31-50.

Computer Integration

- Computer integration led to rapid growth in the demand for more skilled and more educated workers.
- Many white-collar clerical and production tasks became routinized, while managerial and professional skills were enhanced.
- As computer integration rose, less educated workers faced headwinds.



Source: Autor, D. H., Katz, L. F., & Krueger, A. B. (1998). Computing inequality: have computers changed the labor market?. *The Quarterly journal of economics*, 113(4), 1169-1213.

The current labor market environment

Wage Polarization

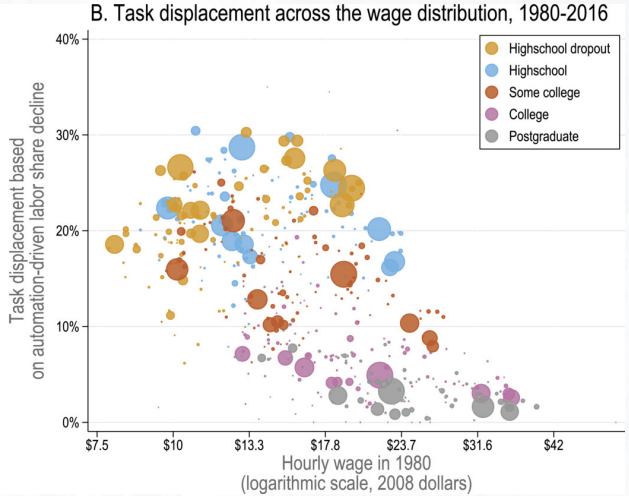
- The latter half of the 20th century and beginning of the 21st century saw deepening inequality in labor market outcomes, largely driven by the college wage premium.
- While wage changes across previous periods increased more or less linearly across income percentiles, recent decades saw a “polarization” in wages.

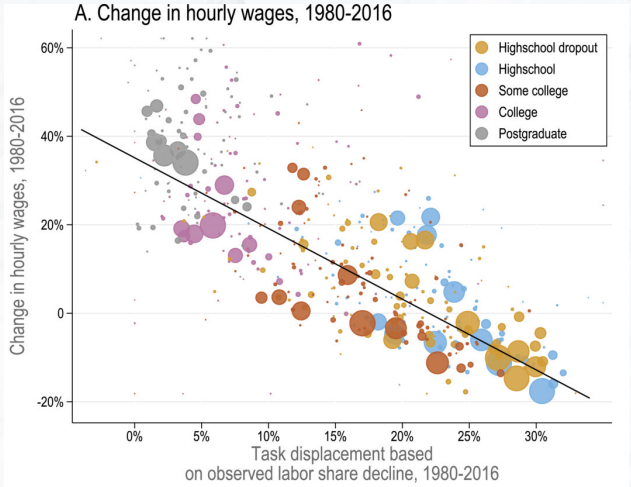
Source: Acemoglu, D., & Autor, D. (2011). Skills, tasks and technologies: Implications for employment and earnings. In *Handbook of labor economics* (Vol. 4, pp. 1043-1171). Elsevier.

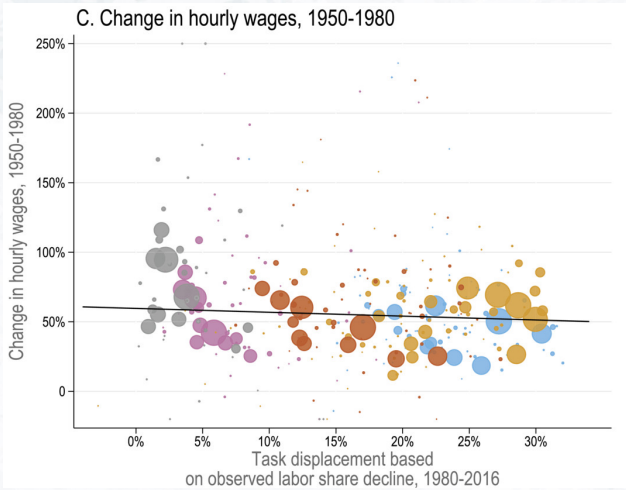
The current labor market environment

Wages & Task Displacement

- This polarization is visible when we examine workers by educational attainment.
- Workers whose tasks have been displaced are:
  - Concentrated among the middle class
  - Concentrated among the less educated
  - Seeing significantly lower (and sometimes negative) wage gains.







Source: Acemoglu, D., & Restrepo, P. (2022). Tasks, automation, and the rise in us wage inequality. *Econometrica*, 90(5), 1973-2016.

The current labor market environment

Post-COVID

- Post-Covid, these trends have alleviated. This is likely due to:
  - Increasing rates of job transition toward higher paying jobs
  - Labor market tightness
- Relative to January 2020, real wages have increased for non-college workers
- Impact of policies

Source: Autor, D., Dube, A., & McGrew, A. (2023). The unexpected compression: Competition at work in the low wage labor market (No. w31010). *National Bureau of Economic Research*.

