The Center for Global Enterprise
CEO Exchange

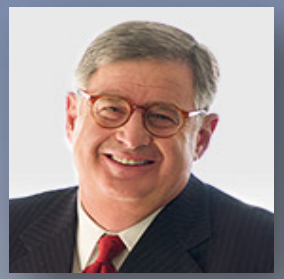
The New Enlightenment
An Applied Management Research Program

The Four Seasons &
MIT Sloan School of Management
November 5-6, 2019
Boston

Welcoming Remarks

Sam Palmisano, *Chairman, The Center for Global Enterprise (CGE)*
Claudio Cisullo, *Chairman, CC Trust Group & CGE Board Member*

CGE Leadership



Samuel J. Palmisano, former Chairman, President and CEO, IBM; Chairman, CGE

David J. Kappos, Partner, Cravath, Swain & Moore; former U.S. Under Secretary of Commerce & Director of the U.S. Patent and Trademark Office

Jim Breyer, Founder & CEO, Breyer Capital

Christopher G. Caine, Founder and CEO, Mercator XXI; President, CGE

Shelly Lazarus, former Worldwide CEO & Chairman, Ogilvy & Mather

Kevin M. Warsh, Distinguished Visiting Fellow and Lecturer, Stanford University; former Special Assistant to the President for Economic Policy

Douglas D. Haynes, former Director, McKinsey & Company

Michael Spence, Nobel prize winning economist; Professor of Economics, Stern School of Business; Professor Emeritus of Management, Stanford Graduate School of Business

Jerry Yang, Founding Partner, AME Cloud Ventures; co-founder, Yahoo!

Claudio Cisullo, Founder & Chairman, CC Trust Group AG

Li Shufu, Chairman, Geely Holding Group

THE CENTER FOR GLOBAL ENTERPRISE

Boston, MA CEO Exchange

Agenda

Tuesday, November 5, 2019 (Location: Four Seasons Hotel – Winthrop/Levitt Room – 2nd floor)

3:00pm **Opening Remarks**
Sam Palmisano, *Chairman, The Center for Global Enterprise (CGE)*
Claudio Cisullo, *Chairman, CC Trust Group & CGE Board Member*

3:30pm **The New Enlightenment: What it means for CEOs**
Presenters: Chris Caine, *President, CGE*, Mike Wing, *Strategic Advisor & Communications, CGE*, Irving Wladawsky-Berger, *CGE & IDE Fellow*

4:30pm **CEO Discussion – Suitability for Machine Learning (Workforce Focus)**
Discussion Leaders: Daniel Rock PhD, *Post-Doctoral Associate, MIT*, Irving Wladawsky-Berger, *CGE & IDE Fellow*
CEO Respondent: Marcel Stalder, *CEO, ChainIQ*

6:00pm **CEO Dinner: Millennial/Generation Z attitudes on deploying AI/ML in the workplace**
(Four Seasons Hotel – Philips Room - 2nd floor)
Presenters: Chris Caine, *President, CGE*, John Zogby, *CEO, Zogby Strategies*

Boston, MA CEO Exchange

Wednesday, November 6, 2019 (Location: MIT Sloan School of Management Board Room E60-112)

8:00am	**Breakfast Discussion: Global Financial and Productivity Trends** Presenter: Kevin Warsh, *Distinguished Fellow Stanford University and CGE Board Member*
8:45am	**Technology-Driven Disruption and Opportunity** Presenters: Erik Brynjolfsson, *Director MIT Initiative on the Digital Economy* & Michael Spence, *Nobel Laureate and CGE Board Member*
10:00am	**Break**
10:15am	**CEO Discussion: Multi-Stakeholder Benefits (Societal Focus)** Discussion Leaders: Jim Breyer, *Founder & CEO Breyer Capital & CGE Board Member*, Dave Kappos, *Partner, Cravath, Swaine & Moore & CGE Board Member*, Michael Spence, *Nobel Laureate and CGE Board Member* **CEO Respondents**: Rob Atkinson, *President, ITIF* and Ilya Levtov, *CEO, Craft*
11:15am	**CEO Discussion - The Reorganization of Work (Management Focus)** Discussion Leaders: Sam Palmisano, *Chairman, CGE,* Doug Haynes, *CGE Board Member,* Shelly Lazarus, *Chairman Emeritus, Ogilvy and CGE Board Member* **CEO Respondent**: Lee Styslinger III, *CEO, Altec*
12:30pm	**Closing Luncheon Discussion: Bringing Value to You & Your Industry** Sam Palmisano, *Chairman, CGE* Erik Brynjolfsson, *Director, MIT Initiative on the Digital Economy*
1:30pm	**Adjournment**

The New Enlightenment:
What it means for CEOs

Chris Caine, *President, CGE*
Mike Wing, *Strategic Advisor & Communications, CGE*
Irving Wladawsky-Berger, *CGE & IDE Fellow*

The New Enlightenment = *Sustaining Global Progress*

Global Advancements

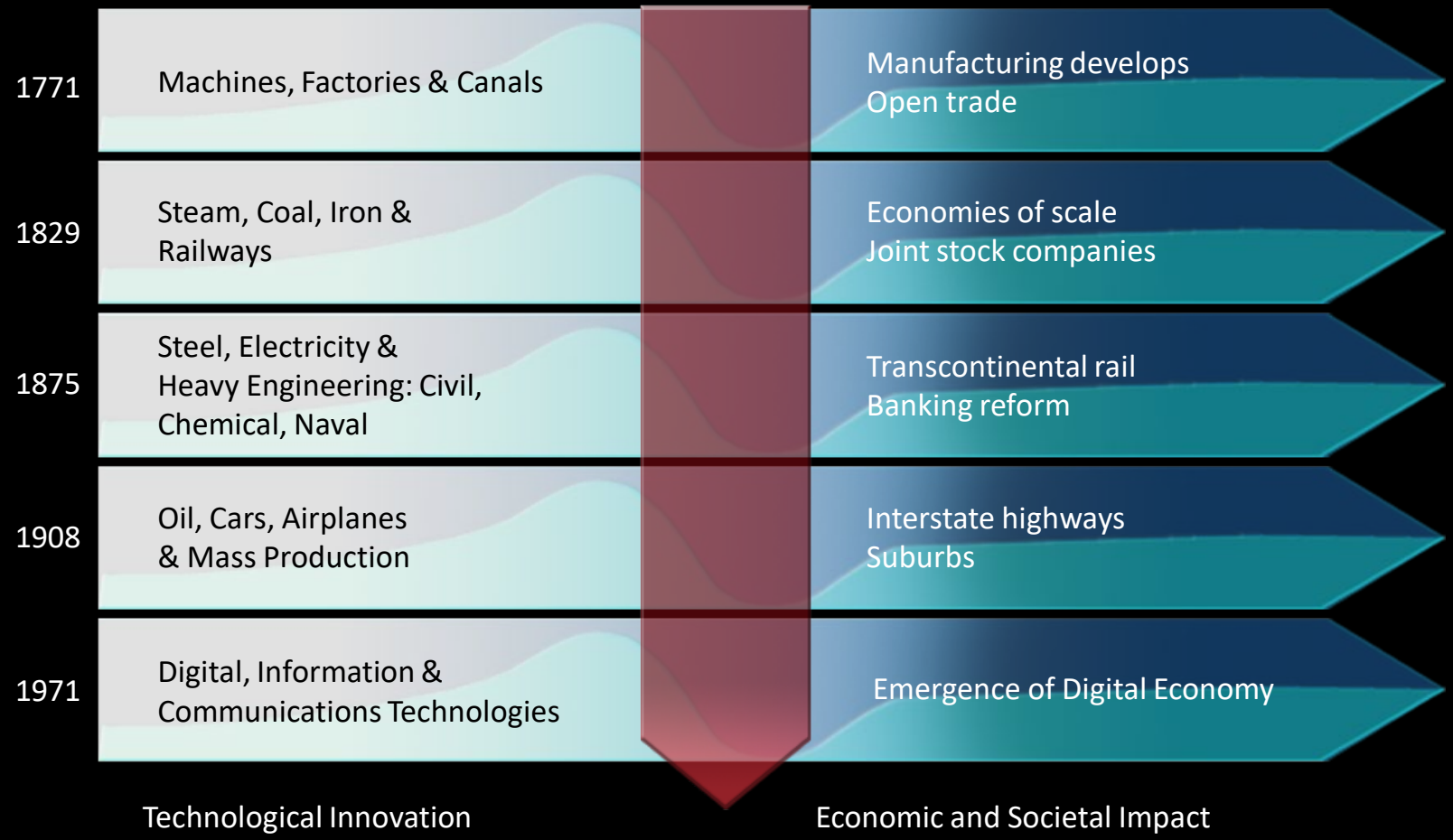
- **The world's entire population now linked by trade**
- **The world was 8% more connected in 2015 than in 2005**
- **Data flows grew 60%+ from 2005-15**
- **14 of top 25 ports were in the developing world by 2014** (The world's busiest container port since 2011, Shanghai, did not appear in the top twenty-five in 1990.)
- **Foreign direct investment into developing countries is almost 60% of global FDI today**
- **95% of humans accessed at least 2G cell coverage by 2015** (Electricity – 82%)
- **Developing world now equal to developed world in trade of high-tech goods**

The New Enlightenment = *Sustaining Global Progress*

Advances Continue

- **Shared prosperity:** Global real GDP per capita passed $8,000 in 2014. (For the first time ever, poverty declined as population grew.)
- **Rising life expectancy rates across the world**
- **Gender inclusion in education continues to significantly expand**
- **Urbanization:** 68% of the world's population will live in urban areas by 2050
- **World Bank:** "Economic inequality in most emerging economies has declined or remained unchanged over the last decade."

Historical Perspective



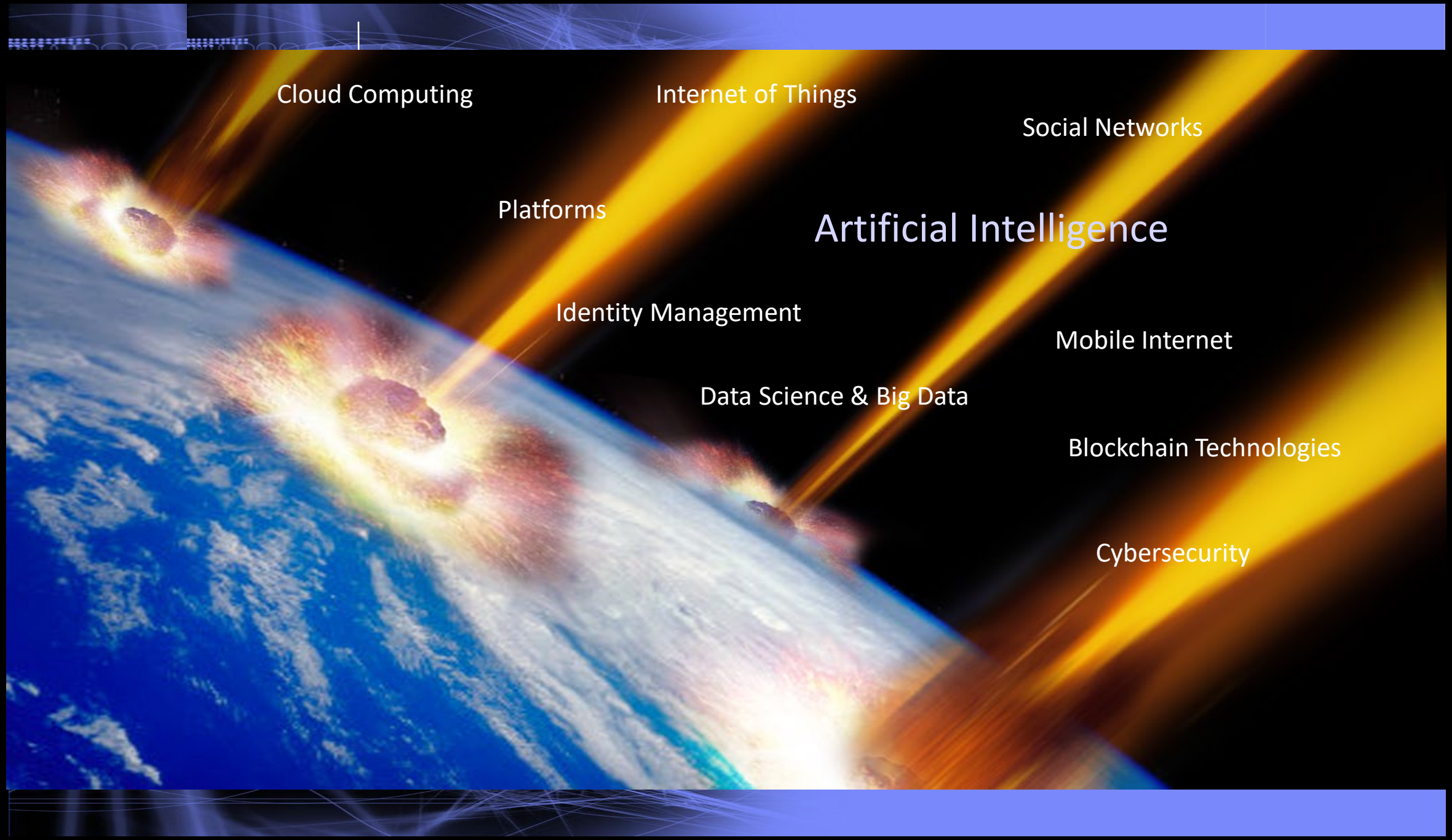
Source: Carlota Perez, Technological Revolution and Financial Capital (2002)

Physically Engineered Systems

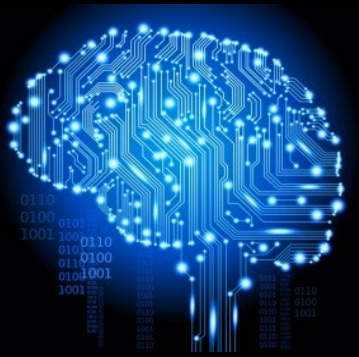
Socio-technical Systems: People, Services, Organizations

Industrial Economy

Information-based Digital Economy

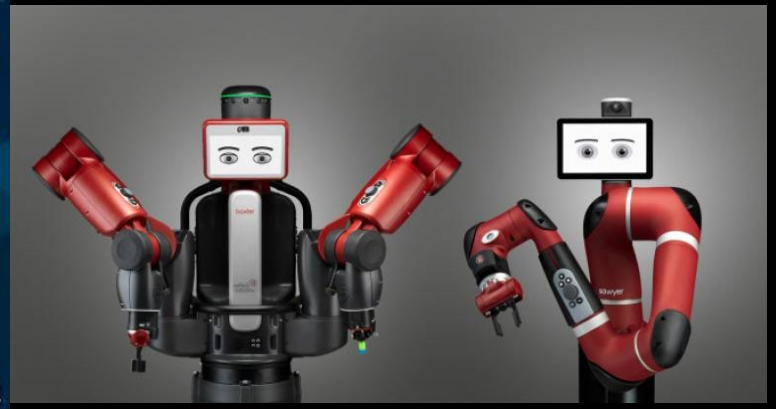

Cloud Computing
Internet of Things
Social Networks
Platforms
Artificial Intelligence
Identity Management
Mobile Internet
Data Science & Big Data
Blockchain Technologies
Cybersecurity

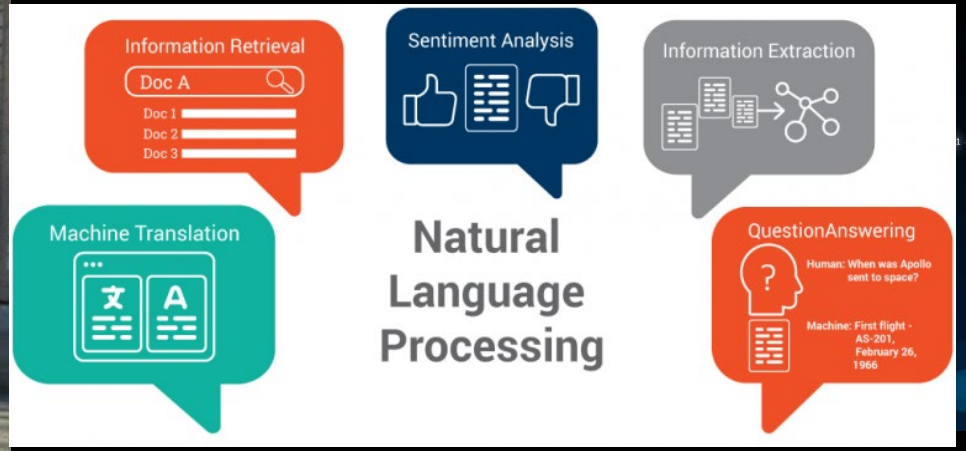
Evolution of Artificial Intelligence



- Born in 1956, AI's founders aspired to develop machines with human-level intelligence and cognitive capabilities, including reasoning and thinking
- Early AI projects grossly underestimated complexity of developing machines with human level intelligence, and in the 1980 the field went through a so-called AI winter
- AI was reborn as IA in 1990s with totally different "brute force" approach based on analyzing vast amounts of information using sophisticated algorithms and powerful parallel computers
- Originated in scientific applications, - high energy physics, astronomy, human genome, - looking for patterns in huge amounts of empirical data
- Scales very nicely: the more data, the more sophisticated the algorithms, the more powerful the computers,… the better the results; perfect for the Big Data, Big IT era

Advances in AI Applications





Intelligence Augmentation (IA)

- Key objective of IA is to leverage technology advances to make humans and everything around us much, much smarter, - including products, processes, organizations, governments, economies, communities, cities and society in general
- Key objective of IA is not to develop machines with general purpose human-level intelligence
- After decades of promise and hype, AI - that is, IA, - is finally achieving an inflection point of market success, and is expected to be the biggest commercial opportunity for companies, industries and nations over the next few decades
- Major technologies, like machine learning, are driving these advances, but there's lots and lots more to do, including innovative applications across a wide variety of industries
- We also need major efforts to better understand the responsible and ethical use of these powerful technologies, such as the new MIT Schwartzman College of Computing and the Stanford Institute for Human-Centered AI

The Globally Enlightened Enterprise (GEE)

Chris Caine, *President, CGE*

What questions need to be answered to crystalize a CEO Roadmap?

New Enlightenment Management Implications

1) How will **value creation** change and what will be the impacts on: a) the enterprise and business models; b) reorganization of work; c) jobs and skills; d) societal stakeholders

2) Decision-making and "earning trust" amidst **constant connectivity and transparency**

3) The rise of **intangible assets** and **intangible liabilities**

What Must GEE Leaders Do?

- Make their organization IA-ready
- Invert the organization – outside-in vs. inside-out
- Repurposing the middle: create internal and external ecosystems for radically distributed decision making
- Ensure the values of the GEE are clear and constantly infused into operating behavior of teams and employees
- Embrace new employment compacts shaped by AI/ML

The New Enlightenment Initiative Workplan

1. **The Reorganization of Work (Management Focus)**
- How will the reorganization of work affect company decision-making?

2. **Suitability for Machine Learning (Workforce focus)**
- How can reasoned approaches be applied to determine which tasks and jobs are best suited for AI/ML within a company?
- What new jobs will be created within a company by the "freeing up" of certain activities and how can workers benefit from these new opportunities?

3. **Multi-Stakeholder Benefits (Societal focus)**
- What is "in it" for different stakeholders in society to embrace a New Enlightenment vision and how can they assess the benefits and risks to values they consider important?

Our Activities To-Date

1. **CEO Exchanges**
   - Hong Kong: June 2019
   - Boston, Massachusetts: November 2019

2. **Applied Research**
   - Sector-specific Macro research
     - > Financial Services
     - > Retailing
     - > Mobility
     - > Logistics
     - > Market Insights and Services
   - Company-specific Micro research

3. **Survey of Stakeholder Attitudes**
   - Understanding the attitudes of Millennials and Generation Z about the internal use of IA, AI, and ML

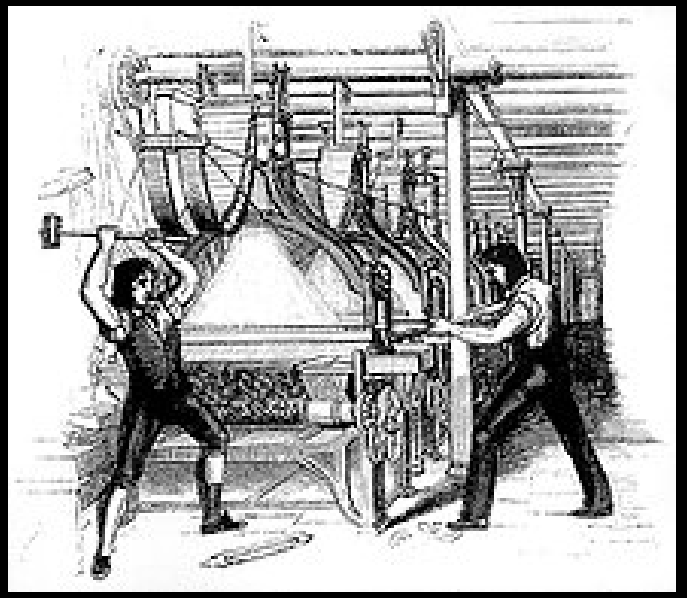
CEO Discussion:
Suitability for Machine Learning
(Workforce Focus)

Daniel Rock PhD, *Post-Doctoral Associate, MIT*
Irving Wladawsky-Berger, *CGE & IDE Fellow*

Will There Be Enough Work in the Future?

RCA Building Construction
Rockefeller Center - 1932

Will There Be Enough Work in the Future?



Technology advances have been replacing workers and transforming industries for the past two centuries.

But, over time the economy has always adapted to the changes, leading to new industries and new jobs

Technology Augmentation

Industrial economy technologies have been augmenting our physical limitations: strength, speed, ability to fly, …

Digital economy technologies are now augmenting our cognitive abilities: deal with huge amounts of data, make tough decisions, address highly complex problems, …

Job Automation versus Job Transformation

Experts believe that fewer than 10% of occupations can be entirely automated by 2030, but over half of all occupations will be significantly transformed by advanced technologies.

Millions worldwide may need to switch occupations and upgrade skills, matching or even exceeding the historical transitions out of agriculture and manufacturing.

Education has long been the answer to technology advances

- Universal primary education in the early 20th century; universal secondary education in the post WWII years
- In the digital economy, workers need to be good at complex problem-solving, teamwork and adaptability, skills we most associate with a higher education
- Life long learning is more important than ever to keep up with the demands of rapidly changing technologies, industries and labor markets.

Measuring the Machine Learning Economy

Daniel Rock
MIT Initiative on the Digital Economy

The Center for Global Enterprise
November 5th, 2019

Preview

1. Many applications of ML have achieved human or superhuman performance.
   - However, we are far from *Artificial General Intelligence* (AGI)
   - So, what *can* machines learn?

2. We develop and implement a 21-question rubric for assessing the *Suitability for Machine Learning* (SML) of tasks

3. We apply this rubric to ~2000 activities, ~18,000 tasks and 964 occupations in O*NET
   - Use two crowdsourcing platforms to get ~10 responses per question per activity

4. Results (preliminary)
   a) ML differs from previous waves of automation
   b) On average, low wage jobs are more exposed, but many high wage jobs are newly affected
   c) No occupations can be fully automated by ML
   d) Nearly all occupations have some exposure to ML. Many have significant exposure
   e) High variability of SML across tasks within occupations
   f) More measurable tasks may be the first to be affected by ML

5. **Implication**: *redesign* of jobs will be the key to productivity gains from ML

The First Wave of the Computer Revolution

Teaching machines what we know

- "Coding" = codifying knowledge
- Mantra: *"Codify, Digitize, Replicate!"*
- Economics: High fixed costs, low marginal costs

The Most "G" of all GPTs

Machine Learning (ML) is…

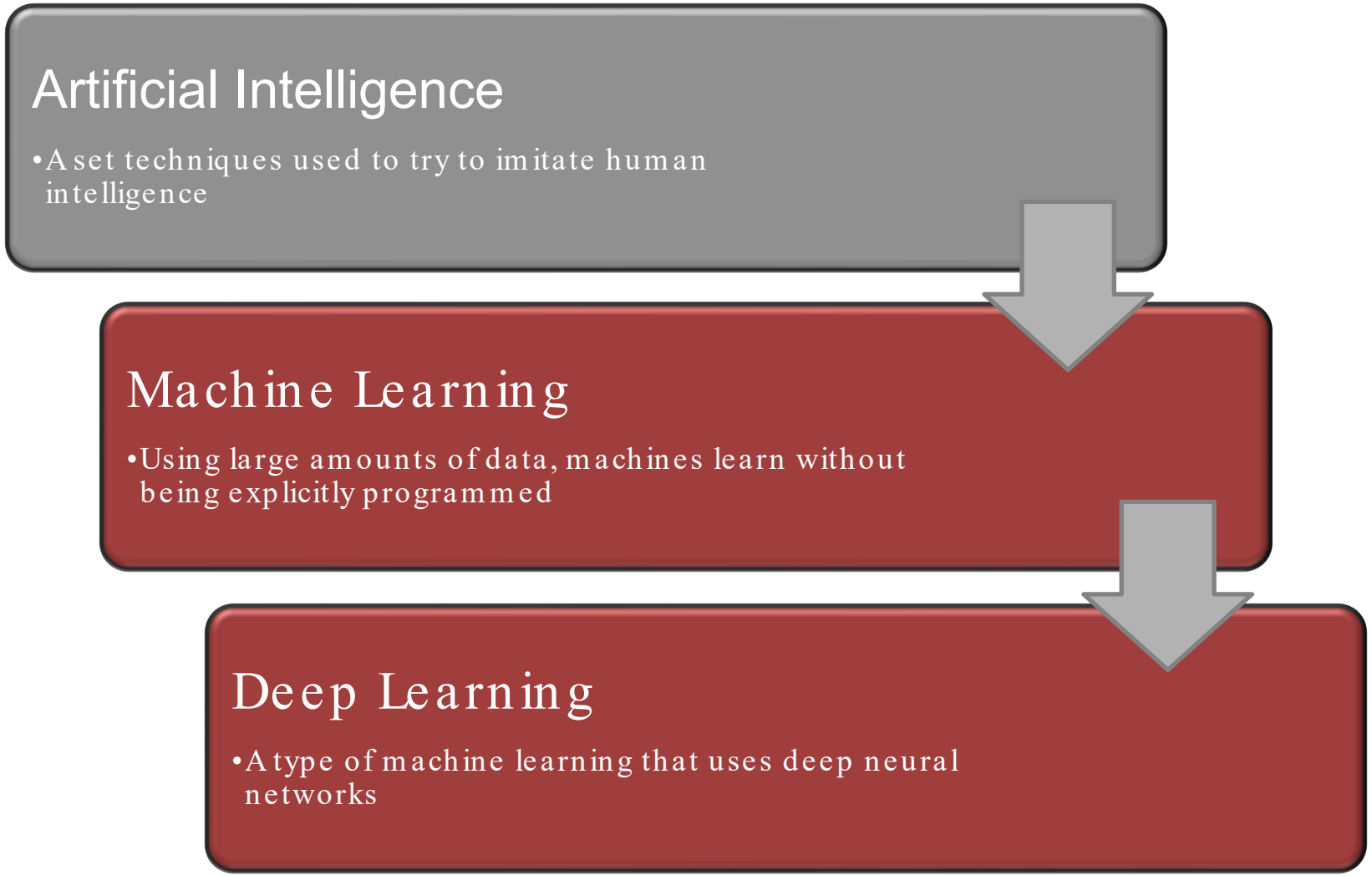
…a General Purpose Technology (GPT) (Bresnahan and Trajtenberg 1995)

- Pervasive
- Improves over time
- Generate complementary innovations

…a Source of Concern

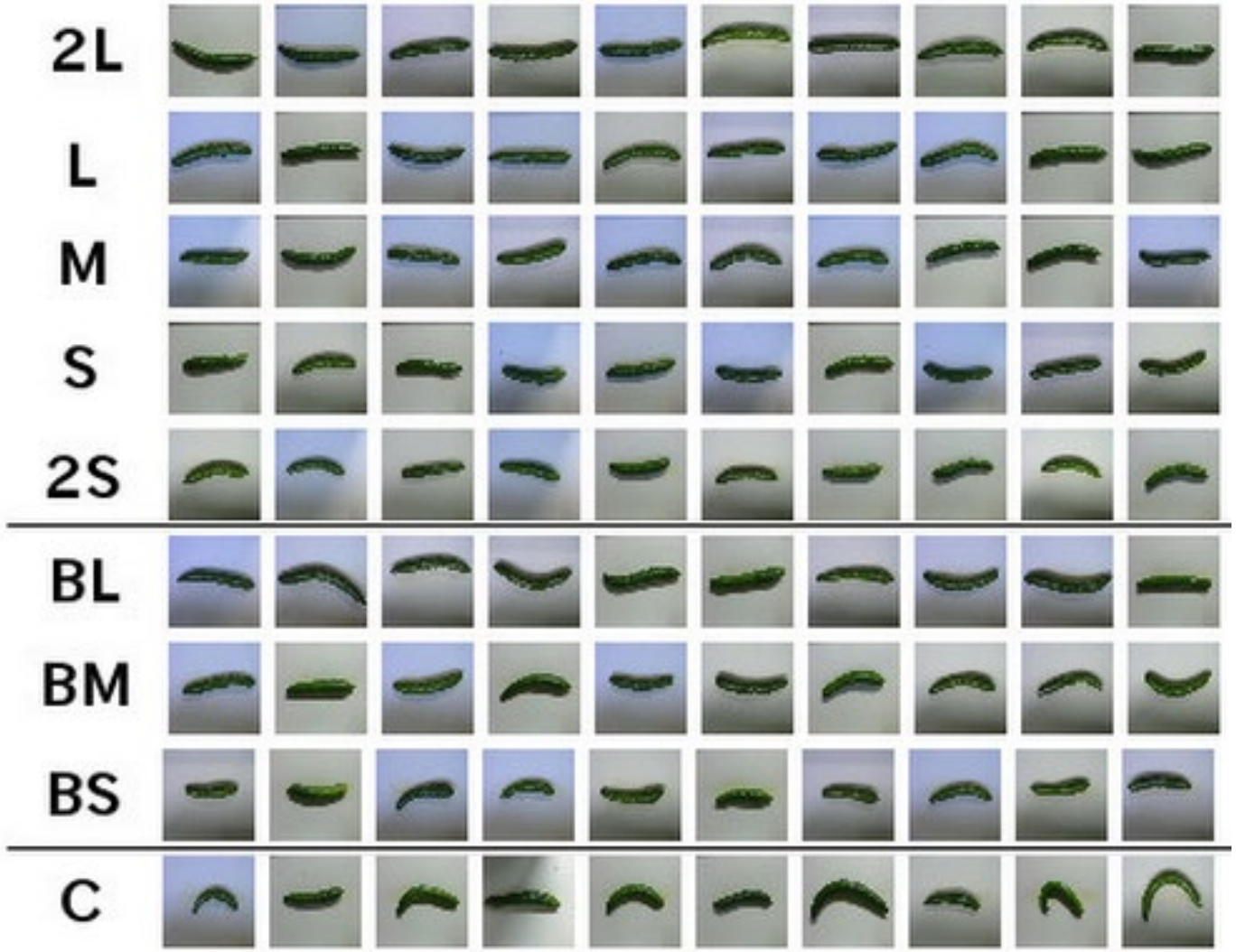
- National Academies: "The case that technological advances have contributed to wage inequality is strong."

The Second Wave of the Second Machine Age: *Machines That Learn*



Who knows what this machine does?

Yep, cucumbers.

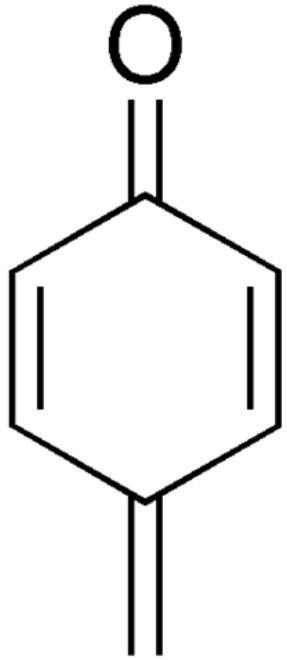


MIT INITIATIVE ON THE DIGITAL ECONOMY

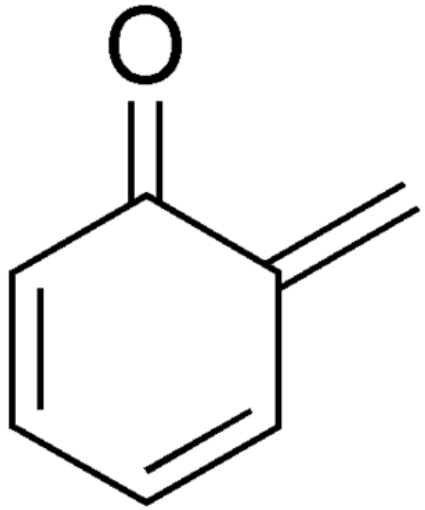
What can experts do with deep learning technology?

Deep learning revolutionizes chemistry: The “Self-Driving Laboratory”

ChemOS



para quinone methide



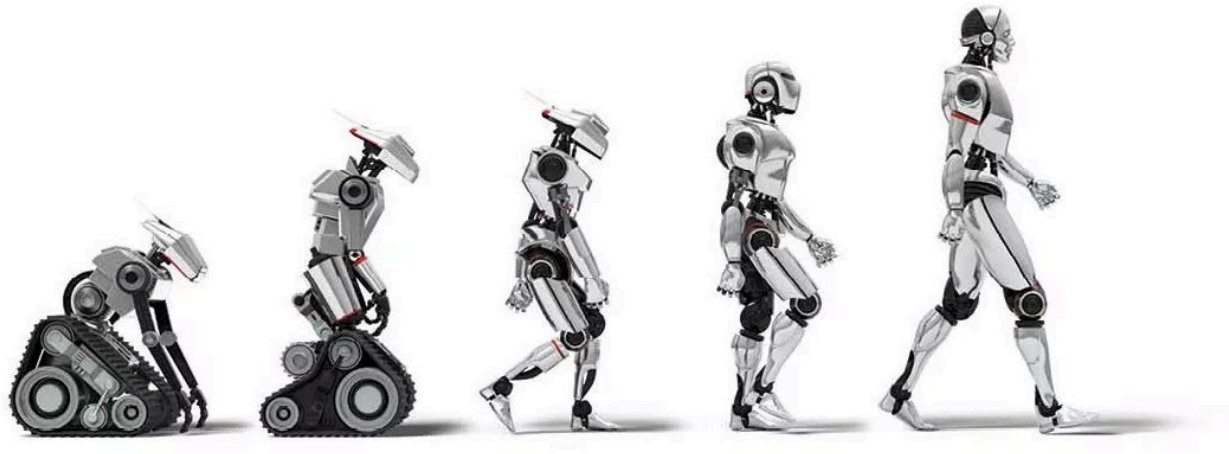
ortho quinone methide

What are the ML superpowers?

What Can Machines Learn?

Impressive recent advances, but most applications have been in one narrow category: *supervised learning*

- Learn map from input features (X) to Output Values and Labels (Y)
  - Deep Neural Networks(DNNs) (Rumelhart et al. 1986; LeCun et al. 1998)
  - Exciting because these are programs that overcome Polanyi's Paradox (1966) per Autor (2014)



Despite many successes, supervised learning is far from AGI

Supervised Learning Applications

Supervised Learning Systems

As two pioneers in the field, Tom Mitchell and Michael I. Jordan, have noted, most of the recent progress in machine learning involves mapping from a set of inputs to a set of outputs. Some examples:

INPUT X	OUTPUT Y	APPLICATION
Voice recording	Transcript	Speech recognition
Historical market data	Future market data	Trading bots
Photograph	Caption	Image tagging
Drug chemical properties	Treatment efficacy	Pharma R&D
Store transaction details	Is the transaction fraudulent?	Fraud detection
Recipe ingredients	Customer reviews	Food recommendations
Purchase histories	Future purchase behavior	Customer retention
Car locations and speed	Traffic flow	Traffic lights
Faces	Names	Face recognition

Source: Brynjolfsson, Erik, and Andrew McAfee. "The business of artificial intelligence." *Harvard Business Review* (2017).

Which Tasks Will Be Done by Machine Learning?

We create a "Suitability for Machine Learning" (SML) rubric of 21 questions

- We apply it to 2,059 Detailed Work Activities in O*NET, 18,112 occupation-specific tasks, and 950 occupations (weighted by task importance)
- Questions are rated on five point scale from "strongly disagree" to "strongly agree"
- Each DWA is scored by 10 different people

Brynjolfsson, Mitchell and Rock, "What Can Machines Learn and What Does It Means for Occupations and the Economy, *AEA P&P*, 2018.

Key Question: Which tasks can ML do well?

1. **Rubric is based on principles from ML research and views of ML researchers**

2. **Seeks to distinguish which tasks current ML technology is able to do well**
   - **Go beyond the "Ng Rule"**

3. **Requirements:**
   - **Taxonomy of tasks (O*NET)**
   - **Structured way of looking at task content and context (Rubric)**
   - **Measurements of tasks at different levels of aggregation**

Methodological Question: Can we prospectively measure sensitivity to new technologies?

1. **Prospective, not retrospective**
   - **Will it have predictive power?**
   - **How can we learn from past technologies?**

2. **Task level, but can be aggregated**
   a. **Occupations**
   b. **Firms**
   c. **Industries**
   d. **MSAs**
   e. **Nations**
   f. **Other ideas?**

3. **Next steps:**
   a. **Robotics**
   b. **Rules-based systems**

Examples of “Work Activities” in O*Net

- Inspect finished products to locate flaws.
- Follow safety procedures for vehicle operation.
- Process medical billing information.
- Analyze jobs using observation, survey, or interview techniques.

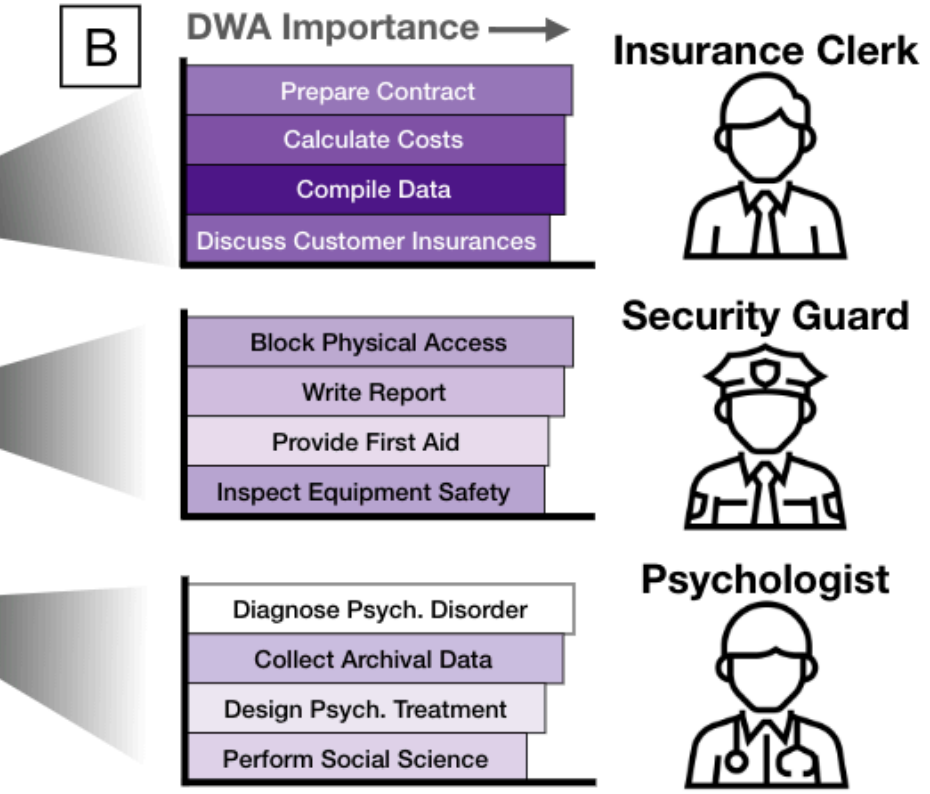
Use the rubric to evaluate ML potential impact

A

Detailed Work Activities (DWAs) are assessed for their suitability for machine learning:

- Does the task require complex reasoning?
- Is the task repeated frequently?
- Is the task predictive?
- Does the task get easier with practice?
- Is the task error tolerant?
- Does the task get easier with practice?
- Does the task rely on speech or visual data?

B



Rubric Questions

1. *Task information is recorded or recordable by computer*
2. *Task feedback is immediate*
3. *It is okay to make mistakes when completing this task*
4. *It is not important that the task is done by a human*
5. *Task does not require complex reasoning*
6. *Task matches labels to concepts, predictions, or actions*
7. *Task involves a brief, simple, highly-structured conversation with a customer or someone else*

Rubric Questions

8. *Task is repeated frequently*

9. *There is no need to explain decisions when doing the task*

10. *The Task is about choosing between multiple predetermined options*

11. *Long-term planning is not required to successfully complete this task*

12. *The task requires working with text data*

13. *The task requires working with image or video data*

14. *The task requires working with speech data*

15. *The task requires working with other types of data*

Rubric Questions

16. *The task can be completed in one second or less*

17. *Each instance, completion, or execution of the task is similar to other instances in how it is done*

18. *Practicing the task to get better is easy*

19. *The task is primarily about predicting something*

20. *The task is part of this occupation (check 1)*

21. *The task output is not error tolerant (check 2)*

O*Net: Tasks Done by Radiologists (27 tasks)

Sample Tasks (out of 27 tasks):

1. Provide advice on types or quantities of radiology equipment needed to maintain facilities.
2. Perform interventional procedures such as image-guided biopsy, percutaneous transluminal angioplasty, transhepatic biliary drainage, or nephrostomy catheter placement.
3. Administer or maintain conscious sedation during and after procedures.
4. **Interpret images using computer-aided detection or diagnosis systems.**
5. Develop treatment plans for radiology patients.
6. Treat malignant internal or external growths by exposure to radiation from radiographs (x-rays), high energy sources, or natural or synthetic radioisotopes.
7. Conduct physical examinations to inform decisions about appropriate procedures.

O*Net: Tasks Done by Radiologists (27 tasks)

Sample Tasks (out of 27 tasks):

1. Provide advice on types or quantities of radiology equipment needed to maintain facilities.
2. Perform interventional procedures such as image-guided biopsy, percutaneous transluminal angioplasty, transhepatic biliary drainage, or nephrostomy catheter placement.
3. Administer or maintain conscious sedation during and after procedures.
4. **Interpret images using computer-aided detection or diagnosis systems.**
5. Develop treatment plans for radiology patients.
6. Treat malignant internal or external growths by exposure to radiation from radiographs (x-rays), high energy sources, or natural or synthetic radioisotopes.
7. **Conduct physical examinations to inform decisions about appropriate procedures**.

“Interpret images using computer-aided detection or diagnosis systems.”

Median Evaluation Scores (1= low, 5 = high):

Q1: Information needed for task is machine-readable:	**5**
Q5: Task output is error-tolerant:	**1.5**
Q9: There is no need to explain decisions when doing the task:	**1.5**
Q16: The task involves working with image data:	**5**

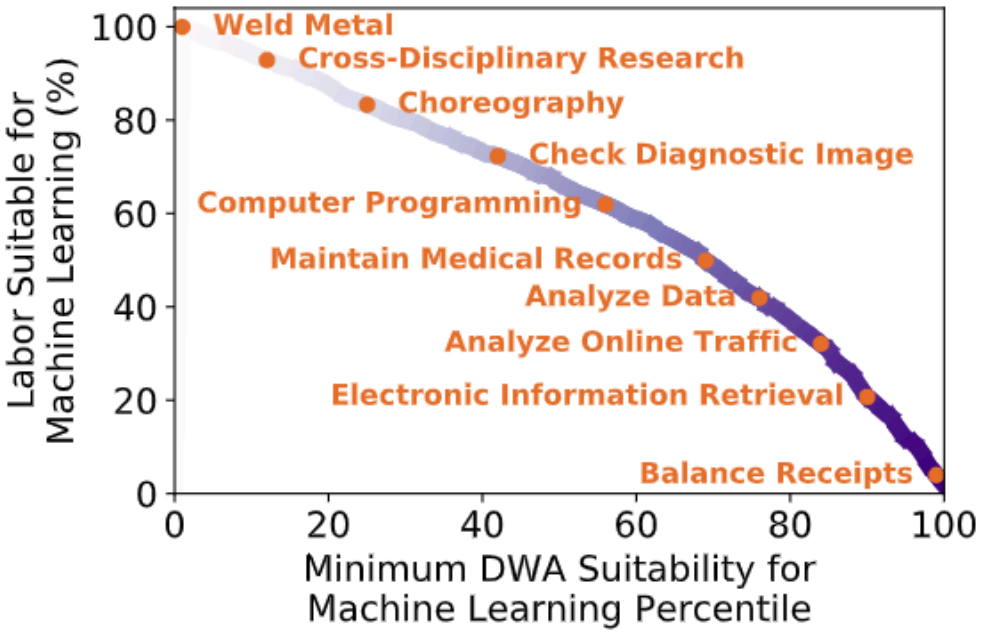
➔ **Overall Task SML: 3 (58th Percentile)**

SML Rankings – Top and Bottom 15 Occupations

LOWEST AND HIGHEST 15 SML SCORE OCCUPATIONS

Rank	Lowest SML Ranked Occupations	SML	Highest SML Ranked Occupations	SML
1	Clinical Psychologists	2.58	Switchboard Operators, Including Answering Service	3.55
2	Music Composers and Arrangers	2.59	Insurance Claims Clerks	3.50
3	Neuropsychologists and Clinical Neuropsychologists	2.60	Postal Service Mail Carriers	3.50
4	Counseling Psychologists	2.61	Meter Readers, Utilities	3.48
5	Lawyers	2.61	Word Processors and Typists	3.47
6	Product Safety Engineers	2.63	Telemarketers	3.46
7	Industrial-Organizational Psychologists	2.64	Telephone Operators	3.46
8	Coroners	2.64	Police, Fire, and Ambulance Dispatchers	3.44
9	Forensic Science Technicians	2.65	Data Entry Keyers	3.43
10	Fire Investigators	2.65	Couriers and Messengers	3.43
11	Range Managers	2.65	File Clerks	3.43
12	Foresters	2.66	Counter Attendants, Cafeteria, Food Concession, and Coffee Shop	3.43
13	Private Detectives and Investigators	2.66	Payroll and Timekeeping Clerks	3.43
14	Oral and Maxillofacial Surgeons	2.66	Baristas	3.42
15	Biofuels/Biodiesel Technology and Product Development Managers	2.66	Gaming and Sports Book Writers and Runners	3.41