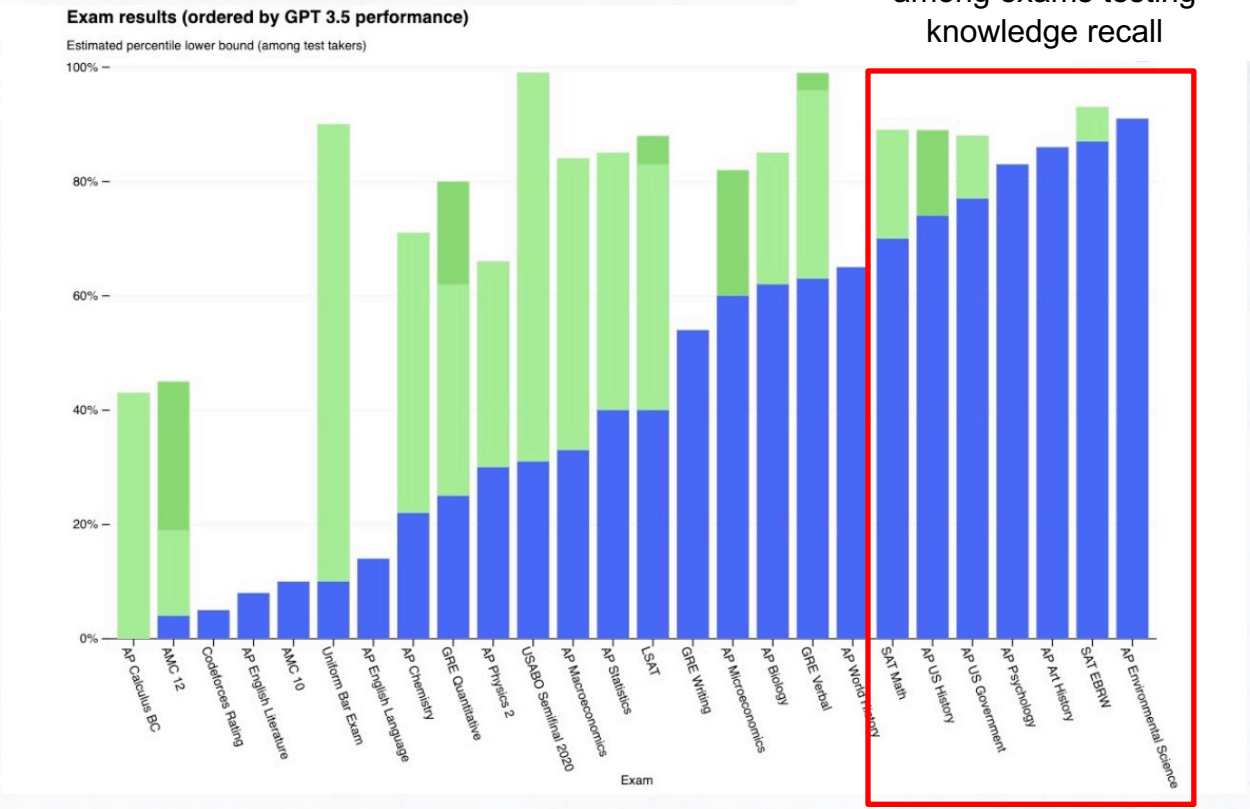
03 →

AI and Humans in the Near Future

(AI)

AI is performing better on standardized exams

High performance initially (and still largely) concentrated among exams testing knowledge recall



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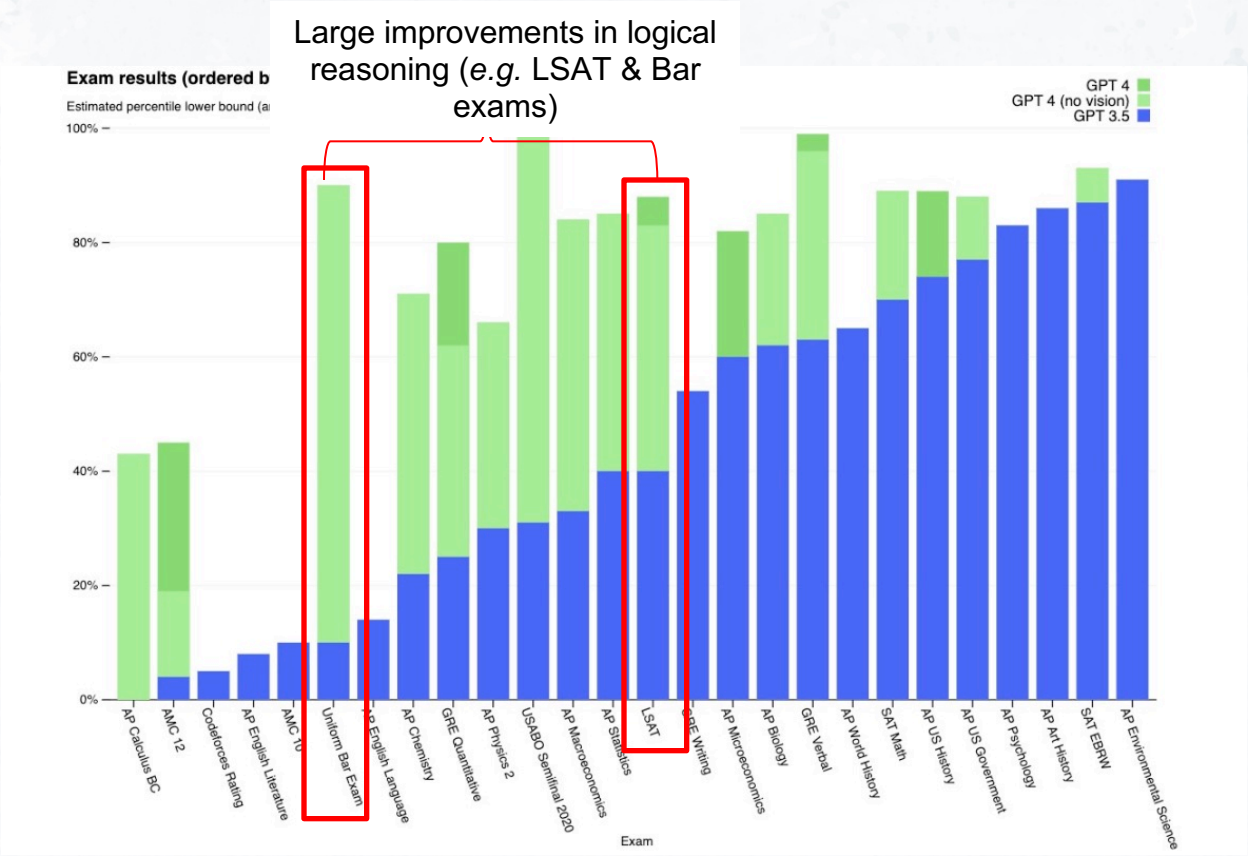
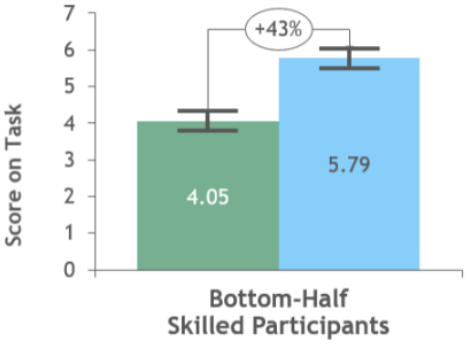
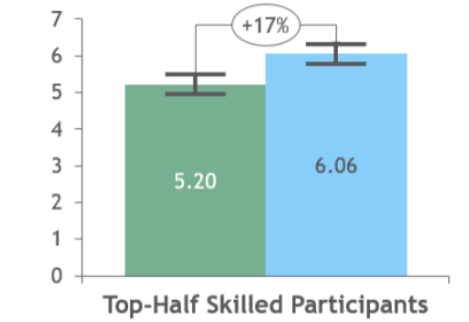