The initial results show disparate potential impact across tasks



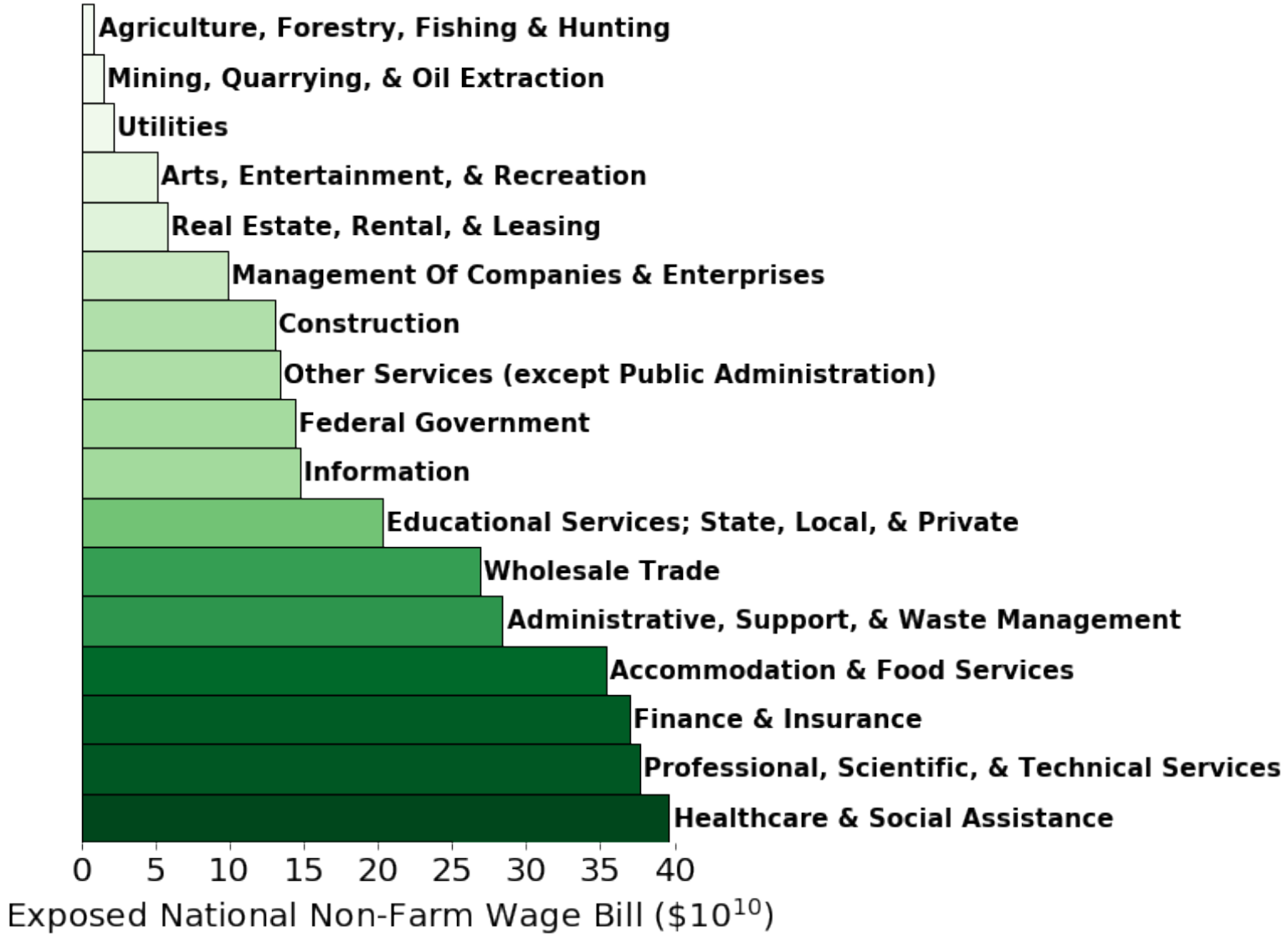
C	Occupation	SML (%)
	Switchboard Operator	64
	Insurance Clerk	62
	Postal Carrier	62
	Meter Reader	62
	Typist	62
	Telemarketer	62
	Telephone Operator	62
	Emergency Dispatcher	61
	⋮	
	Range Manager	41
	Fire Investigator	41
	Forensic Science Tech.	41
	Coroner	41
	Product Safety Eng.	41
	Lawyers	40
	Music Composer	40
	Psychologist (all)	40

Suitability for Machine Learning:

Less — More

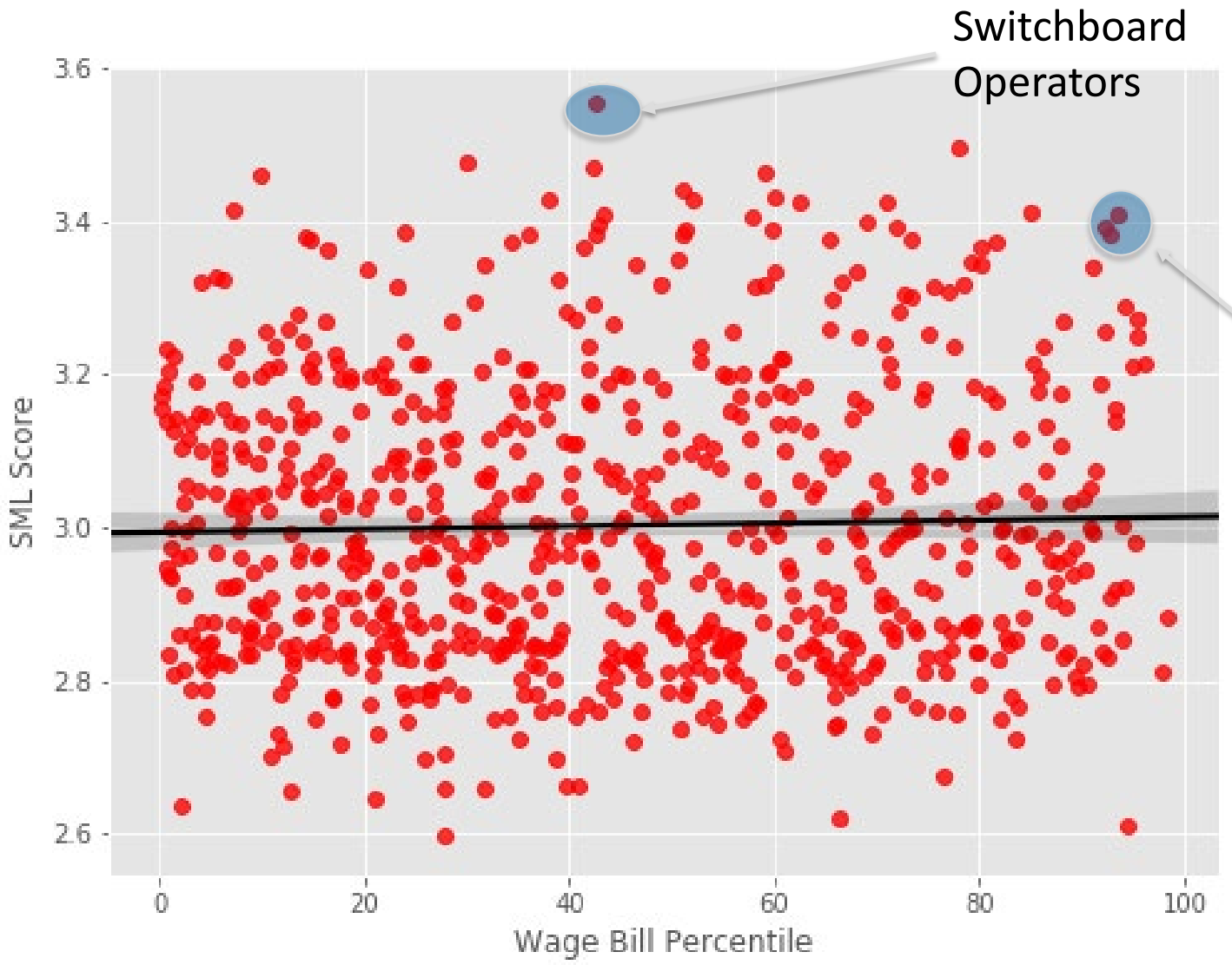
MIT INITIATIVE ON THE DIGITAL ECONOMY

Industries vary in redesign potential



MIT INITIATIVE ON THE DIGITAL ECONOMY

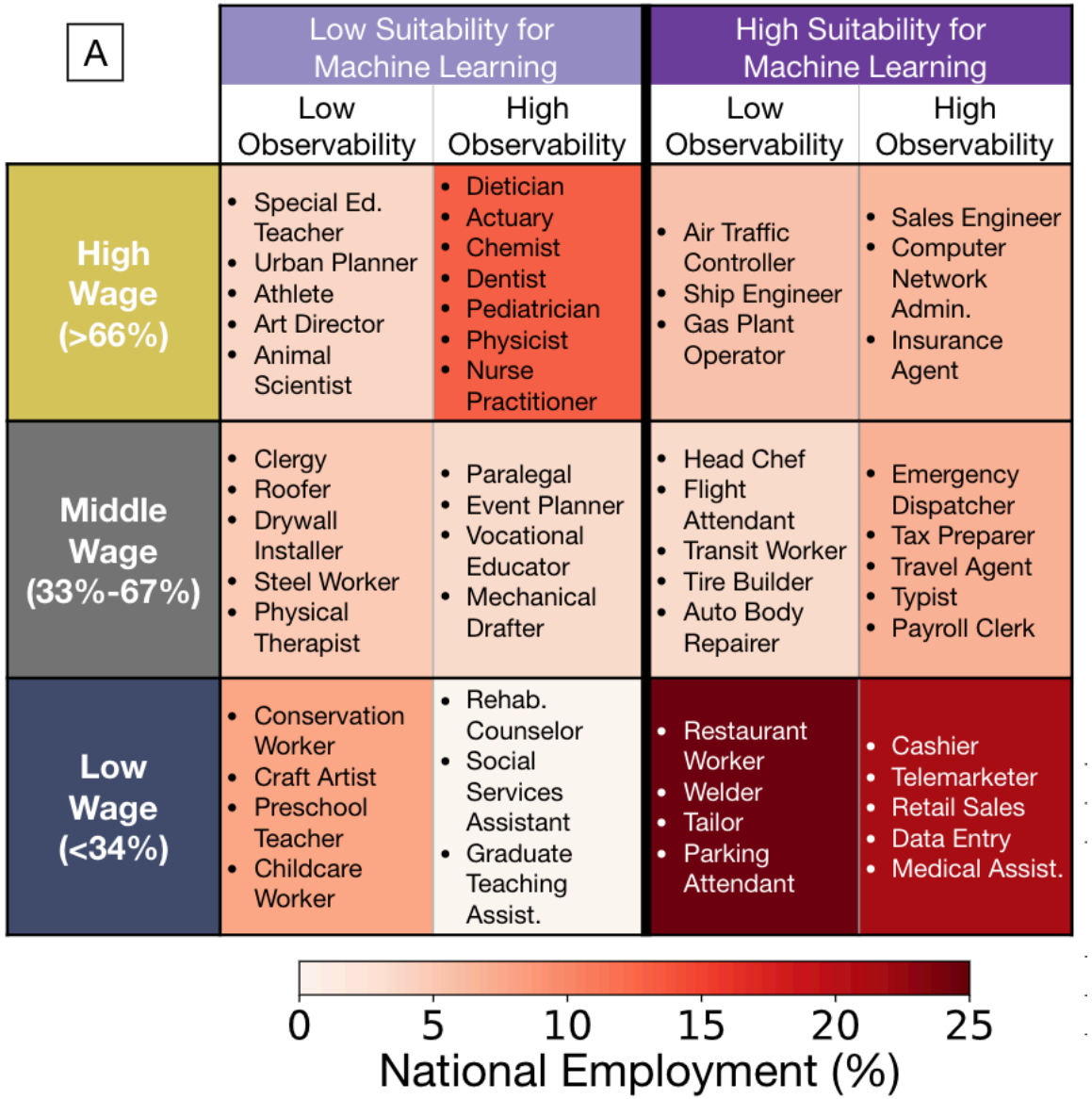
SML is not correlated with total wage bill



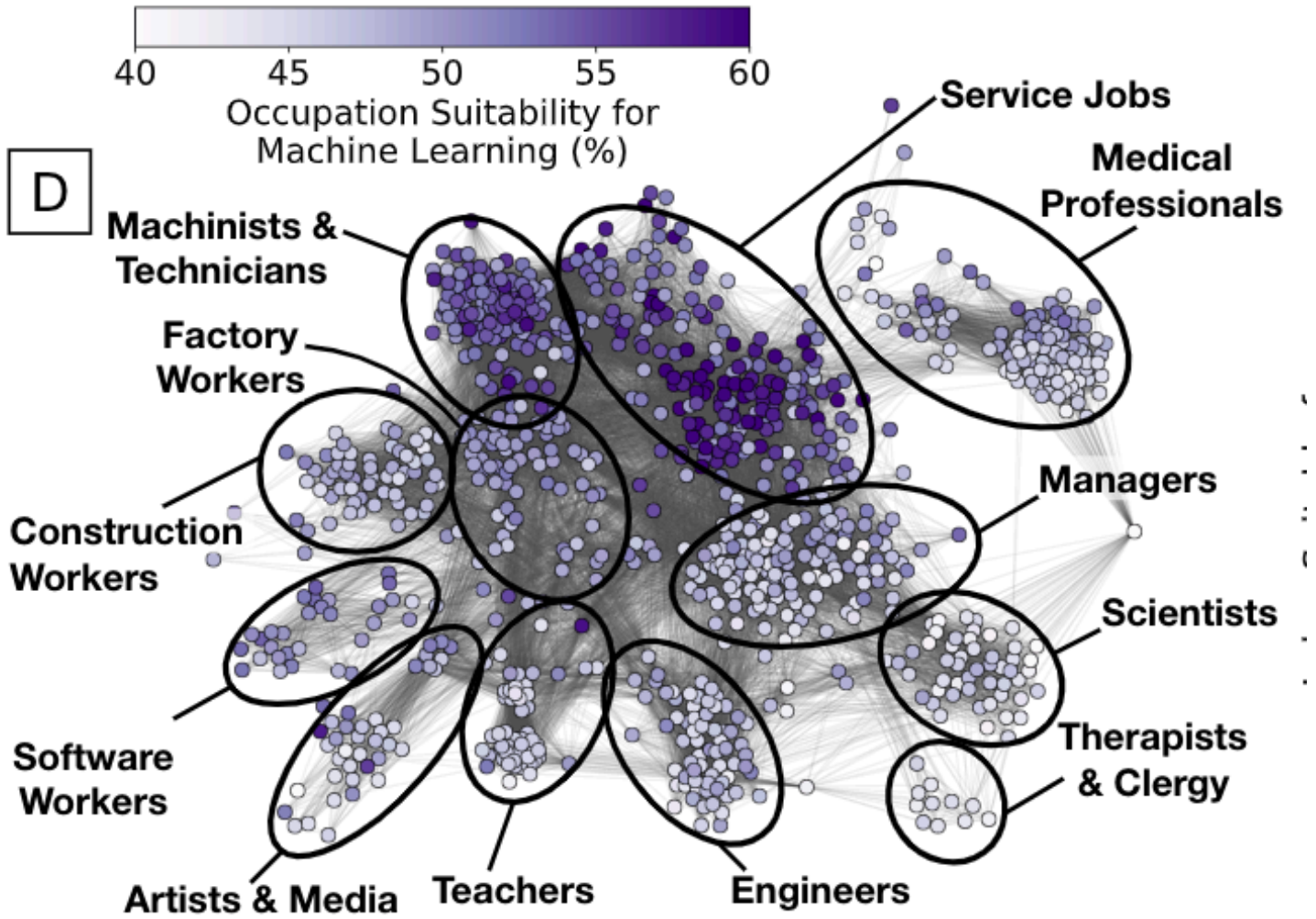
Regression of SML on Wage Bill
Slope: 0.002, t-stat: 0.81

MIT INITIATIVE ON THE DIGITAL ECONOMY

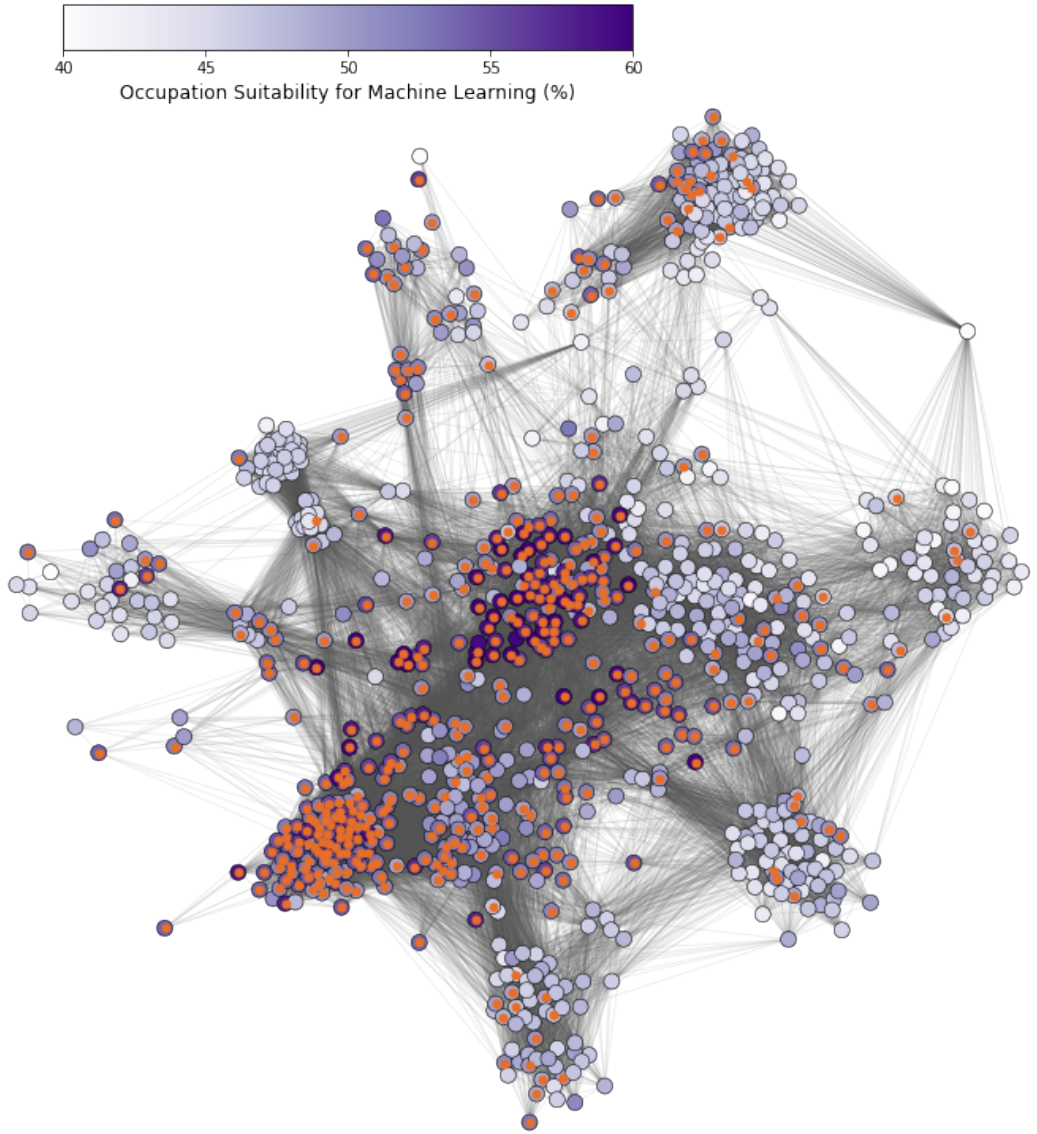
Occupations are unevenly distributed across SML groups



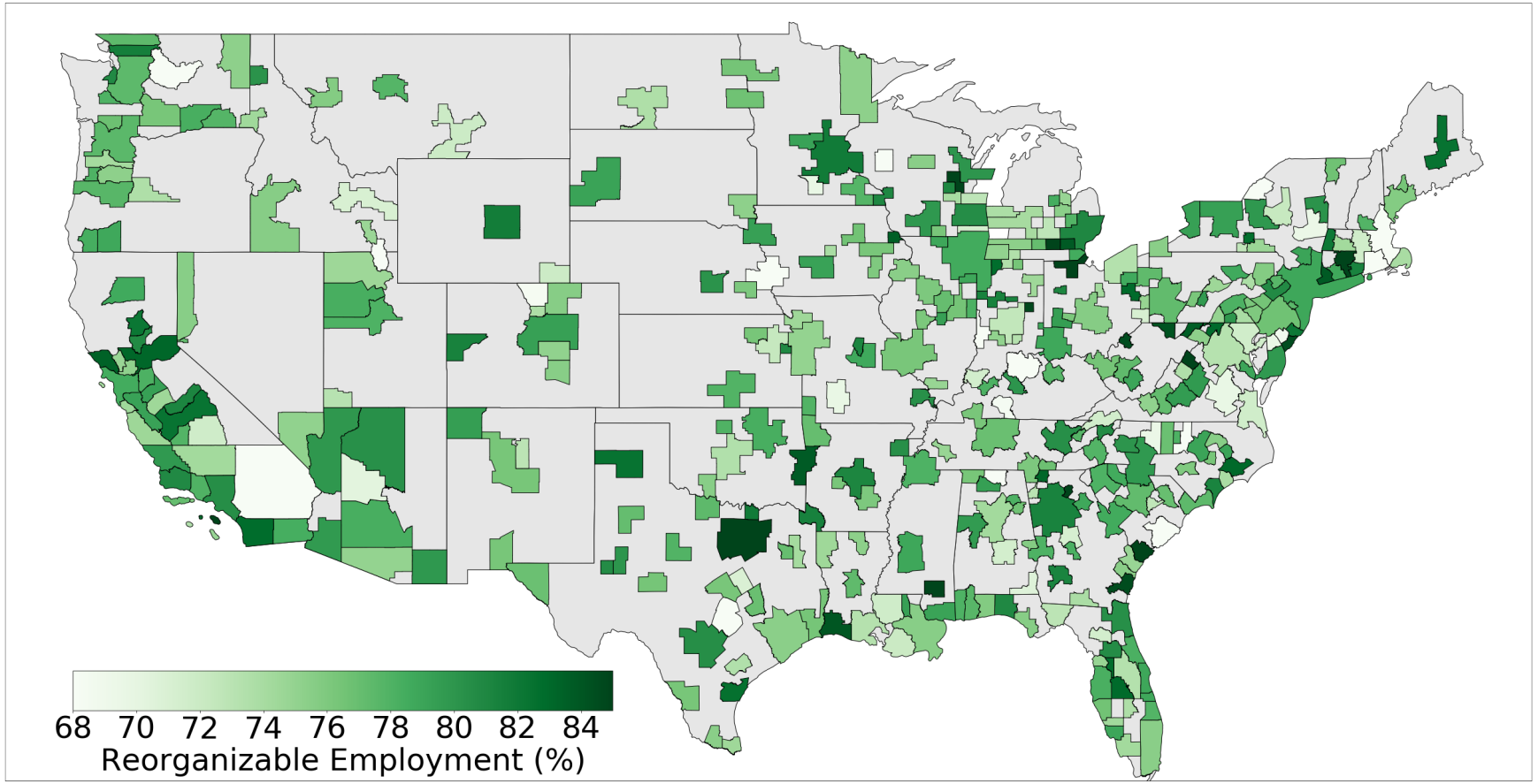
Lots of information processing and manufacturing tasks are exposed