AI augmented humans

- When operating tasks inside the frontier, lower skilled workers exposed to AI catch up to their higher skilled counterparts.

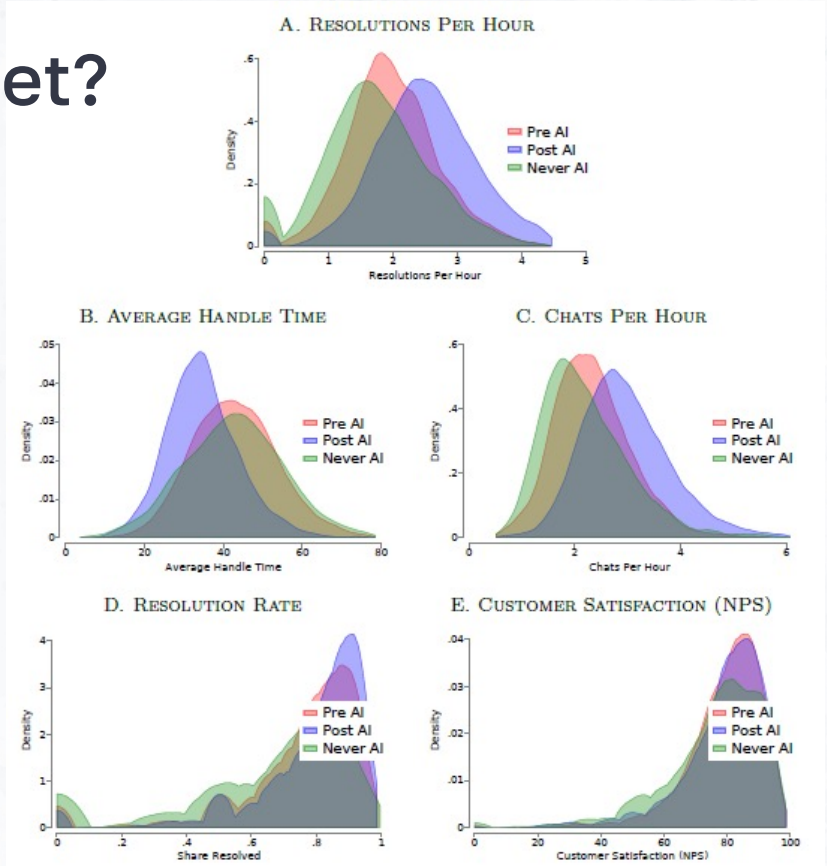




Source: Dell'Acqua, Fabrizio, et al. "Navigating the jagged technological frontier: Field experimental evidence of the effects of AI on knowledge worker productivity and quality." *Harvard Business School Technology & Operations Mgt. Unit Working Paper* 24-013 (2023).

What is AI's current skillset?