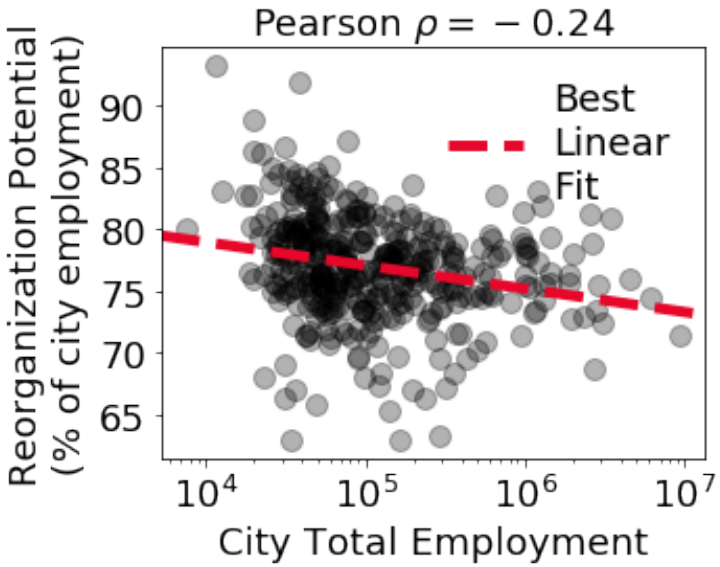


Most occupations in the economy are exposed to redesign potential



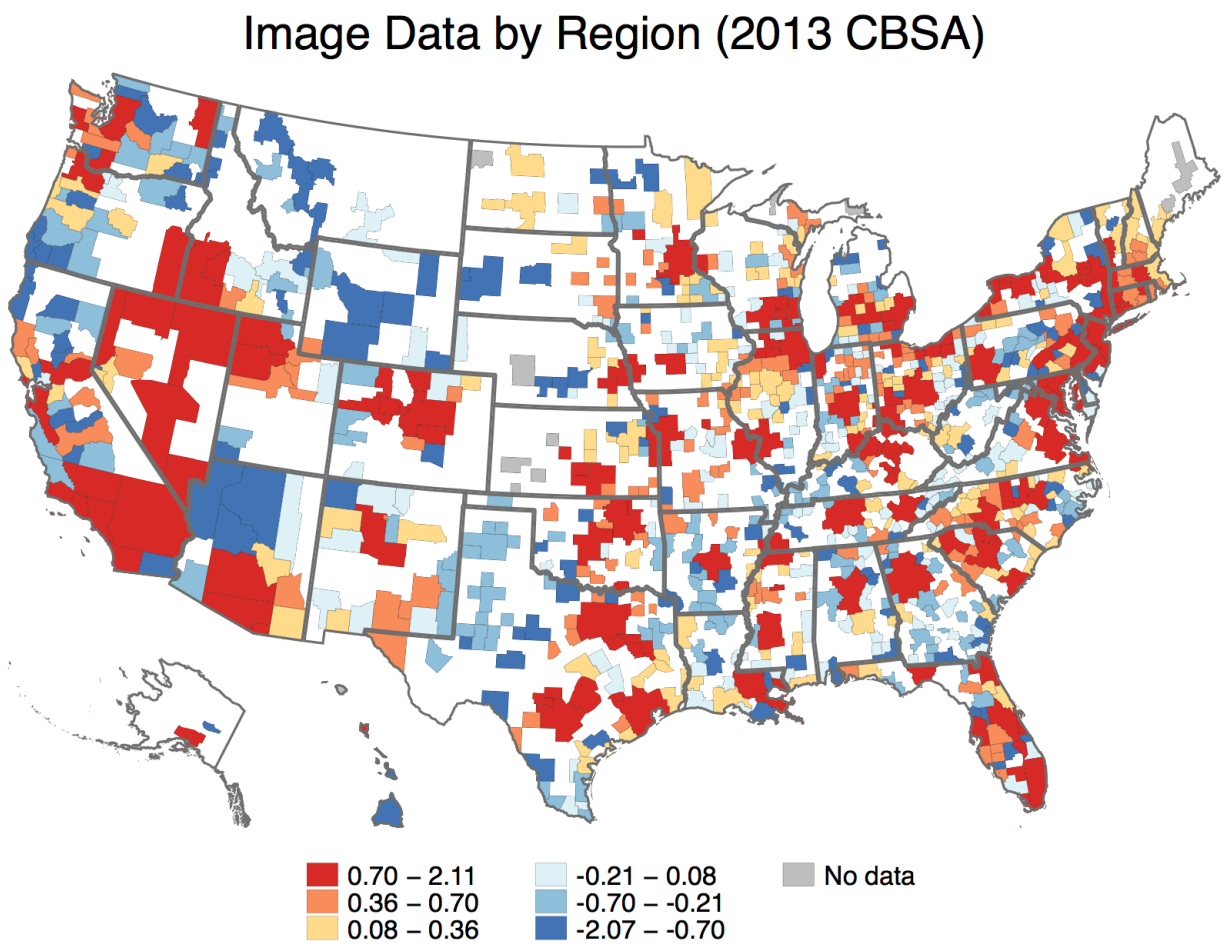
Exposure varies by region and population center size



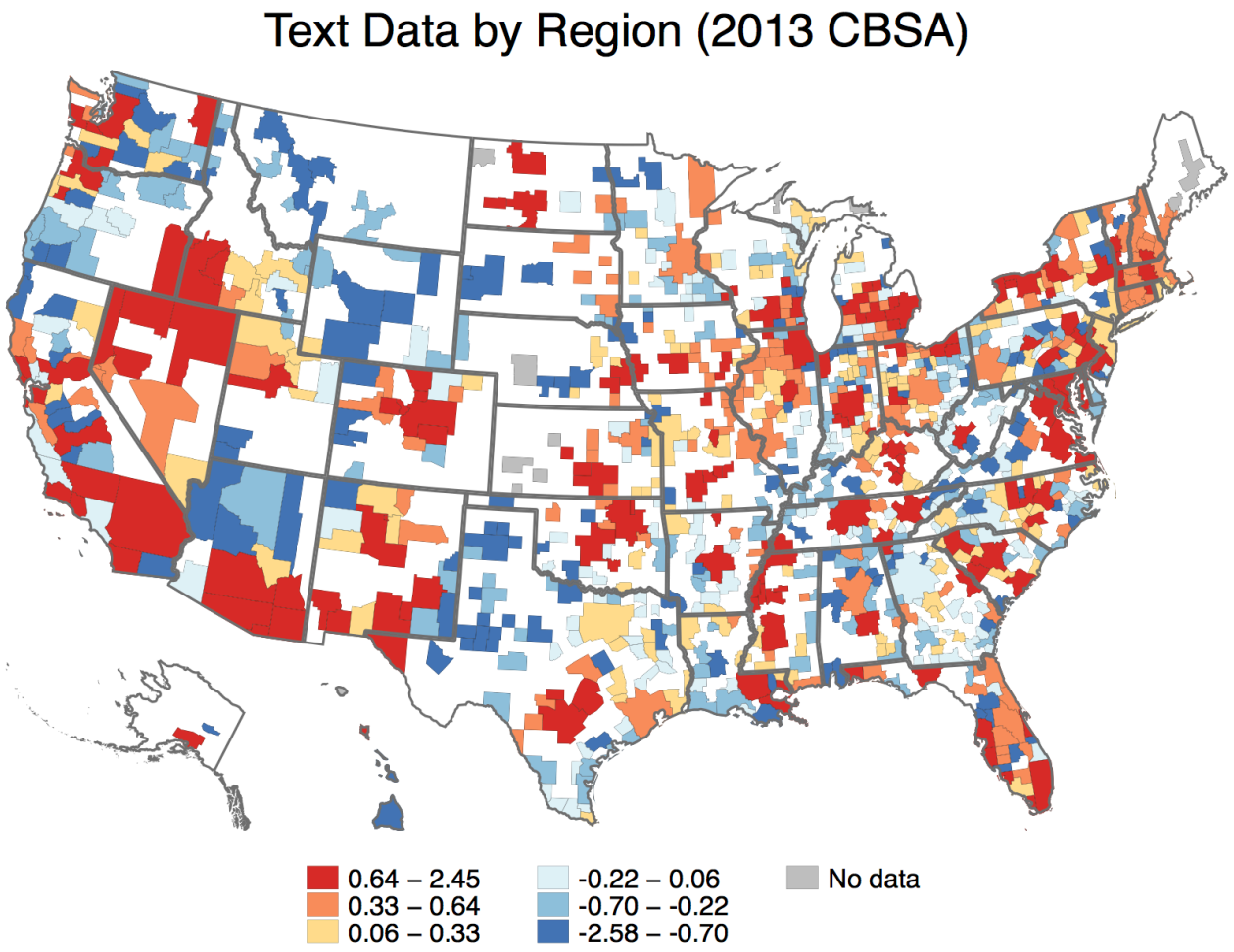


MIT INITIATIVE ON THE DIGITAL ECONOMY

Use of Image Data

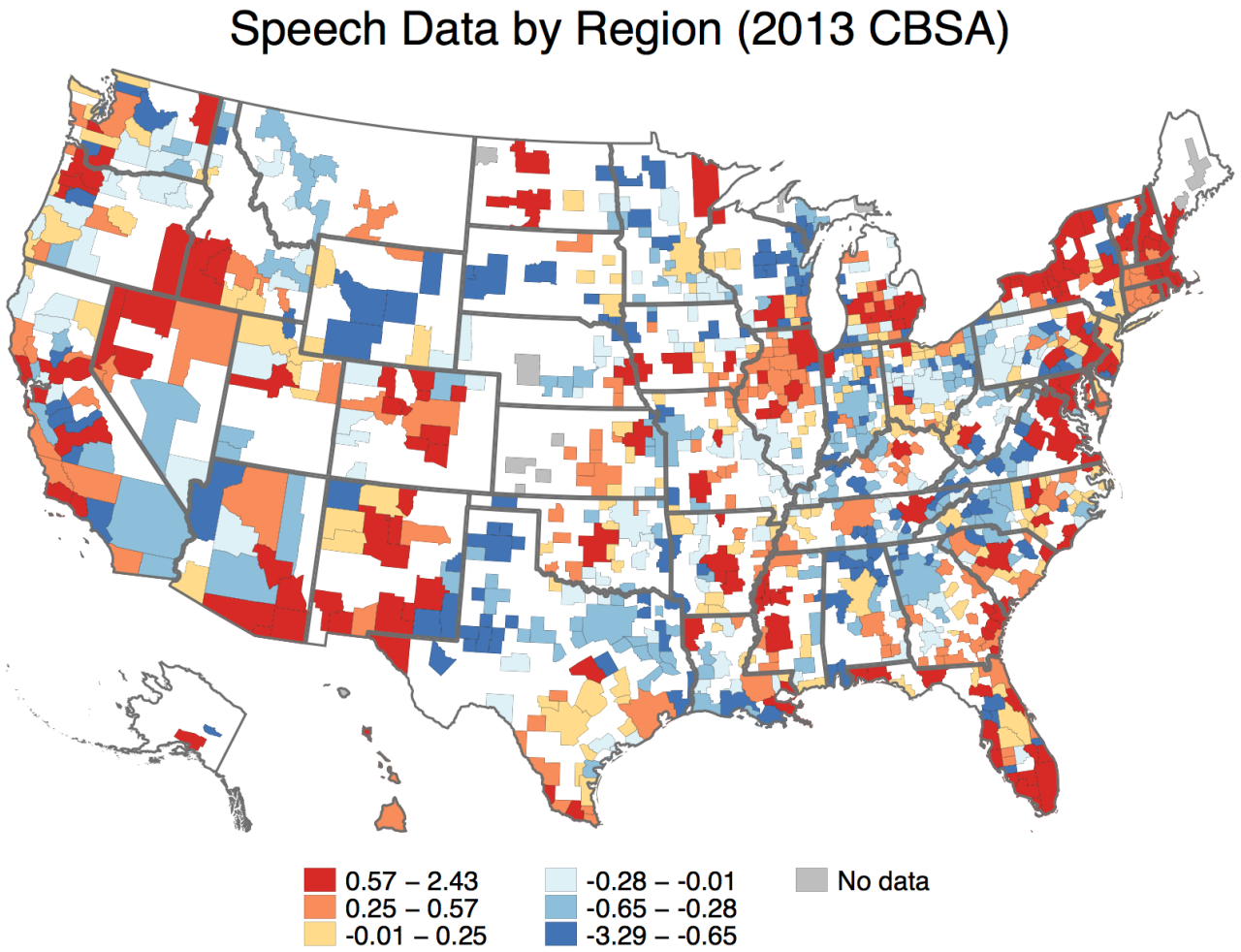


Use of Text Data



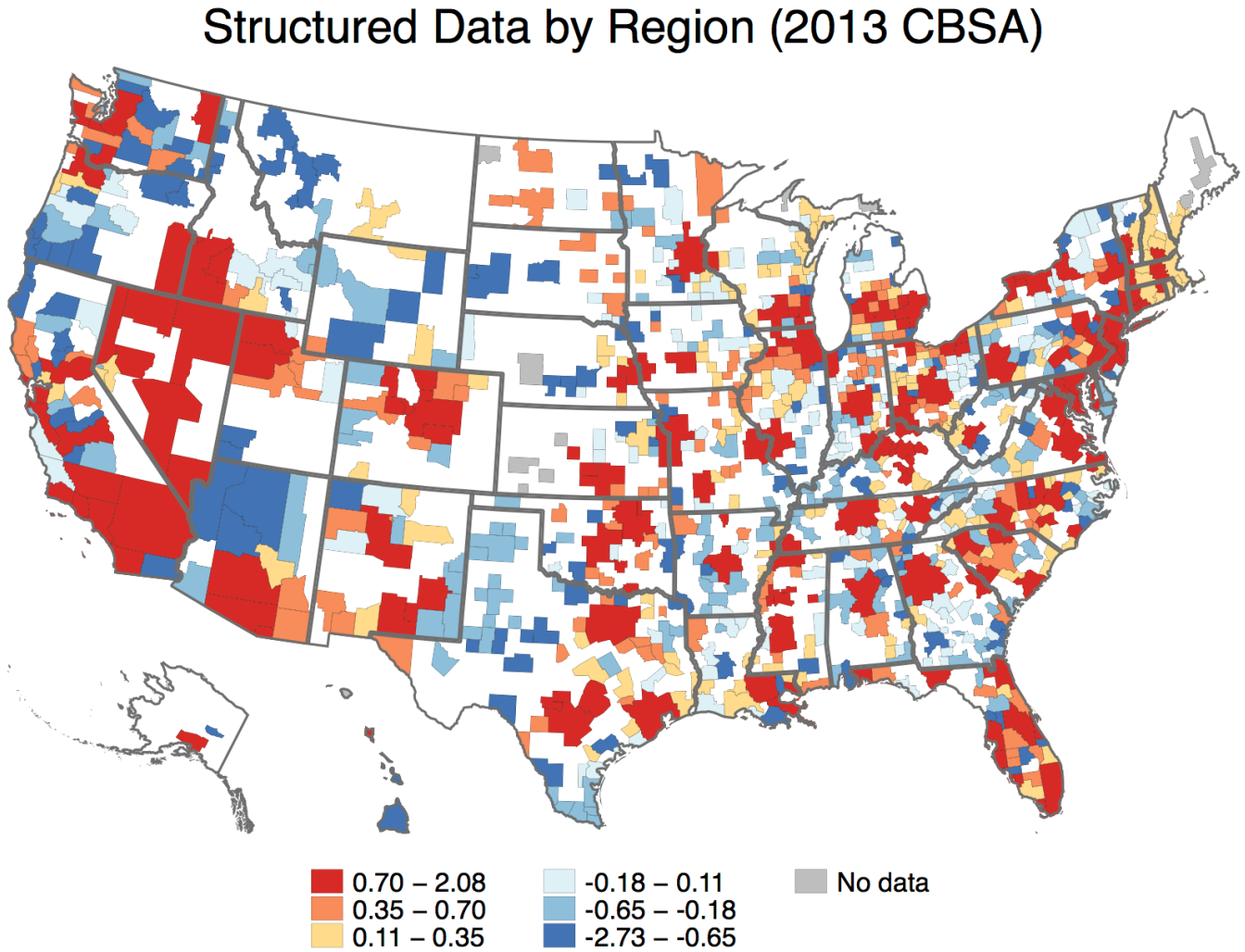
MIT INITIATIVE ON THE DIGITAL ECONOMY

Use of Speech Data



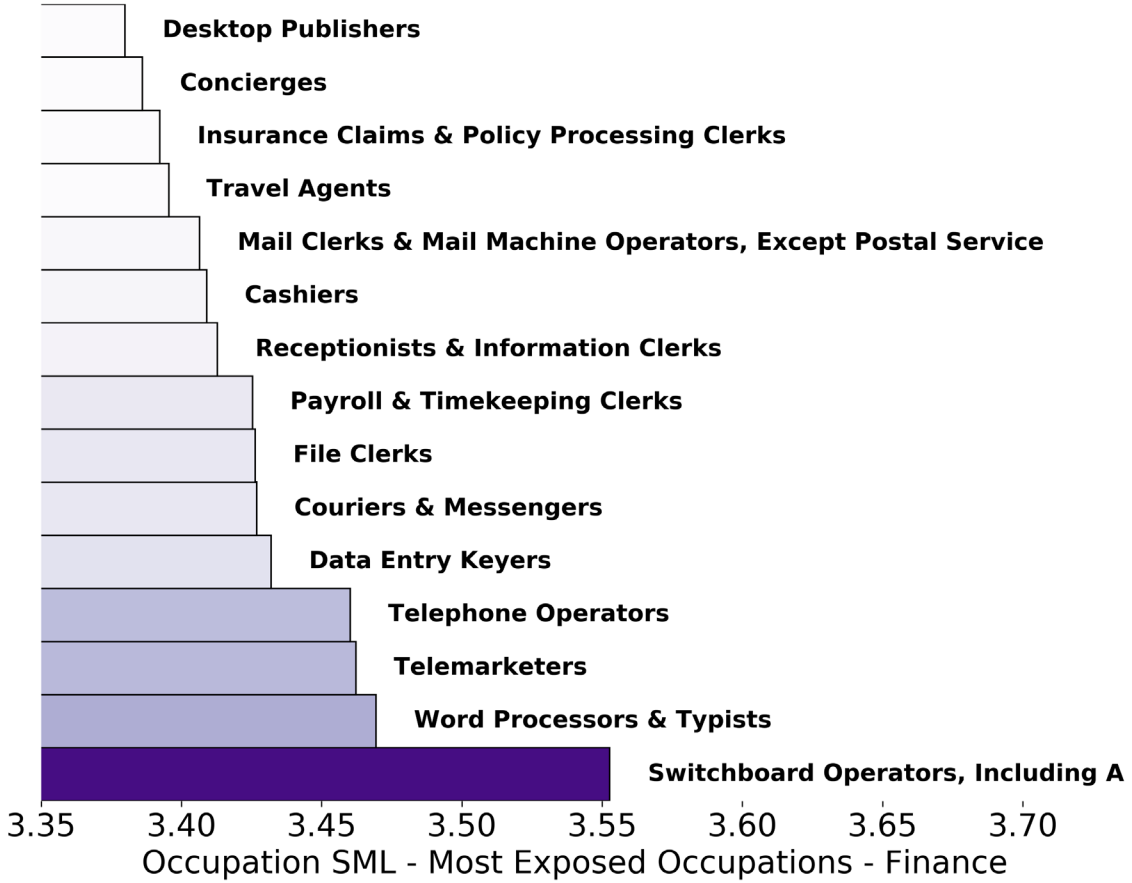
MIT INITIATIVE ON THE DIGITAL ECONOMY

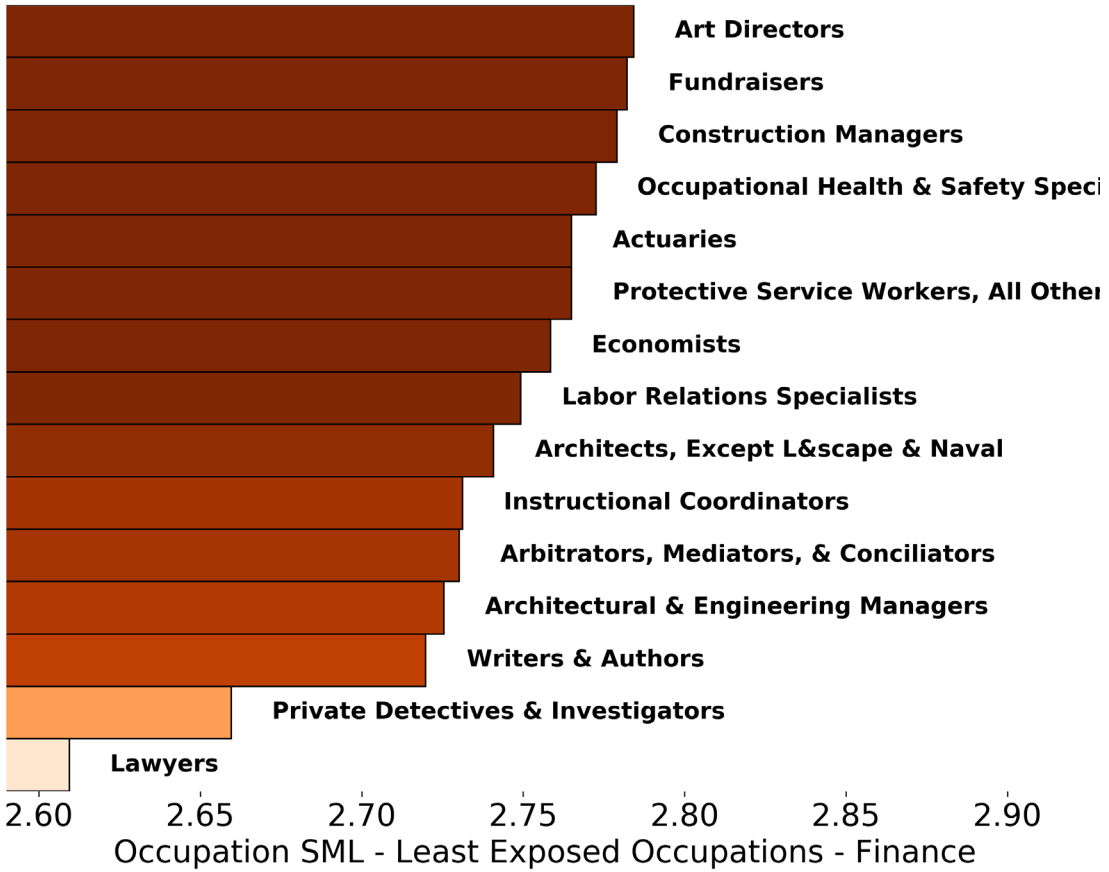
Use of other structured data



MIT INITIATIVE ON THE DIGITAL ECONOMY

Industry-level analysis yields insights about what to expect (Finance)