- More causal evidence for AI improving worker efficiency:
  - Context: customer service agent (a profession with high rates of AI adoption)
- However, product quality (in the form customer satisfaction) largely unchanged



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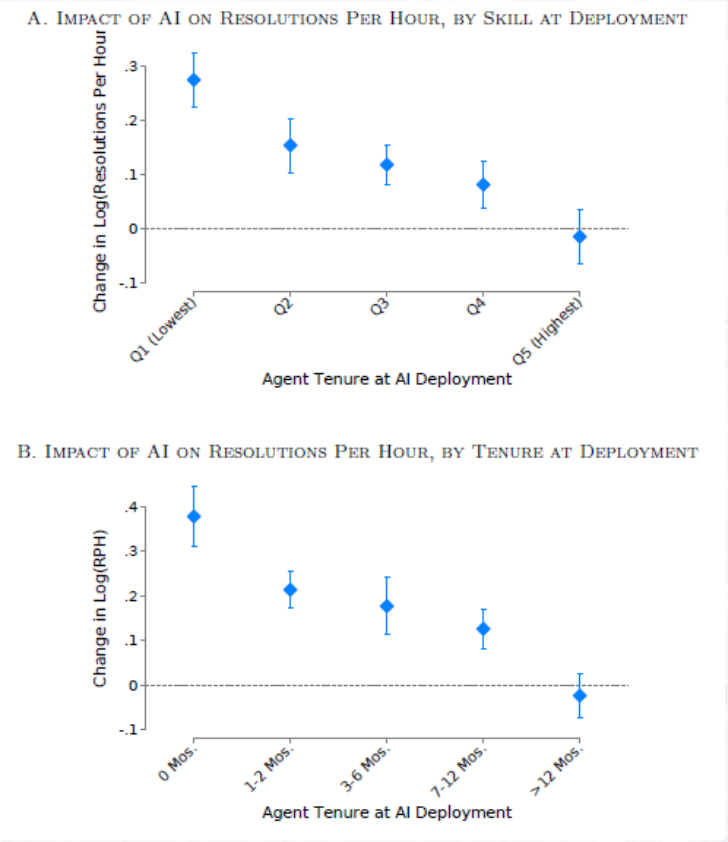
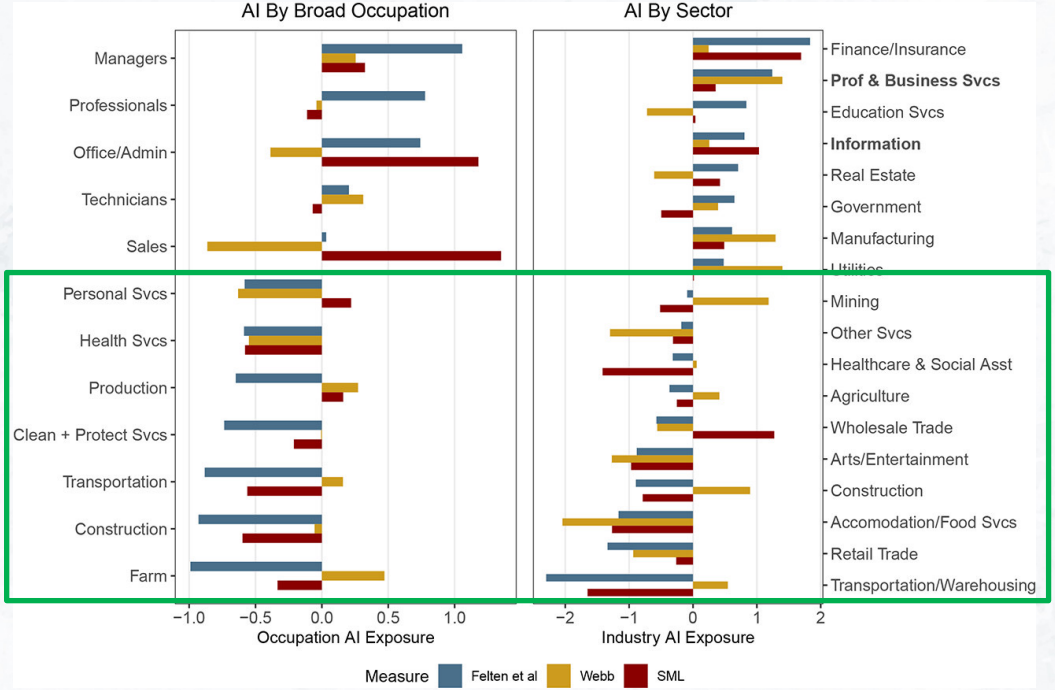
  - Context: customer service agent (a profession with high rates of AI adoption)
- However, product quality (in the form customer satisfaction) largely unchanged
- AI reduces the advantage of skill and tenure.



Source: Dell'Acqua, Fabrizio, et al. "Navigating the jagged technological frontier: Field experimental evidence of the effects of AI on knowledge worker productivity and quality." *Harvard Business School Technology & Operations Mgt. Unit Working Paper* 24-013 (2023).

Industry & Occupation Exposure

- Three measures of AI exposure.
- Less exposed occupations and industries:
  - Jobs that tend to require less education and more manual labor.



Source: Artificial Intelligence and Jobs: Evidence from Online Vacancies. Daron Acemoglu, David Autor, Jonathon Hazell, and Pascual Restrepo. *Journal of Labor Economics*, 2022. 40:S1, S293-S340.

Industry & Occupation Exposure

- Three measures of AI exposure.
- Less exposed occupations and industries:
  - Tend to require less education and more manual labor.
- More exposed occupations and industries:
  - Tend to require more education and less manual labor.
- Firm AI exposure is associated with lower hiring overall.
- So far, aggregate effects of AI are too small to detect.