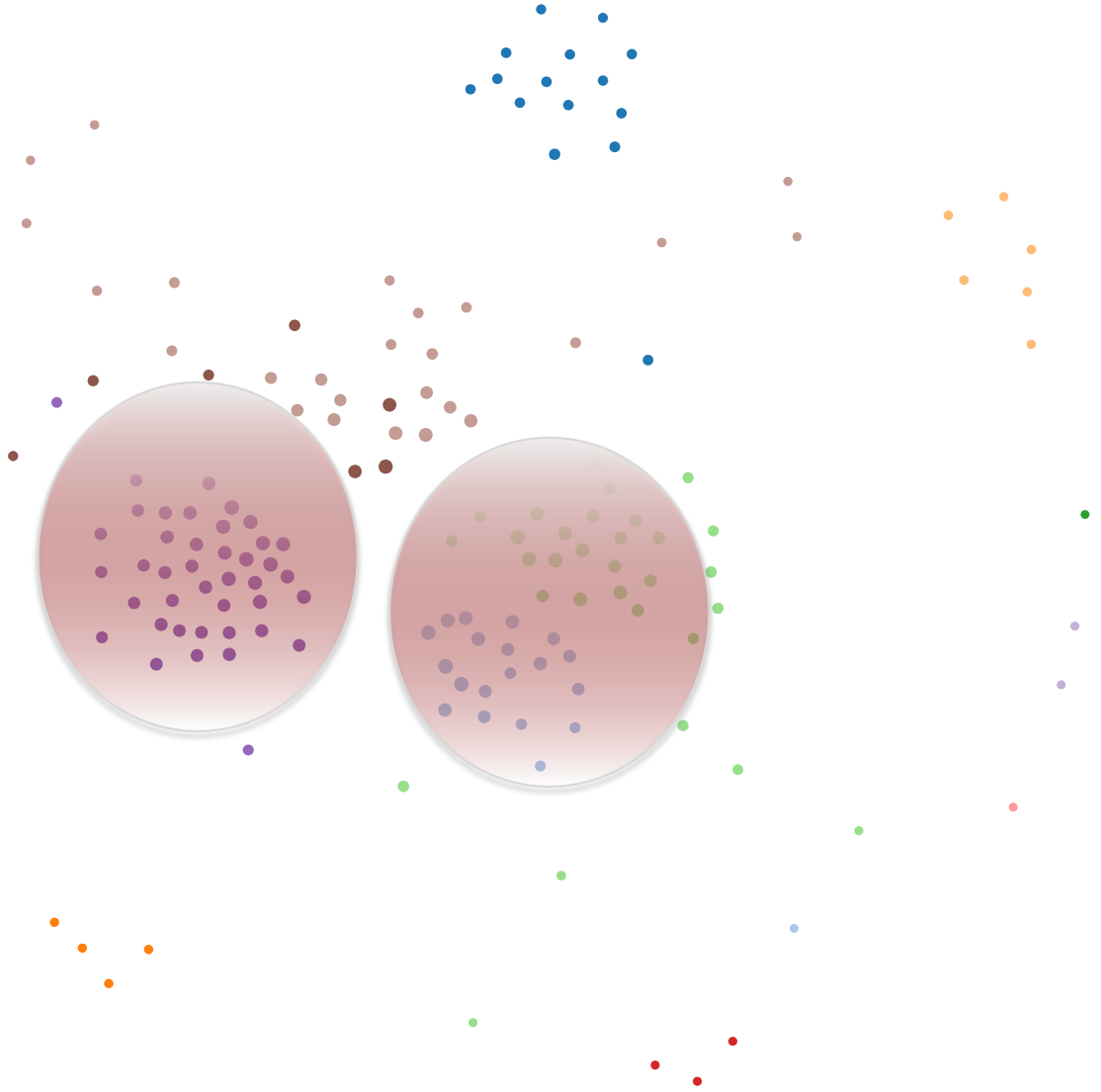




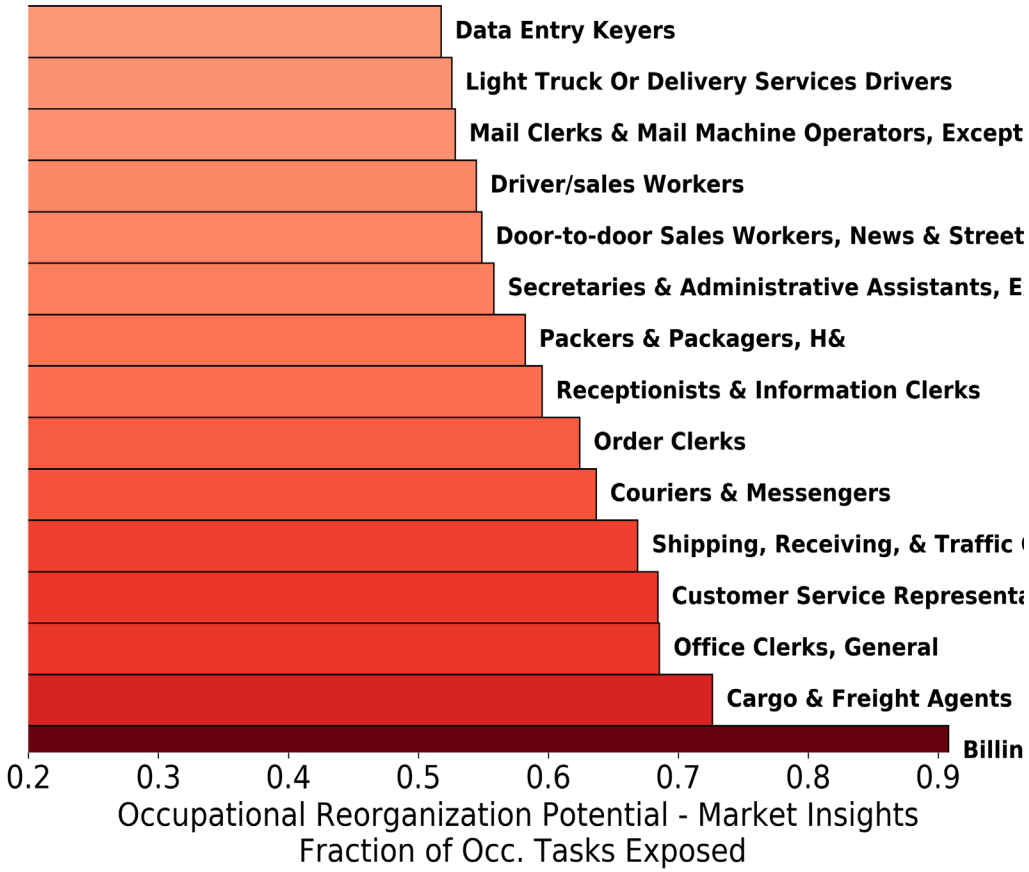
MIT INITIATIVE ON THE DIGITAL ECONOMY

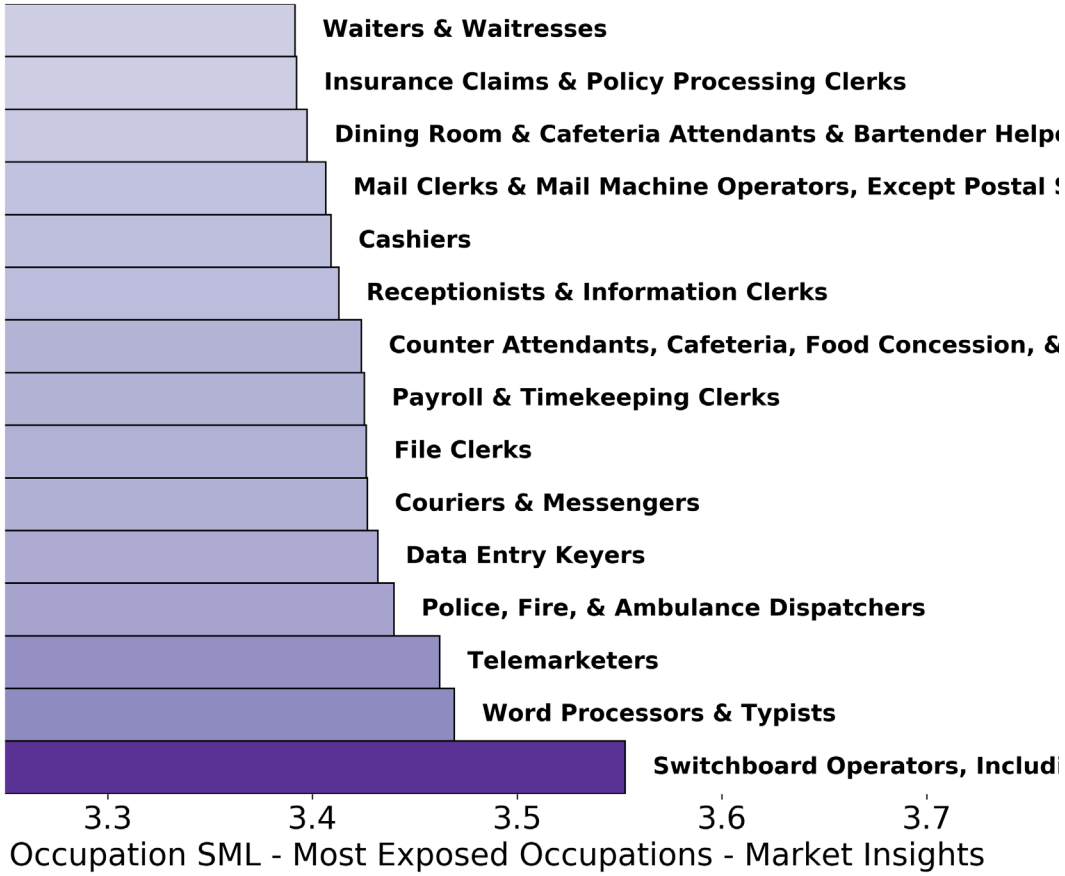
Industry-level analysis yields insights about what to expect (Finance)

Industry-level analysis yields insights about what to expect (Finance)



Industry-level analysis yields insights about what to expect (Market Insights)

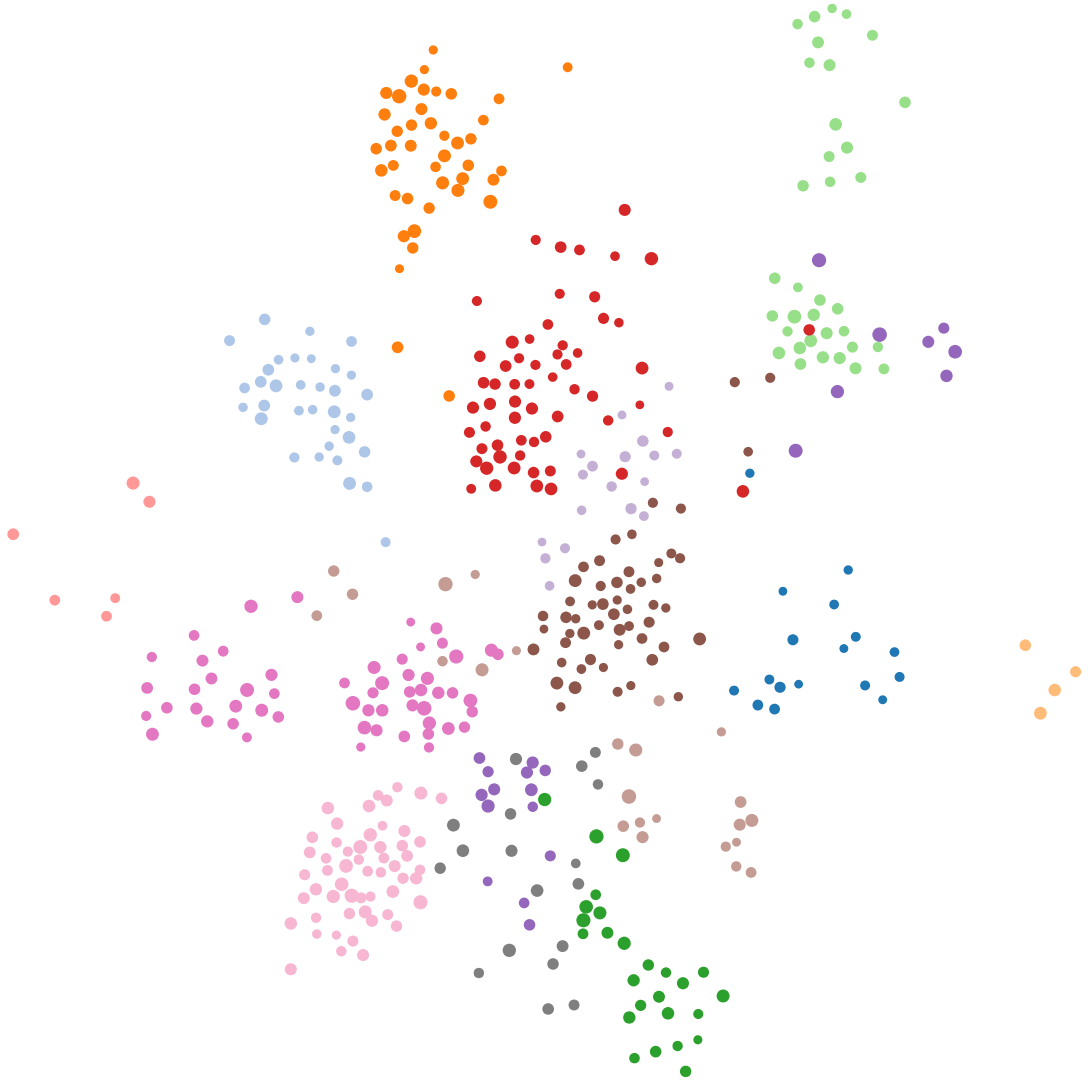




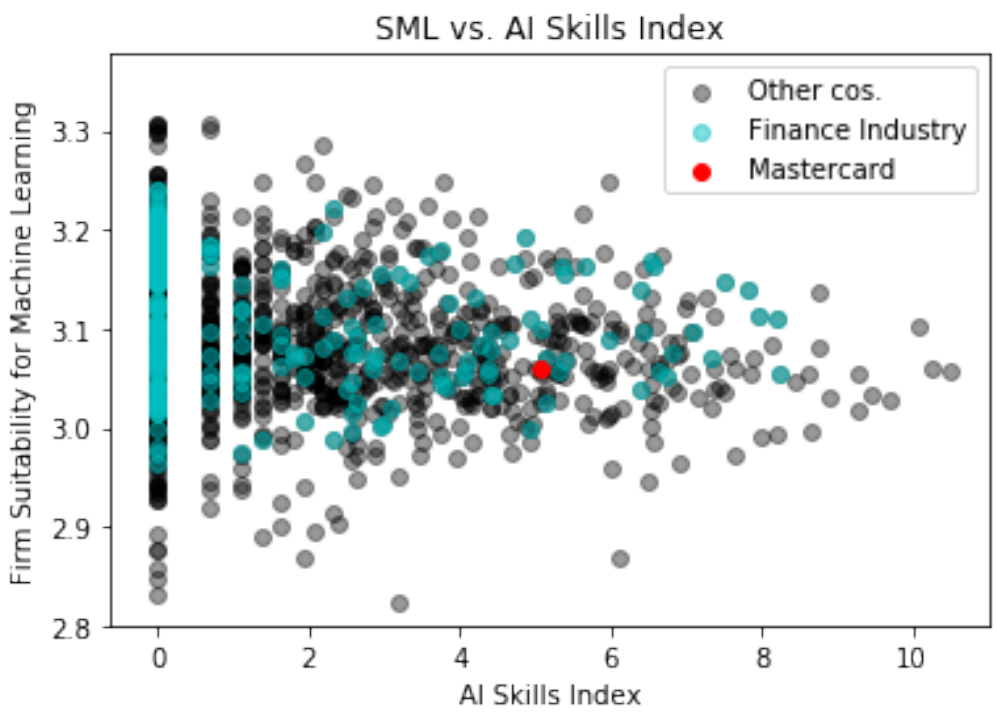
MIT INITIATIVE ON THE DIGITAL ECONOMY

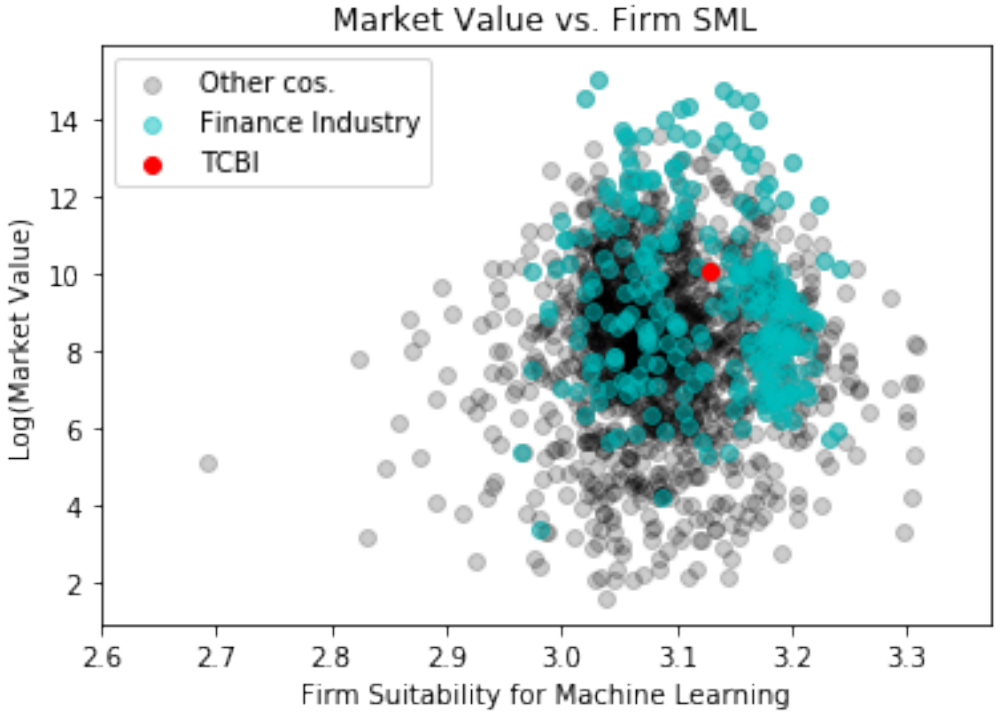
Industry-level analysis yields insights about what to expect (Market Insights)

Industry-level analysis yields insights about what to expect (Market Insights)

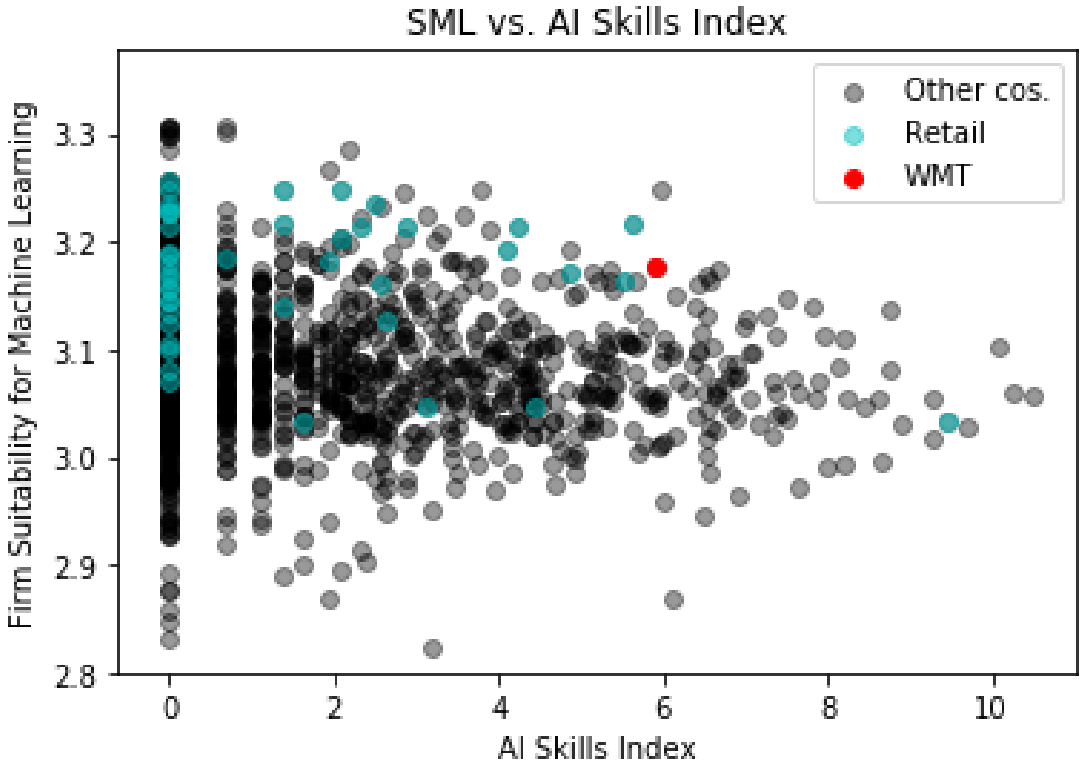


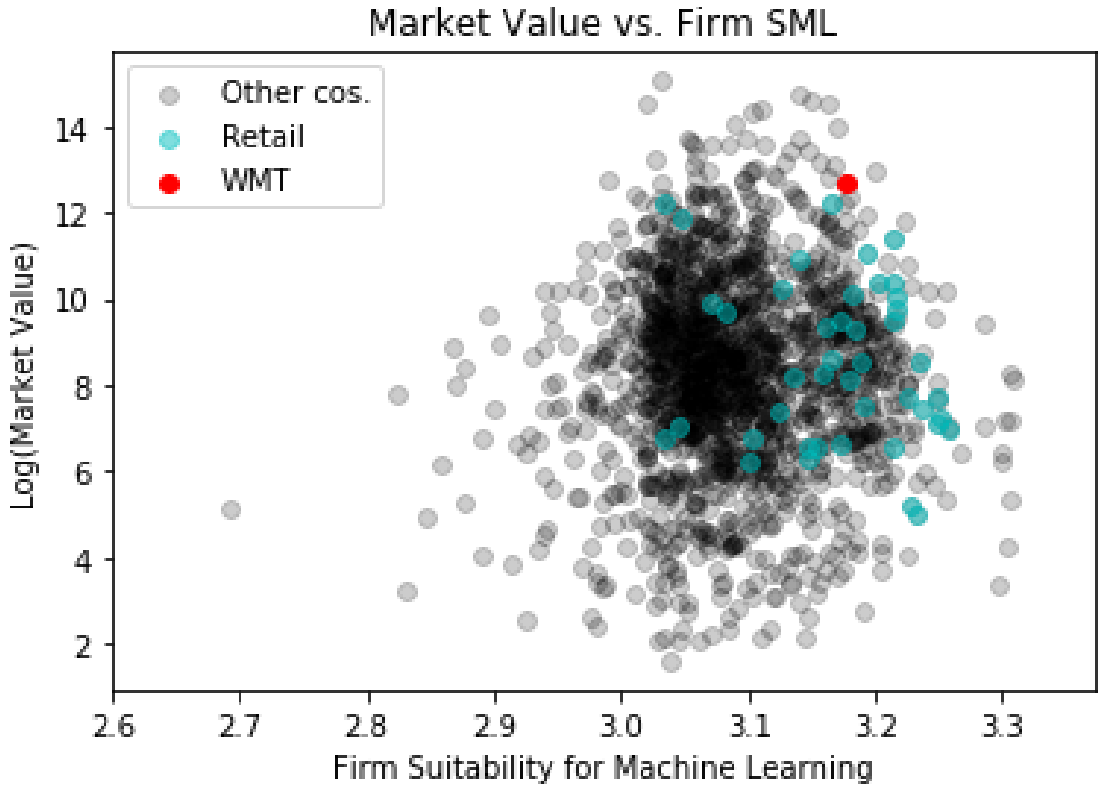
Are the firms using AI the ones with the highest ML Exposure? Is it the largest firms?