Source: Artificial Intelligence and Jobs: Evidence from Online Vacancies. Daron Acemoglu, David Autor, Jonathon Hazell, and Pascual Restrepo. *Journal of Labor Economics*, 2022. 40:S1, S293-S340.

04 →

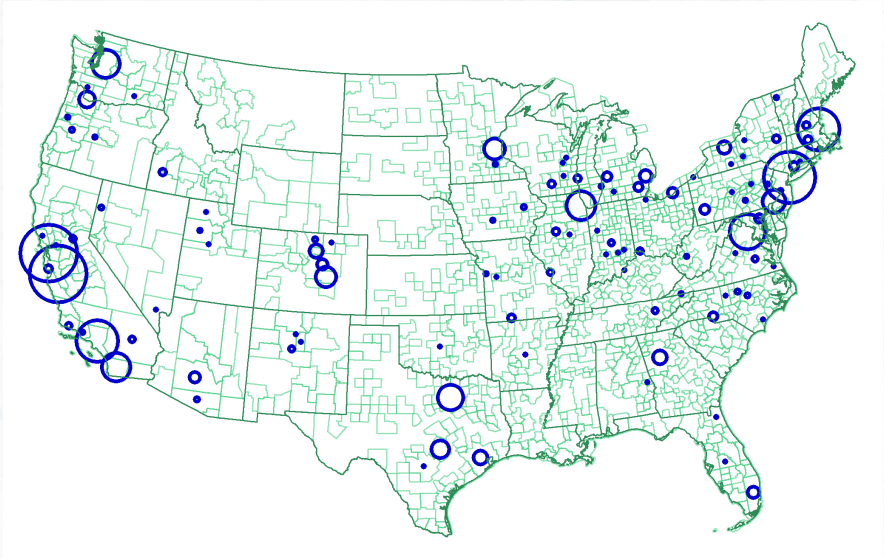
Opportunities and Costs for California

(AI)

Geography matters: Diffusion of Tech Jobs

Years since technological emergence

- Bloom et al rely on earnings calls, data on job postings, and patent data to estimate exposure to "Disruptive Technologies."
- 1,286 technologies identified since 1976.
- CA is home to 3 of the top 5 "pioneer" locations.

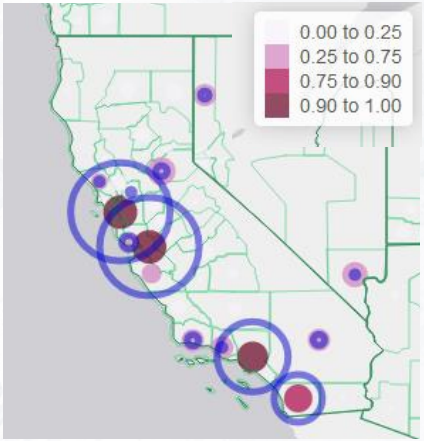


Source: Kalyani, Aakash, Nicholas Bloom, Marcela Carvalho, Tarek Hassan, Josh Lerner, and Ahmed Tahoun. "The Diffusion of New Technologies." Harvard Business School Working Paper, No. 21-144, June 2021. (Revised October 2023.)

Geography matters: Diffusion of Tech Jobs

Years since technological emergence

0-5 years since emergence



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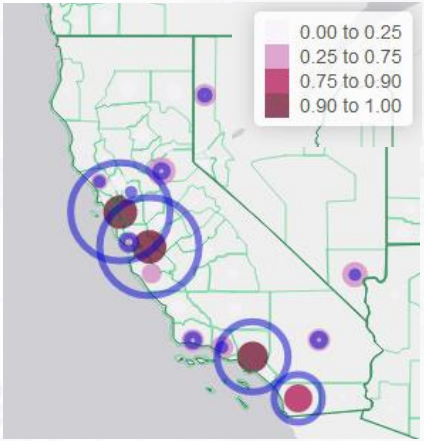
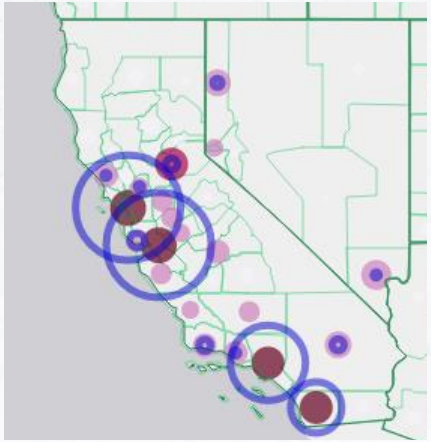


6-10 years since emergence



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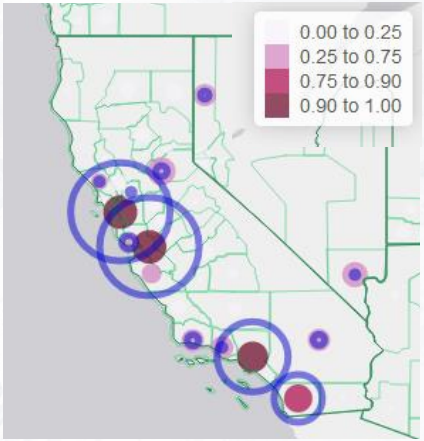