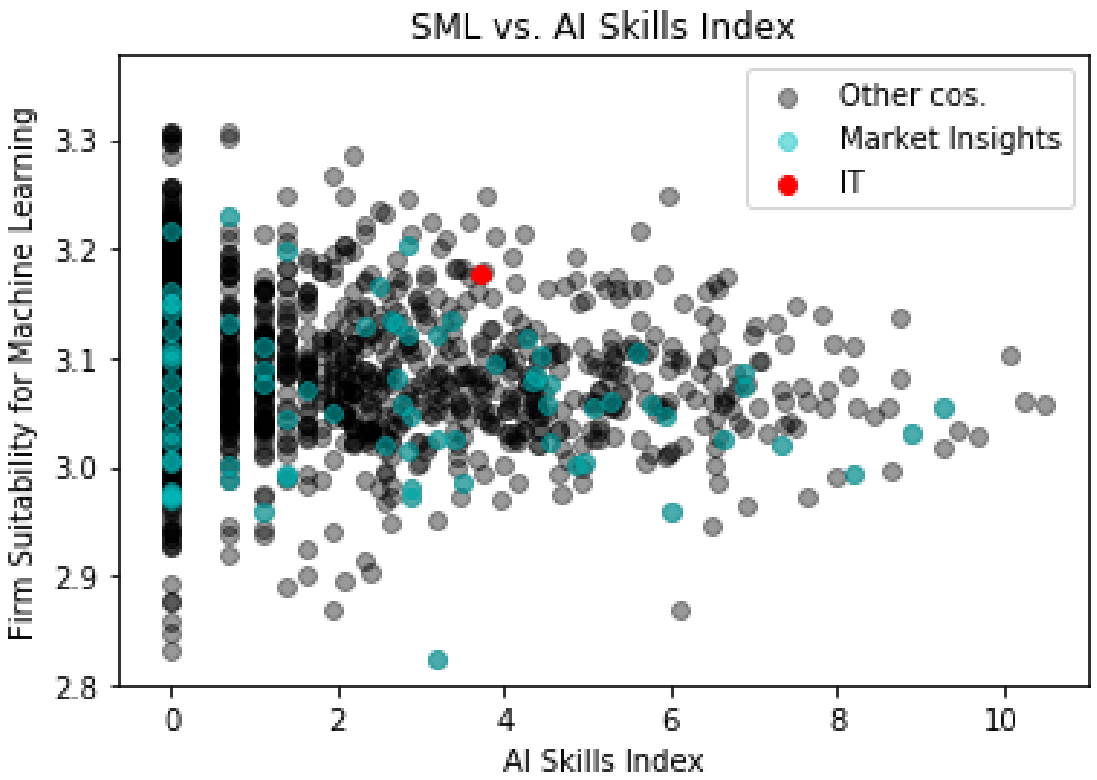


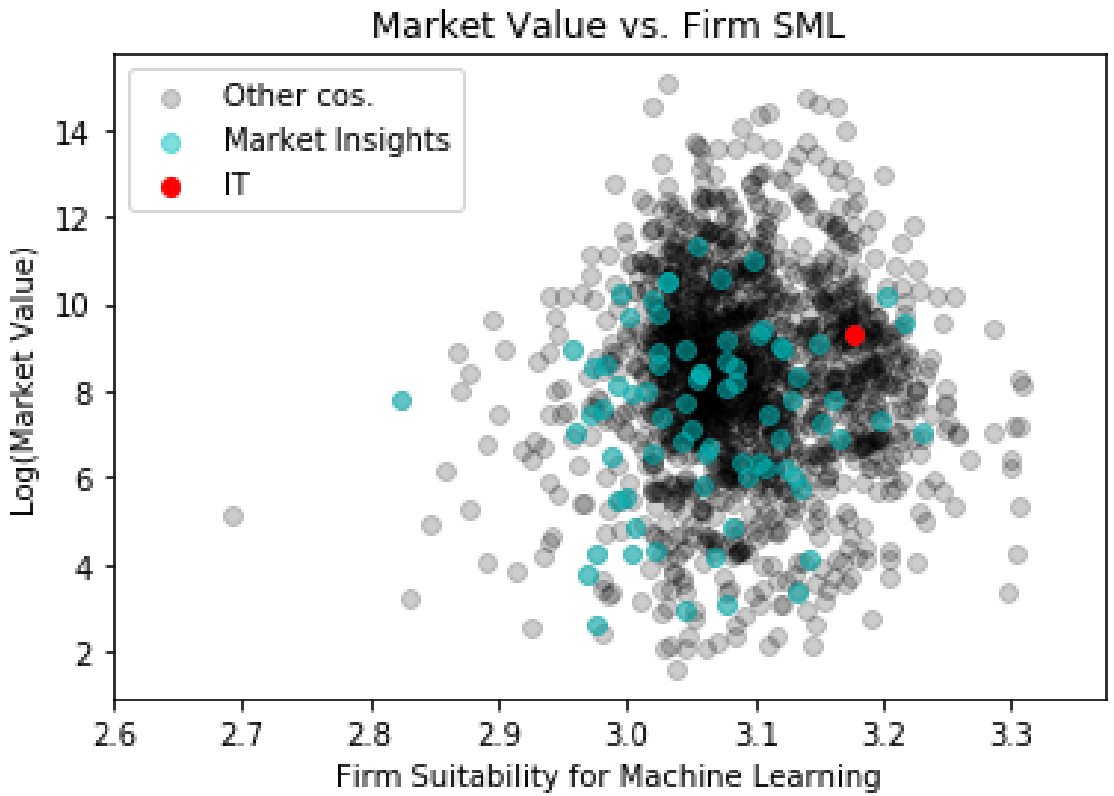
Are the firms using AI the ones with the highest ML Exposure? Is it the largest firms?





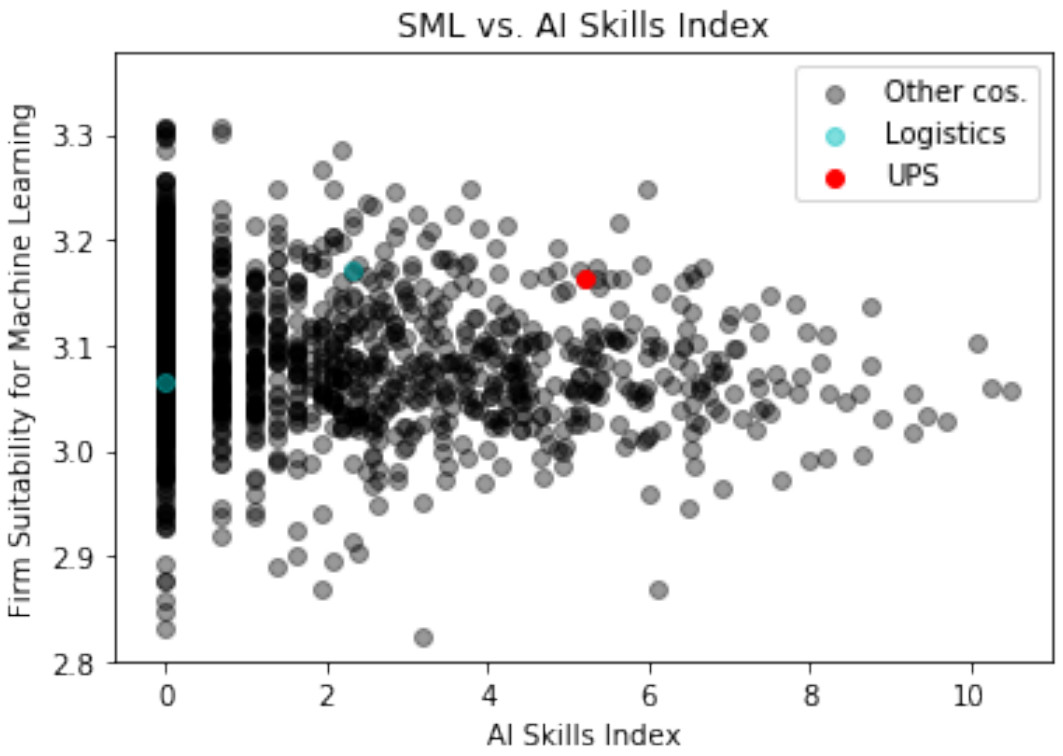
Are the firms using AI the ones with the highest ML Exposure? Is it the largest firms?

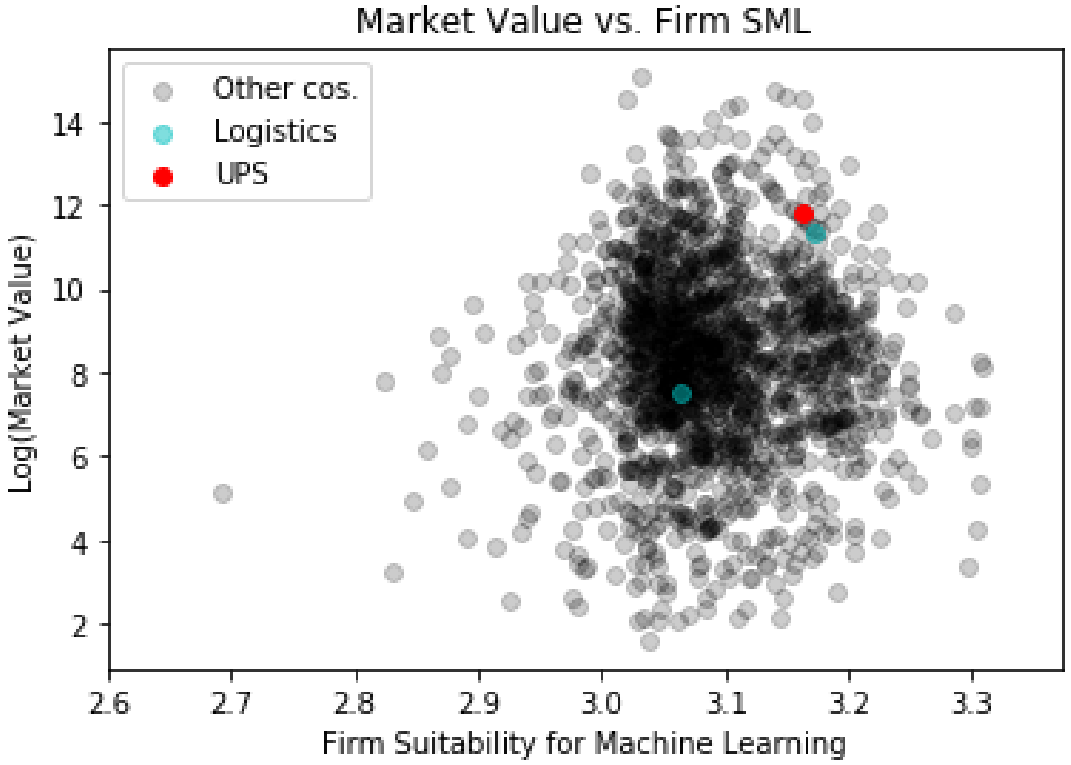




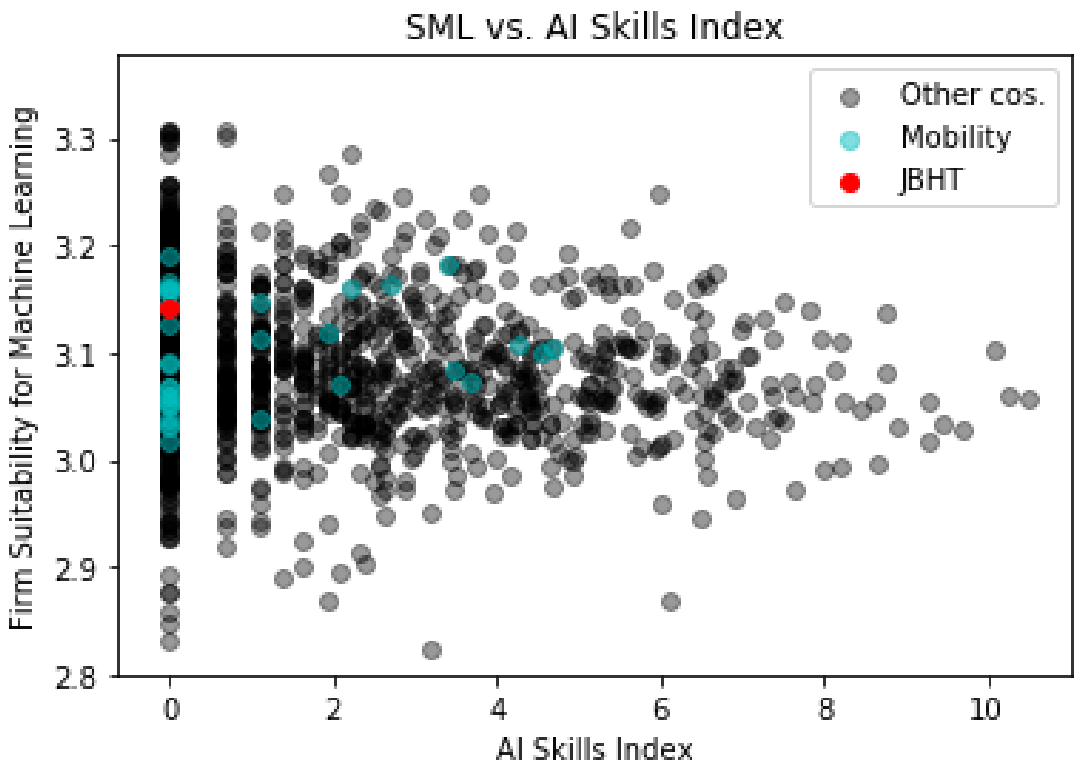
MIT INITIATIVE ON THE DIGITAL ECONOMY

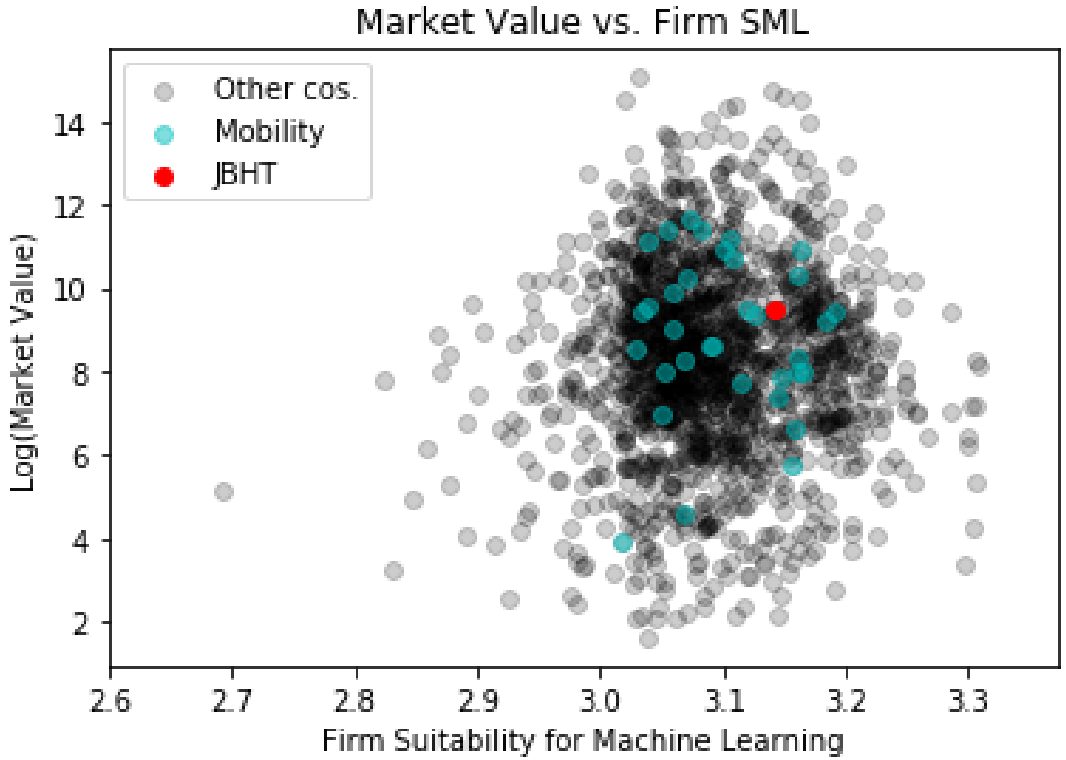
Are the firms using AI the ones with the highest ML Exposure? Is it the largest firms?





Are the firms using AI the ones with the highest ML Exposure? Is it the largest firms?





Three *New* Kinds of Jobs in the ML Economy

With reorganization, we will need people who can:

1. Measure performance for workers
   - Train machines, build complementary teams for humans and bots
2. Redesign how work is done
   - Bundle tasks together in new ways to let ML take over SML tasks
   - Design new tasks for humans
3. Innovate by learning to ask better questions
   - What are the new things we can build?
   - Are there new ways to apply ML to tasks?

Key Takeaways

1. ML is human or superhuman in some tasks, but not all tasks
2. Suitability for Machine Learning (SML) can be assessed via our rubric
3. ML is different from earlier types of automation (even digital)
    - We cannot simply extrapolate past trends
    - SML is cuts across all wages and skill-levels:
        - Few occupations will be fully automated
        - Few are immune
4. SML can be mapped by task clusters, job clusters, geography, firms and industry
5. Reorganization of jobs will be required to unleash ML
    - Productivity gains are “locked up” if workers can’t specialize
6. More measurable tasks may be most SML

MIT Initiative on the Digital Economy

Technology is racing ahead. Our organizations are not keeping pace.

The IDE is partnership addressing the grand challenges of the digital economy via four research themes

PRODUCTIVITY, EMPLOYMENT + INEQUALITY

BIG DATA + HUMAN-AI

NEW DIGITAL BUSINESS MODELS

SOCIAL ANALYTICS + DIGITAL EXPERIMENTATION

THE MIT IDE ENGAGES IN FIVE PRIMARY ACTIVITIES: RESEARCH, CONVENINGS, EDUCATION, VISITING FELLOWS, AND THE INCLUSIVE INNOVATION COMPETITION.

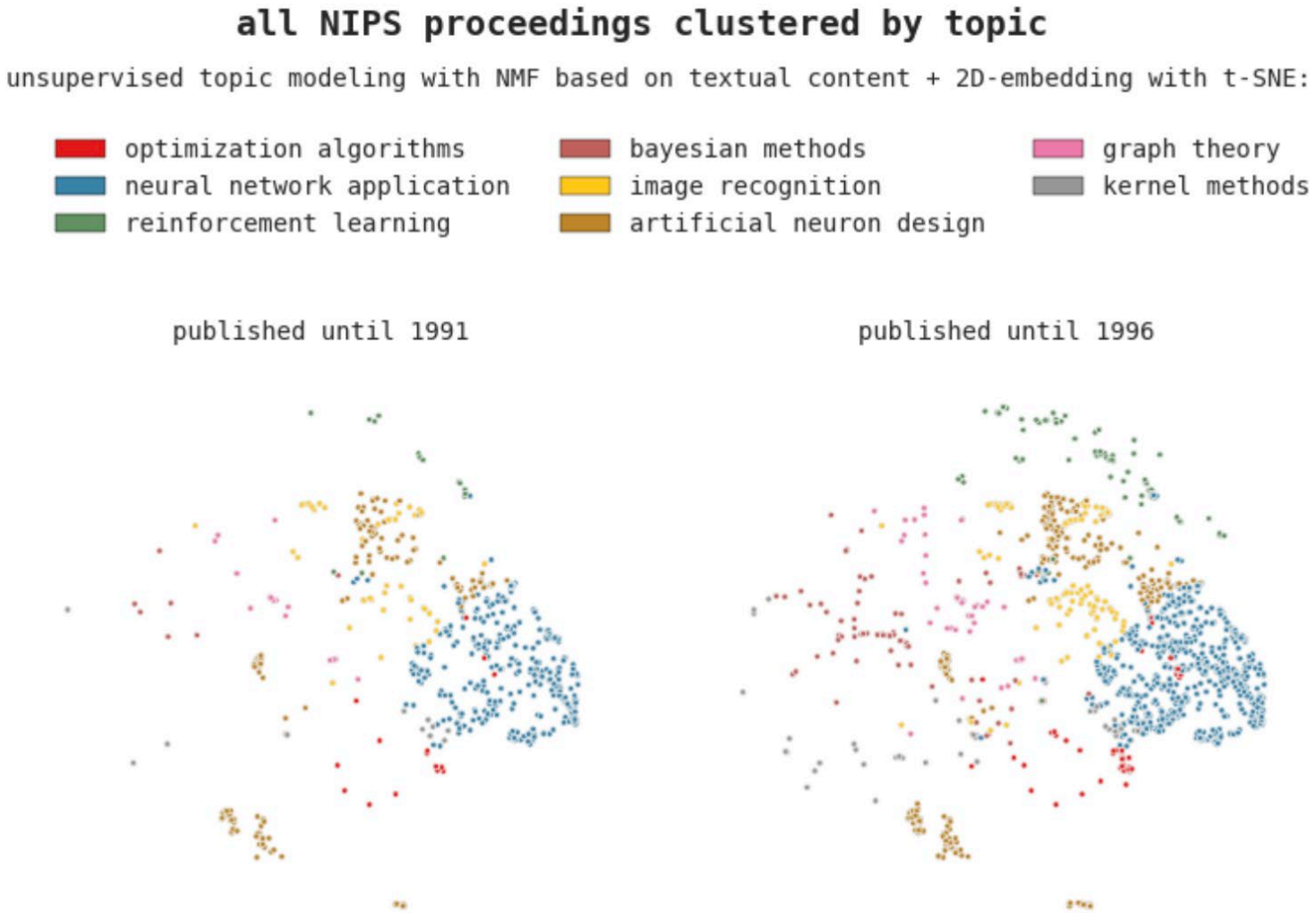
IDE Seeks Corporate Research Partners for RCTs

- **To understand the causal effects of machine learning, we need to conduct Randomized Controlled Trials (RCTs)**
- **Requirements**
  - Staged implementation of AI or ML
  - Dozen or hundreds of locations (randomized for fidelity of treatment/control)
  - 12-24 month timeframe
  - Sectors such as retail or manufacturing with good metrics are often good candidates

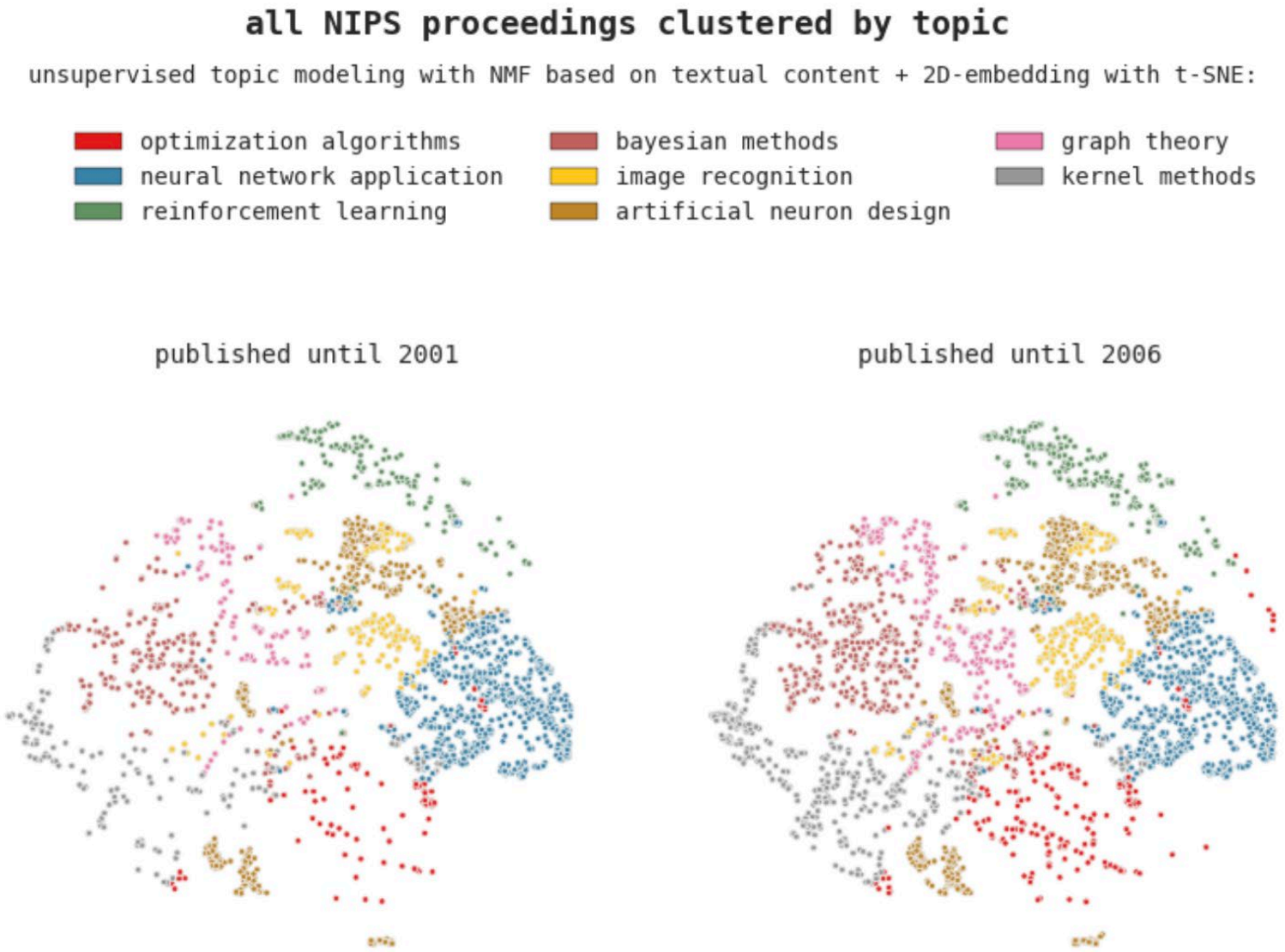
Thanks!

- **Contact: @danielrock / drock@mit.edu**

Where was the growth of ML research progress?

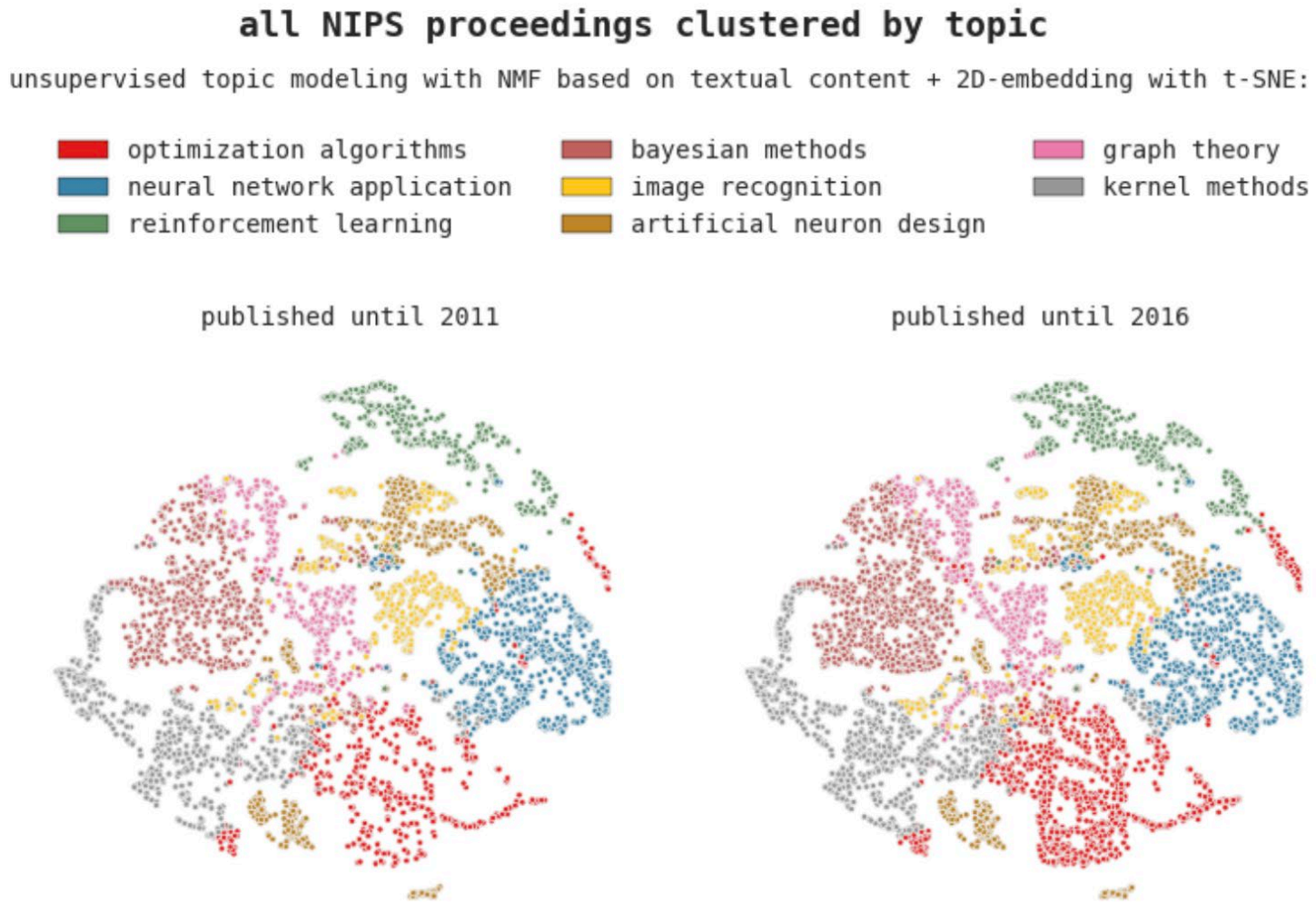


Where was the growth of ML research progress?



MIT INITIATIVE ON THE DIGITAL ECONOMY

Where was the growth of ML research progress?



CEO Dinner:
Millennial/Generation Z attitudes on deploying AI/ML in the workplace

Chris Caine, *President, CGE*
John Zogby, *CEO, Zogby Strategies*

Breakfast Discussion:
Global Financial & Productivity Trends

Kevin Warsh, *Distinguished Fellow Stanford University & CGE Board Member*

Technology-Driven Disruption and Opportunity

Erik Brynjolfsson, *Director, MIT Initiative on the Digital Economy*
Michael Spence, *Nobel Laureate & CGE Board Member*

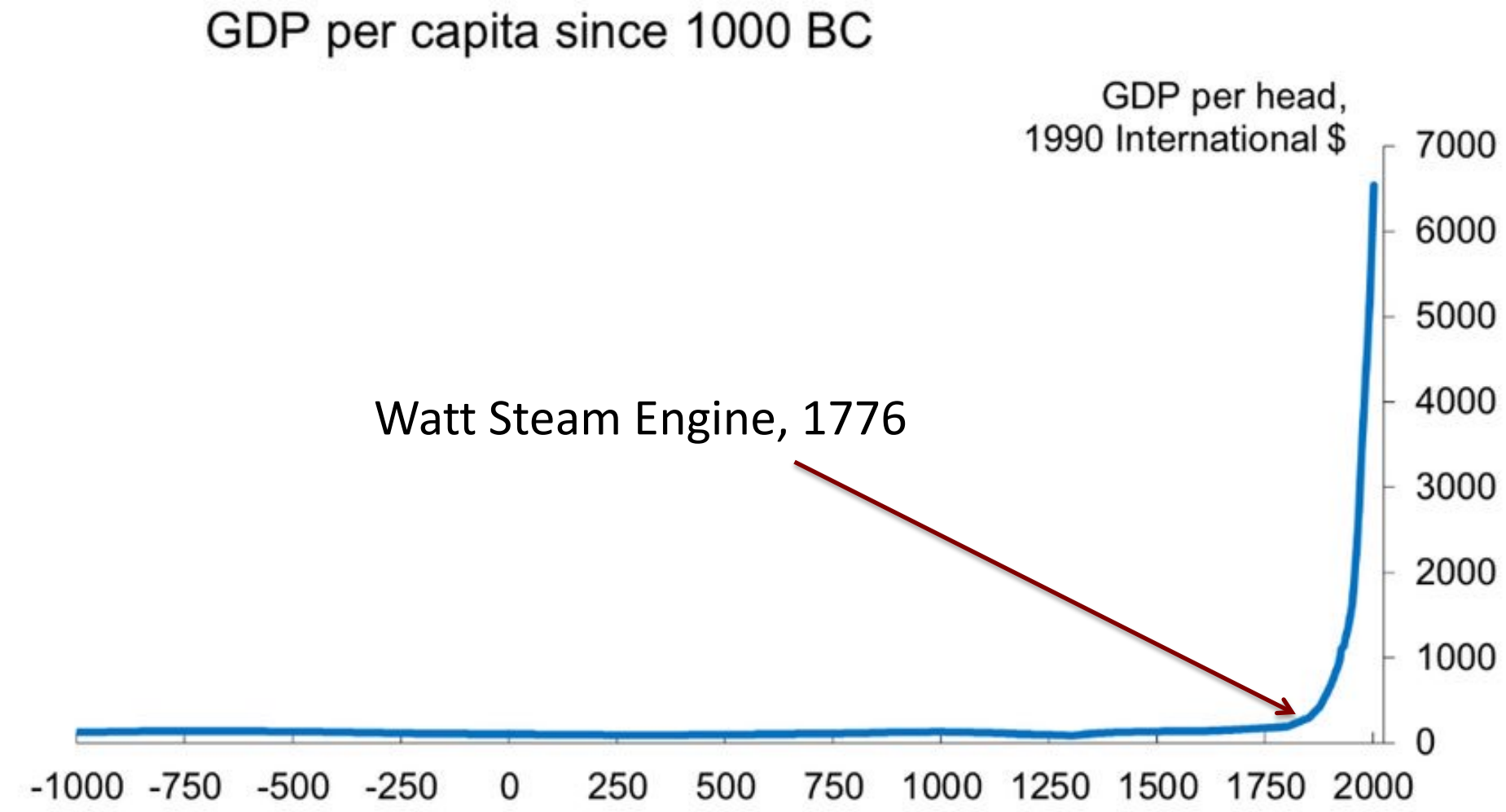
The AI Awakening

Implications for the Economy

Erik Brynjolfsson
MIT Initiative on the Digital Economy

The Center for Global Enterprise
November 6, 2019

The Industrial Revolution Bent the Curve of History



Source: DeLong (1998).

AI is a GPT

GPTs Drive Economic Growth

1. Pervasive
   - Key capabilities of classification, labeling, perception, prediction and diagnosis are core to broad range of tasks, occupations and industries *(Brynjolfsson, Rock and Syverson, 2017)*
2. Able to be improved on over time
   - Essence of machine learning is improving over time (Brynjolfsson & Mitchell, 2017)
   - Overcoming “Polanyi’s Paradox”
3. Able to spawn complementary innovations
   - Perception (esp. vision, voice recognition) and cognition (problem solving) are building blocks that drive combinatorial innovation

MIT INITIATIVE ON THE DIGITAL ECONOMY

The most G of all GPTs

“Our goal is to solve intelligence, and then use that to solve the other problems in the world”

- Demis Hassabis, Google DeepMind

MIT INITIATIVE ON THE DIGITAL ECONOMY

The Second Wave of the Second Machine Age: *Machines That Learn*

Artificial Intelligence

- A set techniques used to try to imitate human intelligence

Machine Learning

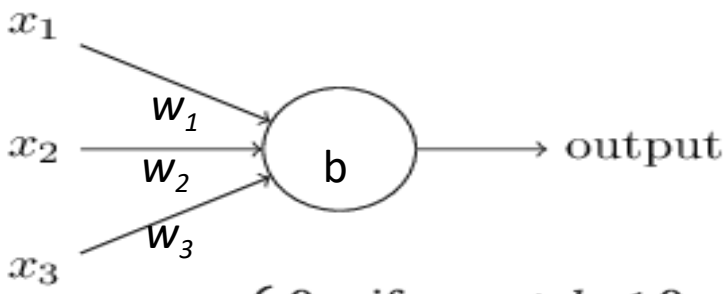
- Using large amounts of data, machines learn without being explicitly programmed

Deep Learning

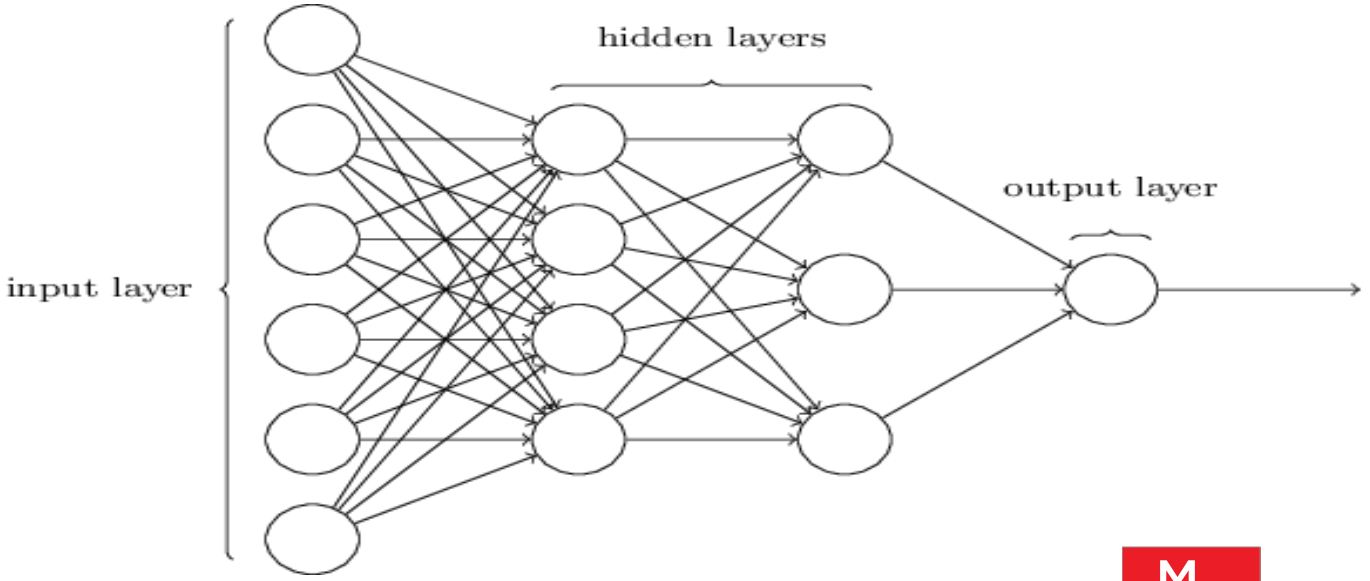
- A type of machine learning that uses deep neural networks

MIT INITIATIVE ON THE DIGITAL ECONOMY

The Power of Deep Neural Networks

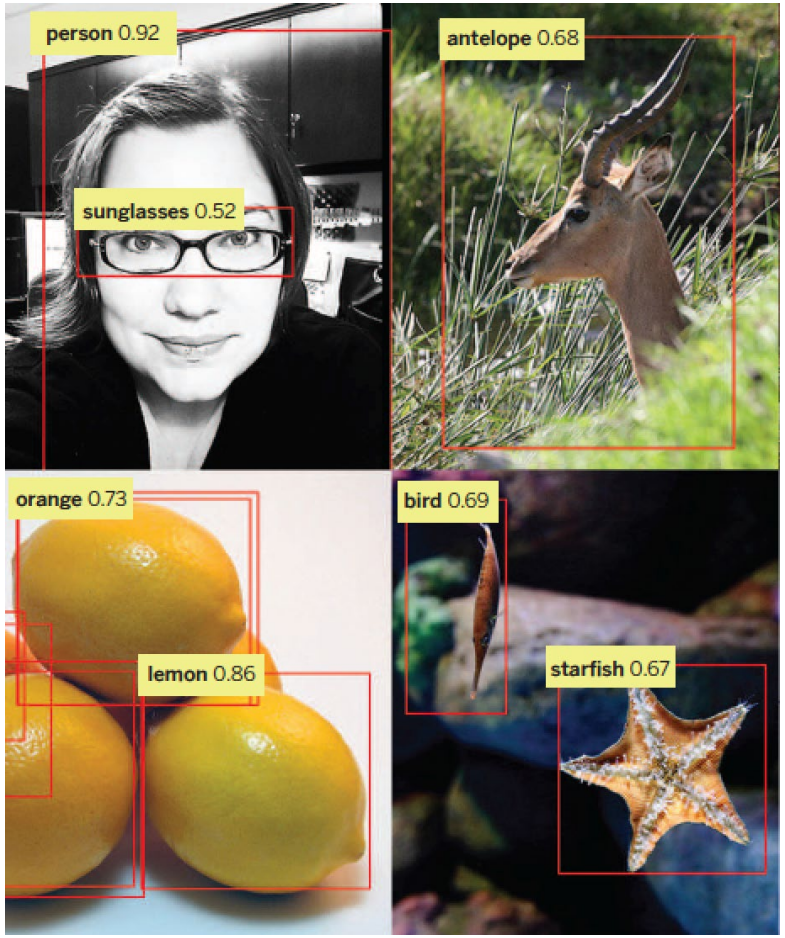


$$\text{output} = \begin{cases} 0 & \text{if } w \cdot x + b \leq 0 \\ 1 & \text{if } w \cdot x + b > 0 \end{cases}$$