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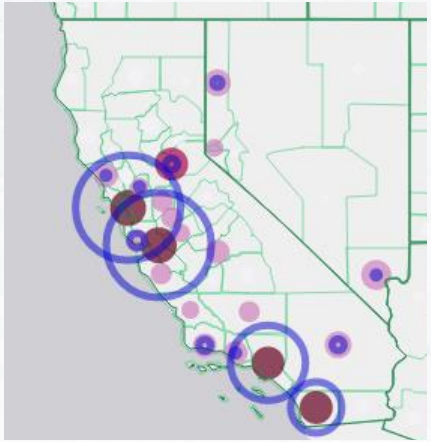
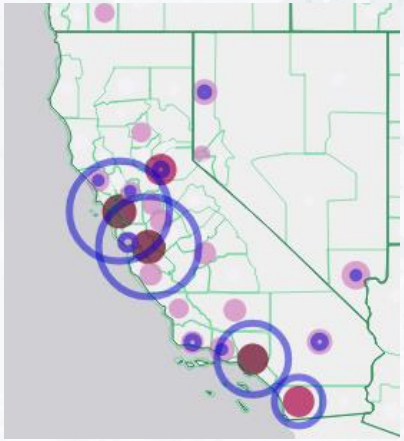


11-20 years since emergence



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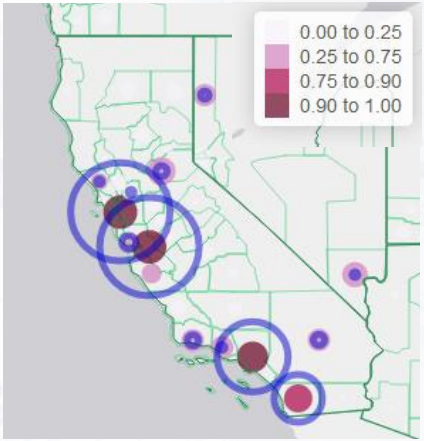
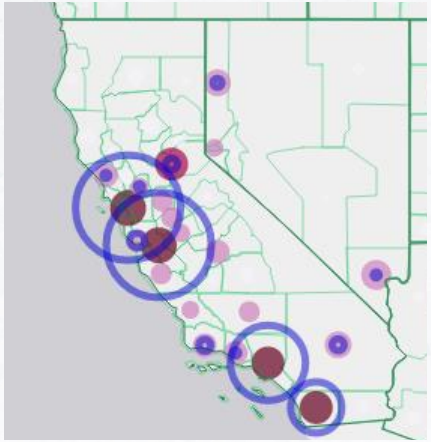
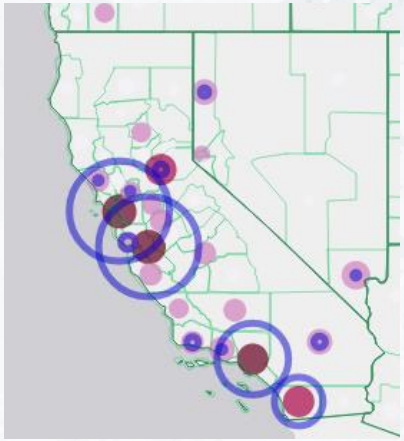


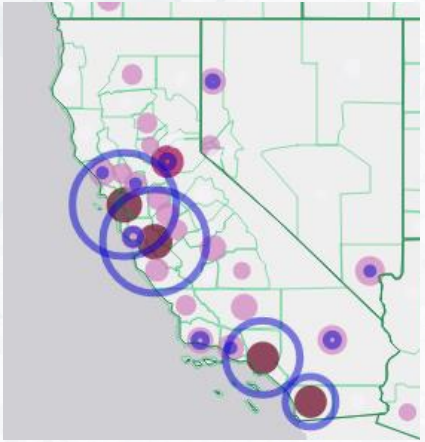
6-10 years since emergence



11-20 years since emergence



21-30 years since emergence



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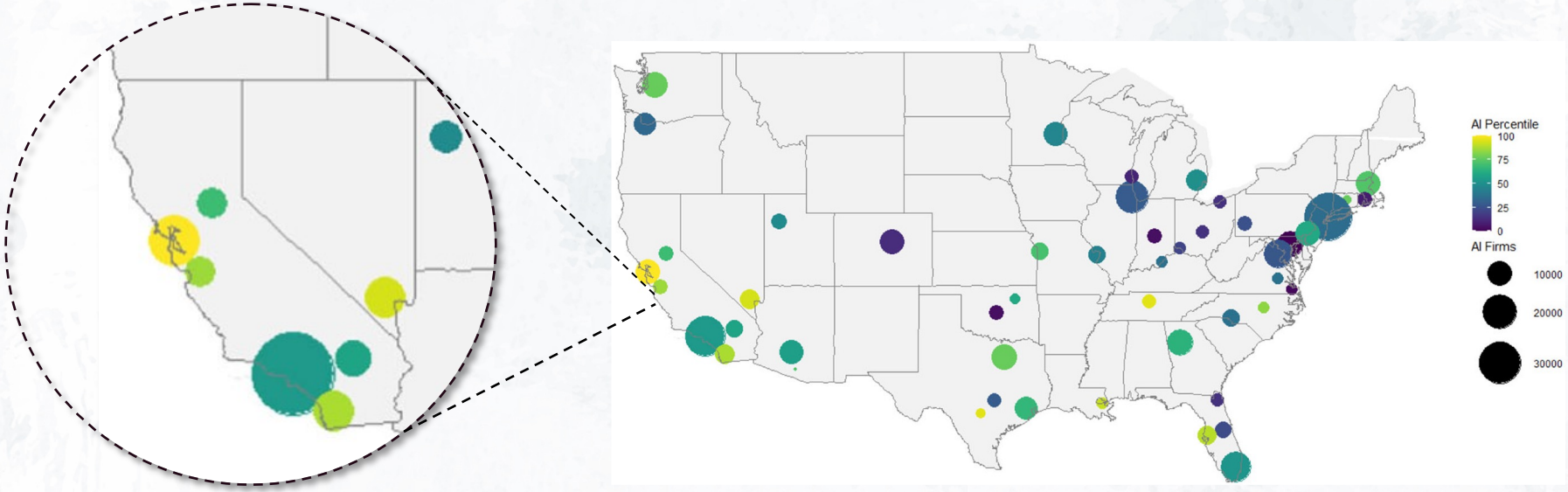
Geography matters: Startups using AI

Employer weighted



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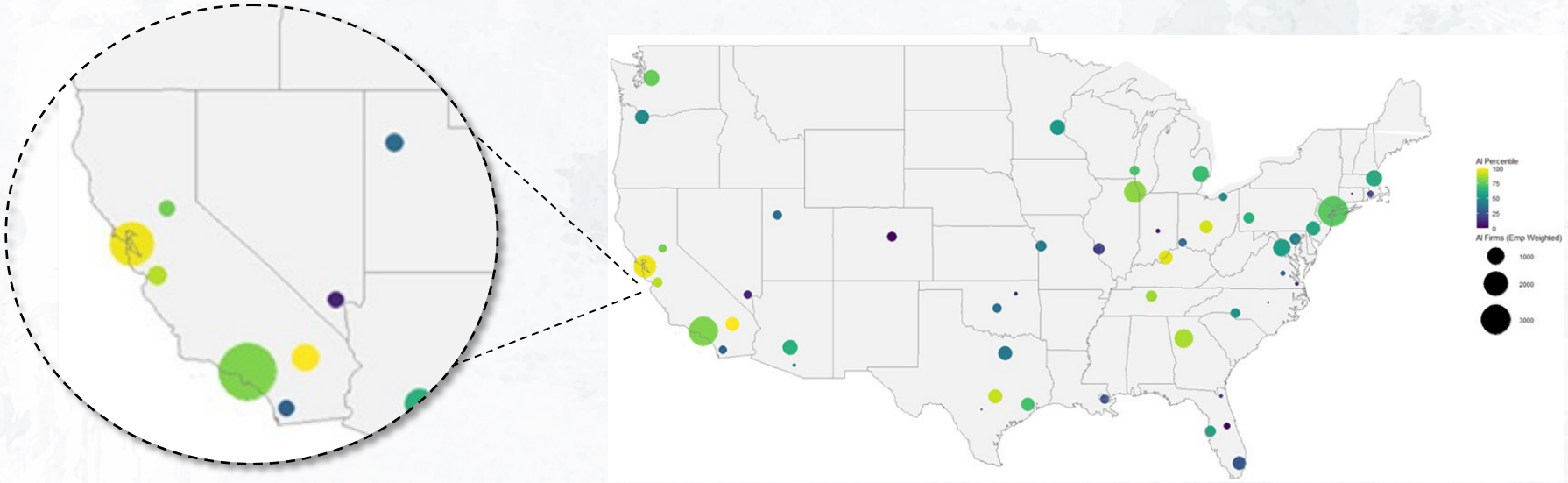
Geography matters: Startups using AI

Employment weighted (Large CBSAs only)



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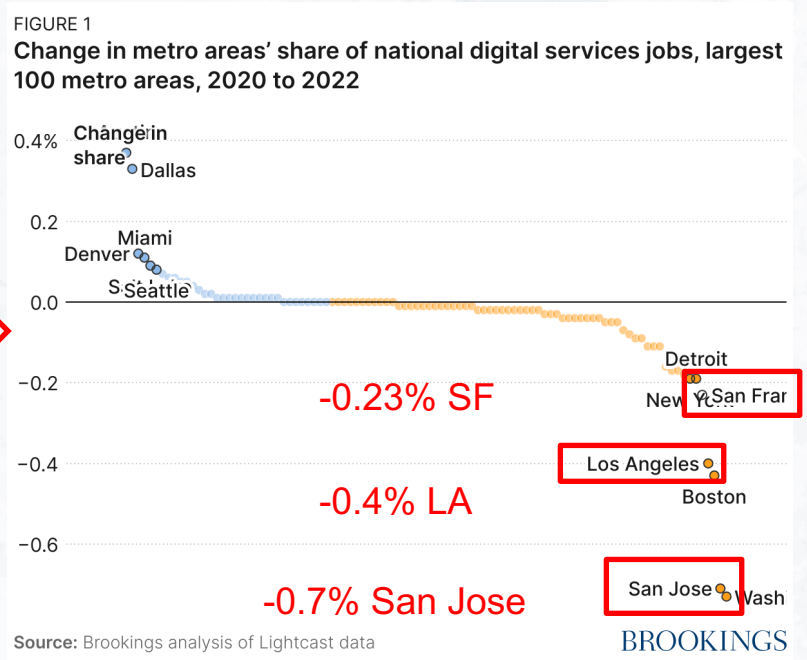
COVID Initiated Tech Worker Exodus?

Table 1. Digital Employment Growth Is Highly Concentrated

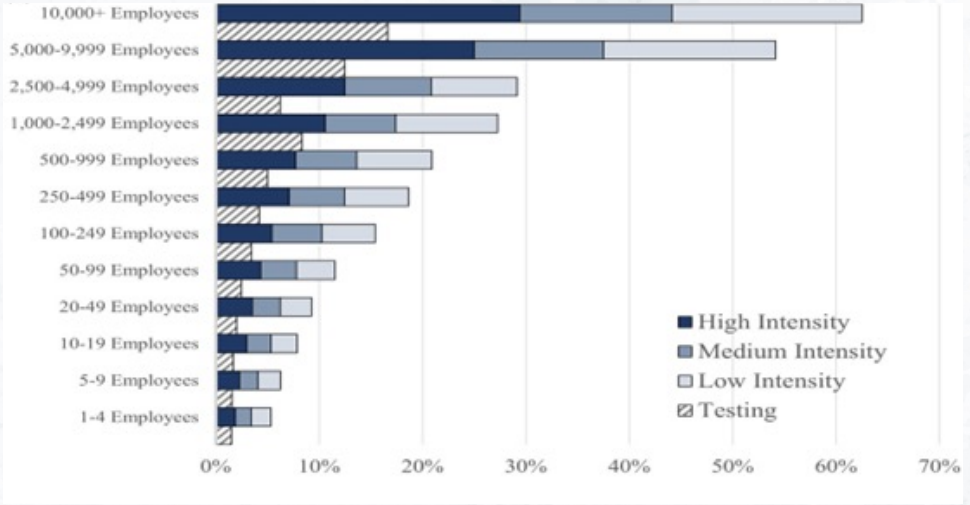
Name	Jobs, 2010	Jobs, 2018	Digital Services Jobs CAGR, 2010-18	Share of Total Job Growth, 2010–18
San Francisco-Oakland-Hayward, California	77,024	186,195	11.7%	10.1%
San Jose-Sunnyvale-Santa Clara, California	79,618	162,509	9.3%	7.7%
New York-Newark-Jersey City, New York-New Jersey-Pennsylvania	144,145	219,729	5.4%	7.0%
Seattle-Tacoma-Bellevue, Washington	86,603	140,182	6.2%	5.0%
Boston-Cambridge-Newton, Massachusetts-New Hampshire	84,346	125,709	5.1%	3.8%
Los Angeles-Long Beach-Anaheim, California	67,490	104,515	5.6%	3.4%



Source: Muro, M., & You, Y. (2023). Tech jobs are finally spreading out, spurred by private investment and federal initiatives. Brookings.

Limits of current AI for small businesses

- AI adoption is highly concentrated among large firms.



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Who can do AI?

- Role of R&D
- Need for large data, not enough in unsupervised
- What role can universities play in the development of future AI?
    - Need for a model of industry-academia partnerships

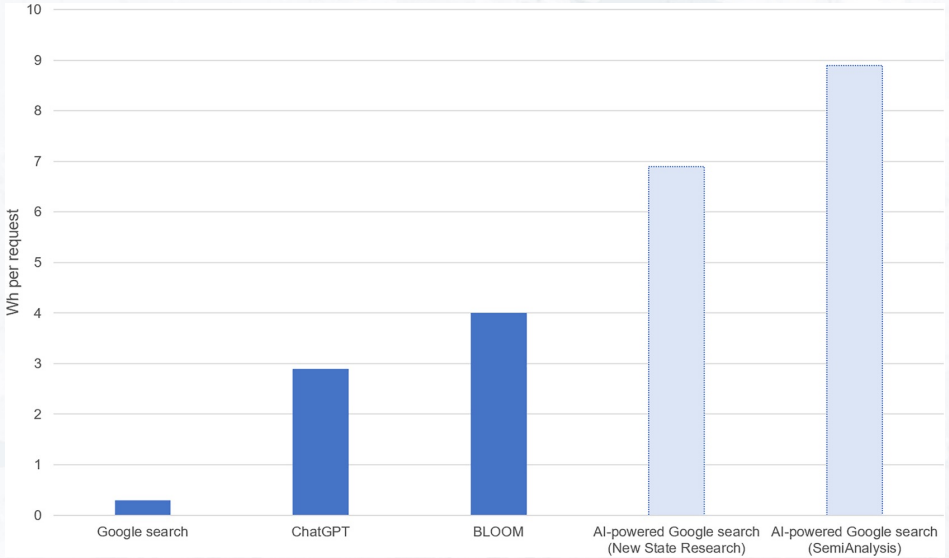
Energy Consumption

Chat GPT

- OpenAI required 3,617 of NVIDIA's HGX A100 servers to support ChatGPT, implying an energy demand of **564 MWh per day**.
- An estimated 1,287 MWh used in GPT-3's entire training phase.

Google

- 60% of AI-related energy consumption from 2019 to 2021 stemmed from inference.



de Vries, A. (2023). The growing energy footprint of artificial intelligence. *Joule*, *7*(10), 2191-2194.

Thanks!

Any questions?

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