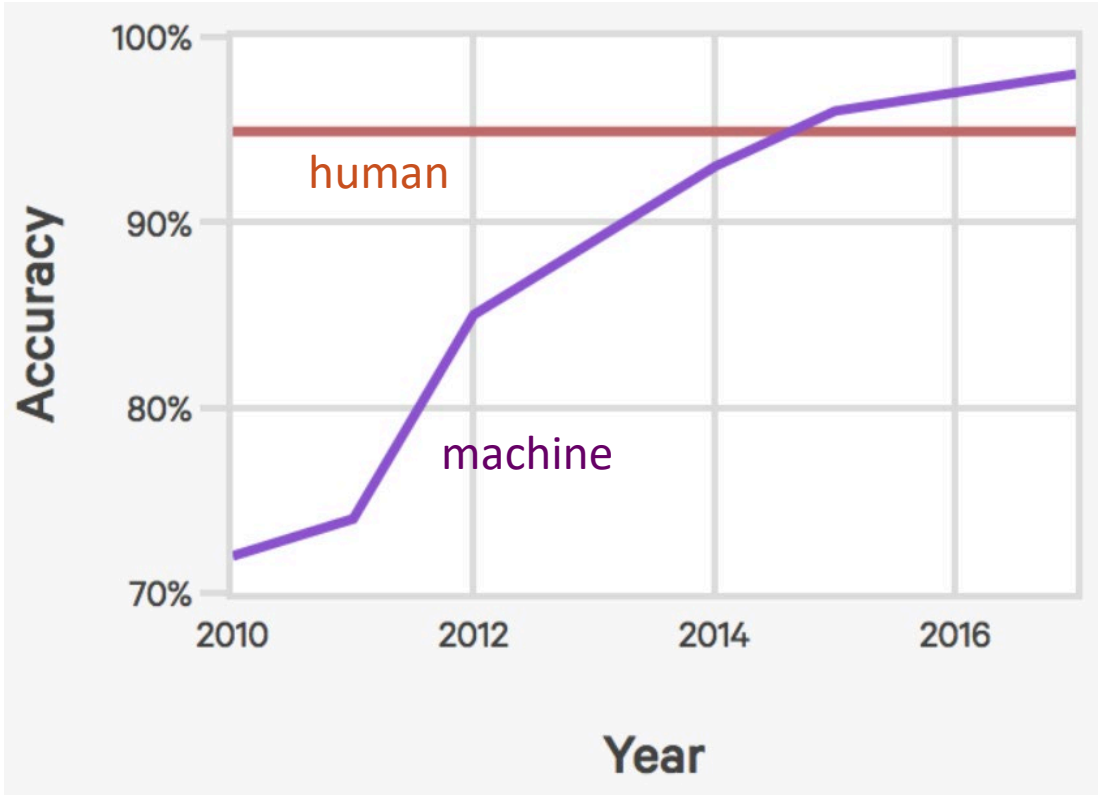
MIT INITIATIVE ON THE DIGITAL ECONOMY

We've Crossed an Important Threshold



ImageNet Visual Recognition Challenge

Accuracy of AI system



source: The AI Index

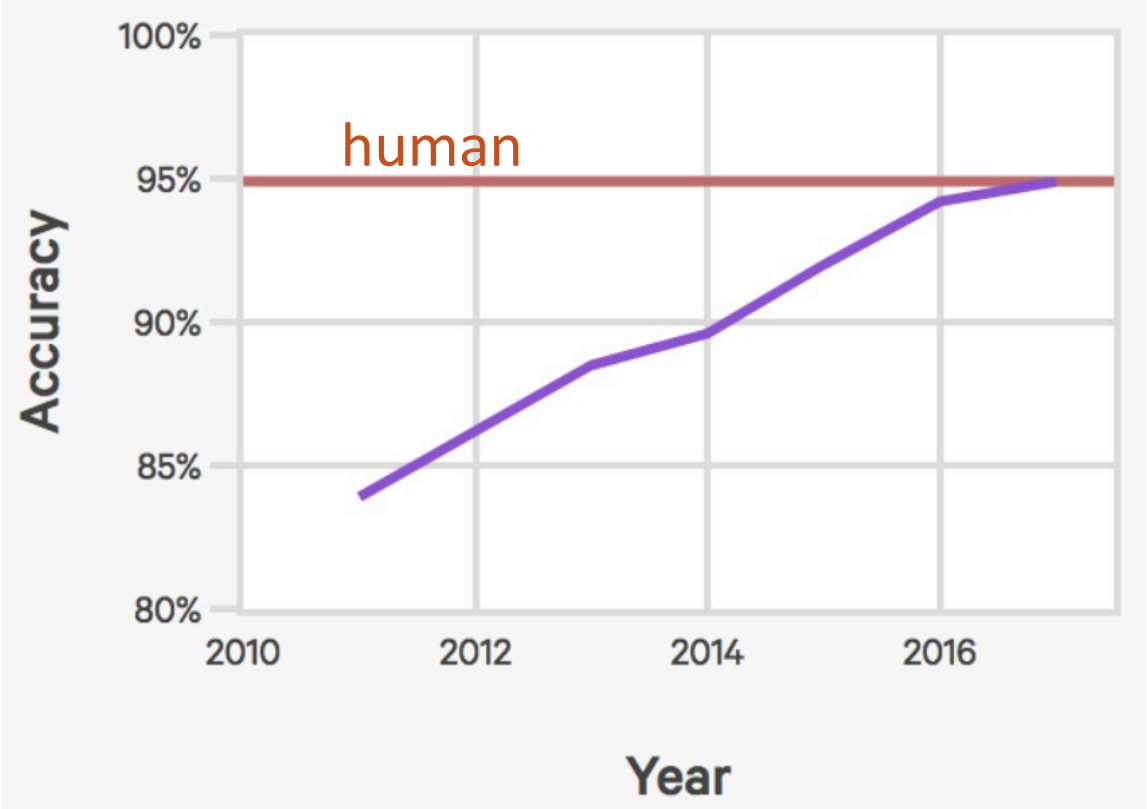
MIT INITIATIVE ON THE DIGITAL ECONOMY

Speech Recognition

Recognize speech from phone call audio

Switchboard HUB5'00 dataset

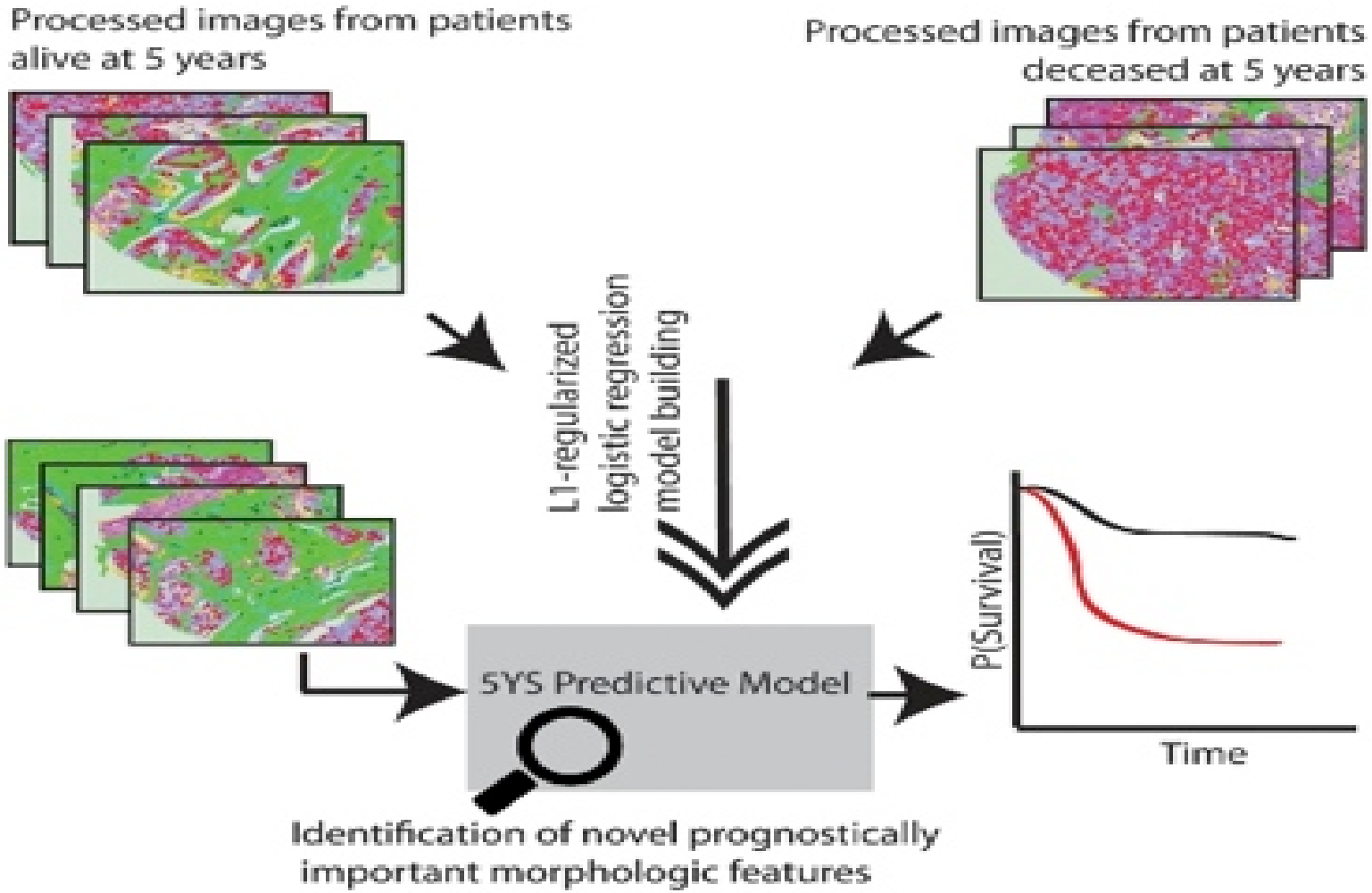
Accuracy of ML system



source: http://aiindex.org/

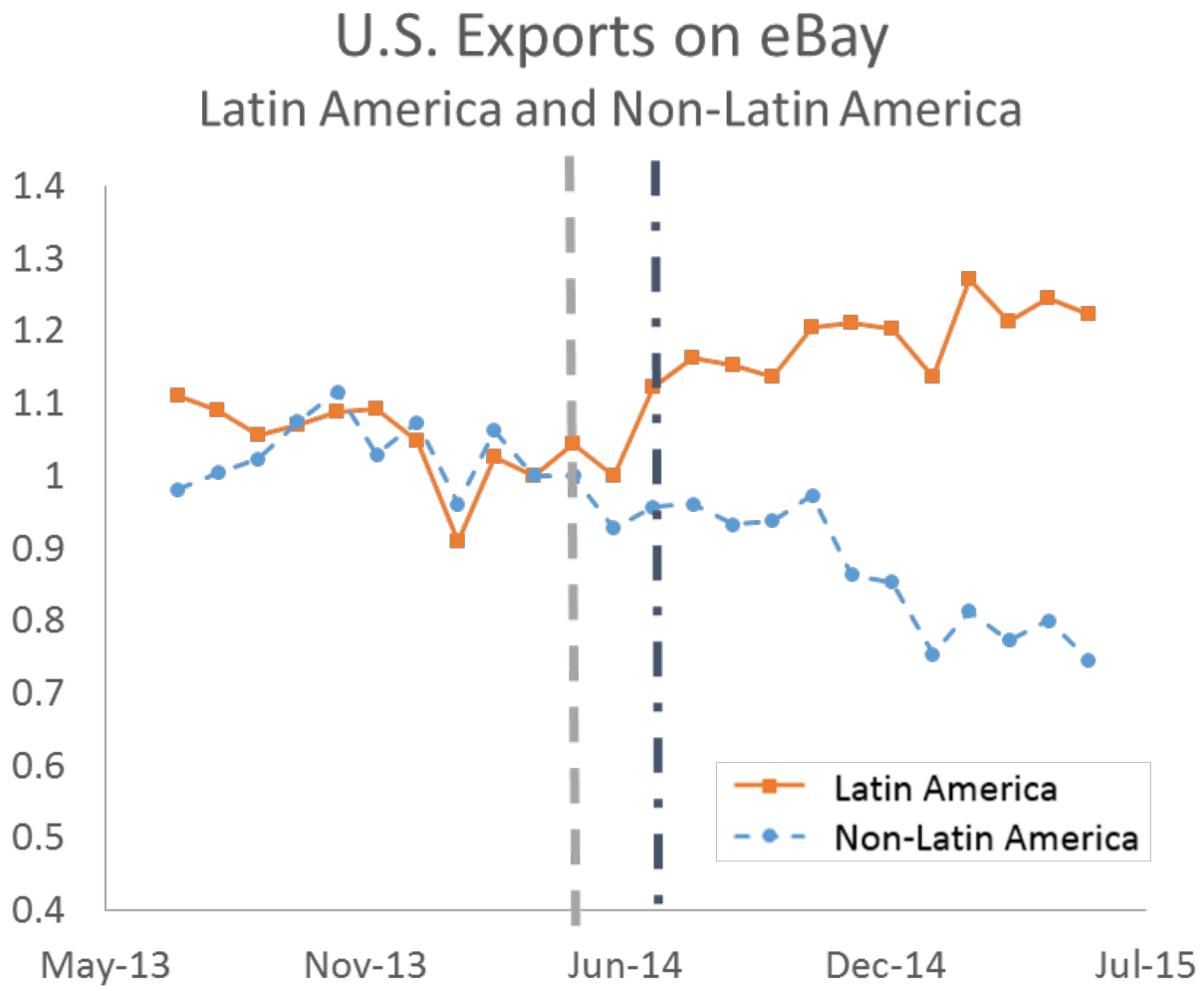
MIT INITIATIVE ON THE DIGITAL ECONOMY

Supervised Learning for Image Recognition



MIT INITIATIVE ON THE DIGITAL ECONOMY

Machine Translation Boosts Trade on eBay by 11%



)

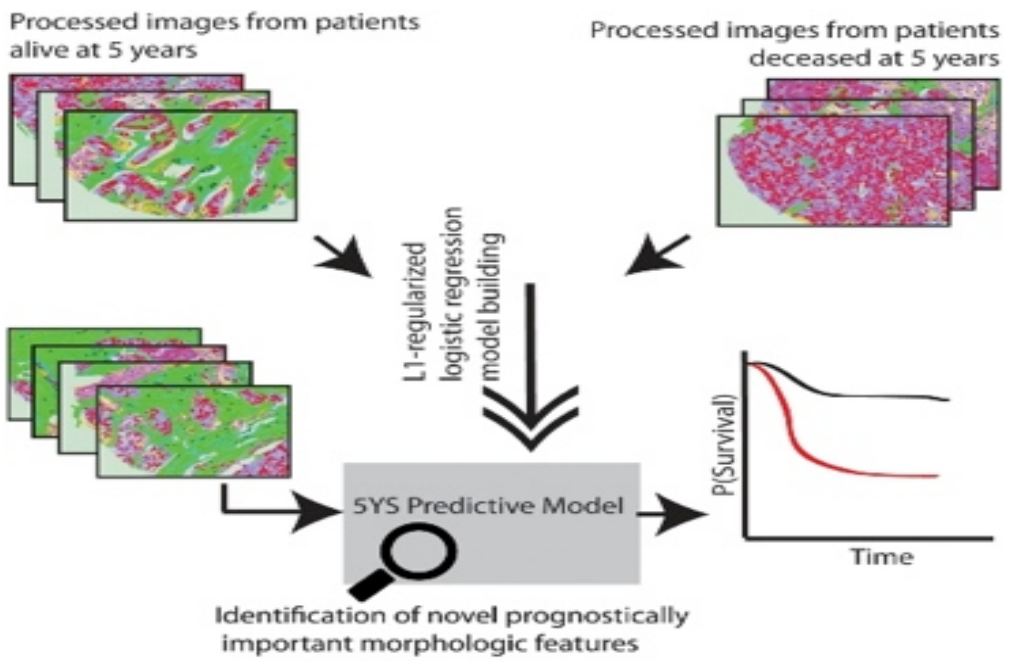
- **Orange: U.S. exports to LatAm**
- **Blue: U.S. exports to non- LatAm**
- **Vertical lines: Introduction of eBay translation**
- **Estimated effect: 11.9%**

Source: Brynjolfsson, Hui and Liu, "Can Machine Learning Affect International Trade?" Management Science, 2019

MIT INITIATIVE ON THE DIGITAL ECONOMY

Problem Solving

Most of the recent progress in machine learning involves mapping from a set of inputs to a set of outputs



INPUT X	OUTPUT Y	APPLICATION
Voice recording	Transcript	Speech recognition
Historical market data	Future market data	Trading bots
Photograph	Caption	Image tagging
Drug chemical properties	Treatment efficacy	Pharma R&D
Store transaction details	Is the transaction fraudulent?	Fraud detection
Recipe ingredients	Customer reviews	Food recommendations
Purchase histories	Future purchase behavior	Customer retention
Car locations and speed	Traffic flow	Traffic lights
Faces	Names	Face recognition

Source: Brynjolfsson, Erik, and Andrew McAfee. "The Business of Artificial Intelligence." *Harvard Business Review* (2017).

Which Tasks Will Be Done by Machine Learning?

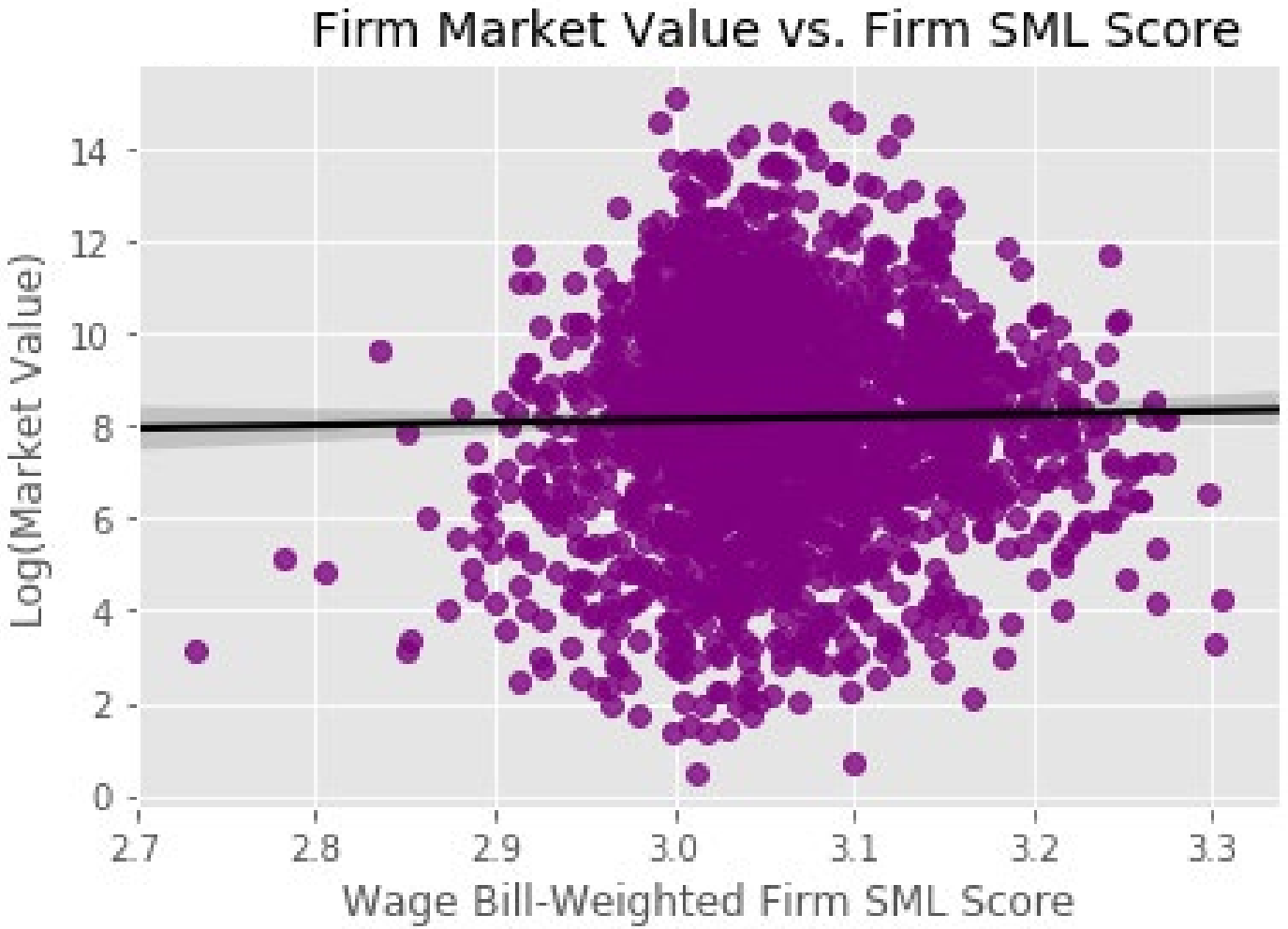
We create a "Suitability for Machine Learning" (SML) rubric of 21 questions

- We apply it to 2,059 Detailed Work Activities in O*NET, 18,112 occupation-specific tasks, and 950 occupations (weighted by task importance)
- Questions are rated on five point scale from "strongly disagree" to "strongly agree"
- Each DWA is scored by 10 different people

Brynjolfsson, Mitchell and Rock, "What Can Machines Learn and What Does It Means for Occupations and the Economy, *AEA P&P*, 2018.

MIT INITIATIVE ON THE DIGITAL ECONOMY

Some firms are more vulnerable

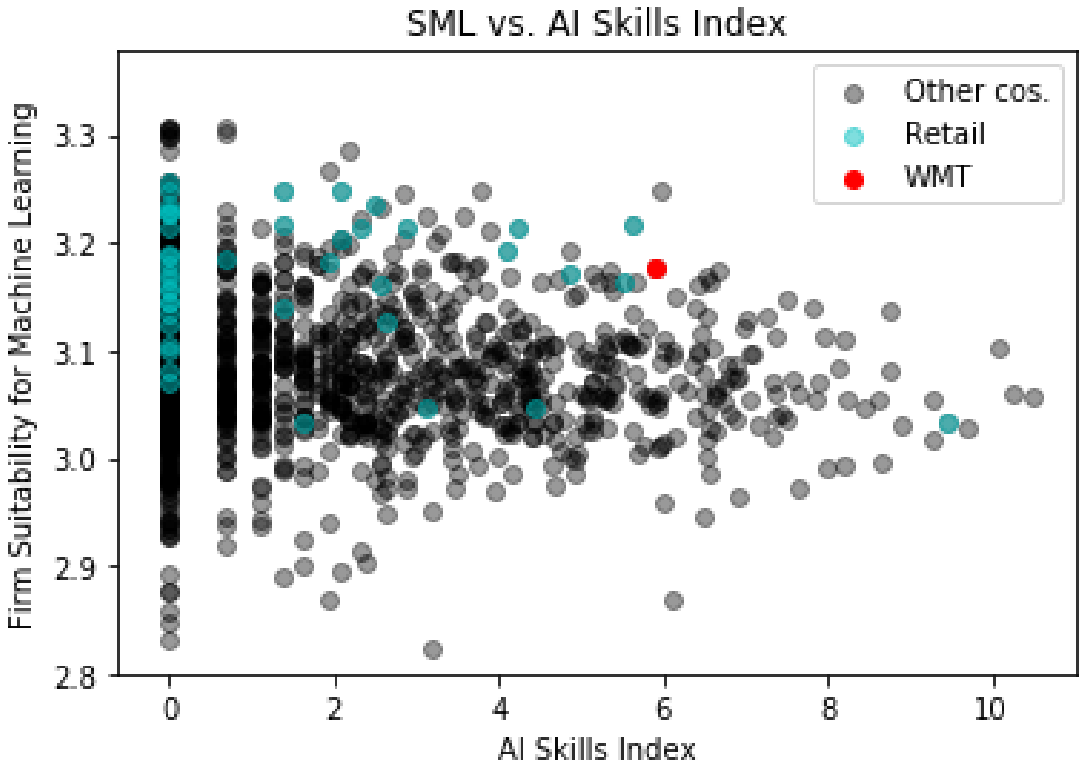


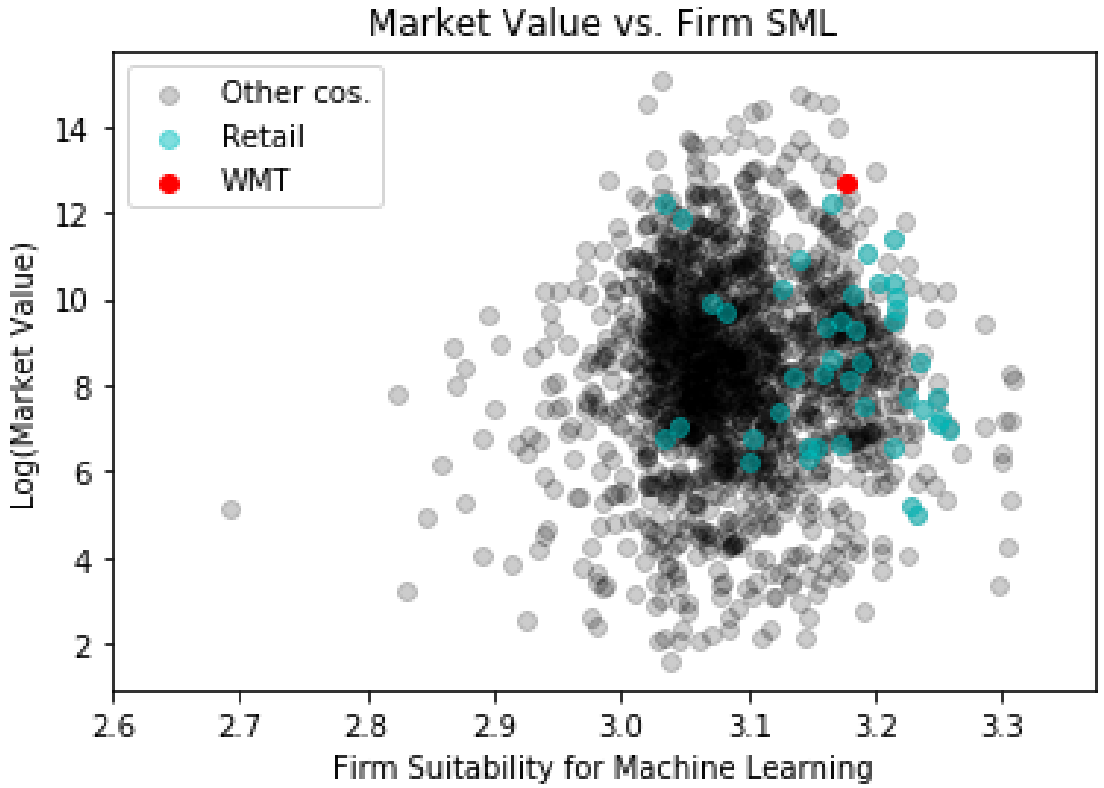
Coef: 0.0009 (t: 1.5)

SML of Firms is uncorrelated with their Market Value (for now!)

MIT INITIATIVE ON THE DIGITAL ECONOMY

Are the firms using AI the ones with the highest ML Exposure? Is it the largest firms?





MIT INITIATIVE ON THE DIGITAL ECONOMY

Where's the AI Productivity Boom?

MIT
INITIATIVE ON THE
DIGITAL ECONOMY

The Disappointing Recent Reality

- **Productivity growth has *slowed* everywhere**
  - We are more than one decade into a slowdown in the U.S. and OECD countries
- **United States:**
  - 1995-2004: 2.8% per year
  - 2005-2018: 1.3% per year
- **OECD: 29 of 30 countries saw similar-sized slowdowns after 2004**

MIT INITIATIVE ON THE DIGITAL ECONOMY

Alternative Explanations for the Paradox

1. **False hopes**
   - Technological optimism unwarranted; future productivity acceleration won't come

2. **Mismeasurement**
   - Reality better than measured; no current slowdown

3. **Distribution and dissipation**
   - Technological benefits are real but concentrated; agents take large dissipative efforts to grab benefits

4. **Implementation and restructuring lags**
   - Technology is real, but benefits take time to emerge

MIT INITIATIVE ON THE DIGITAL ECONOMY

Computerization > Computers

Technology (10%)

Complementary Skills and Processes (90%)

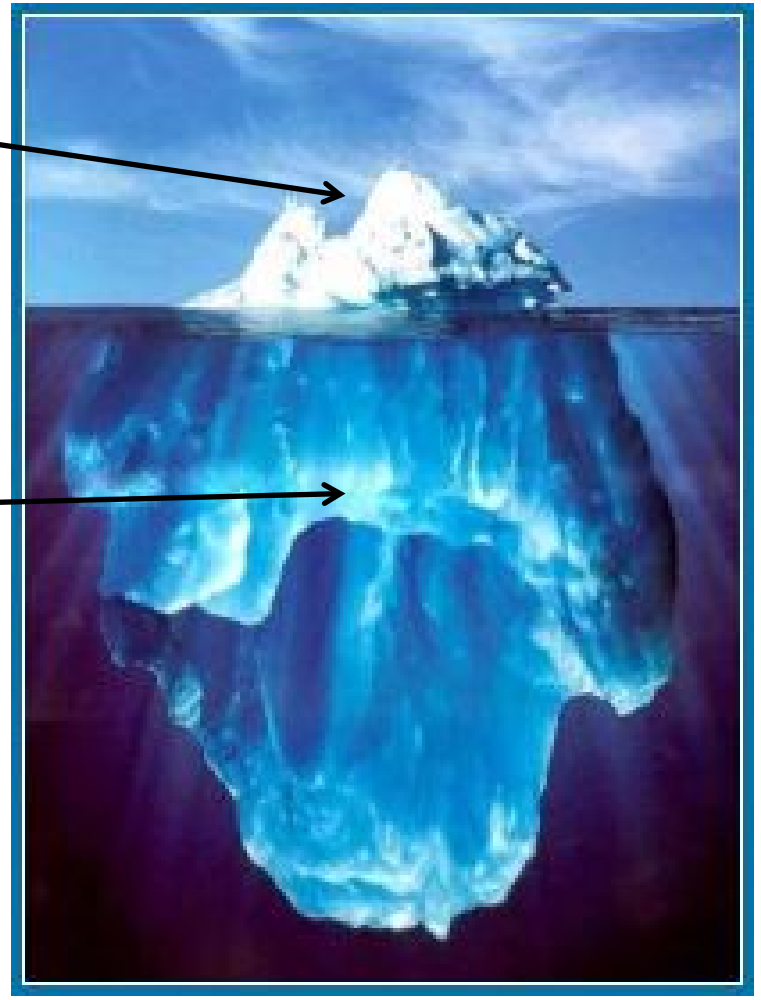
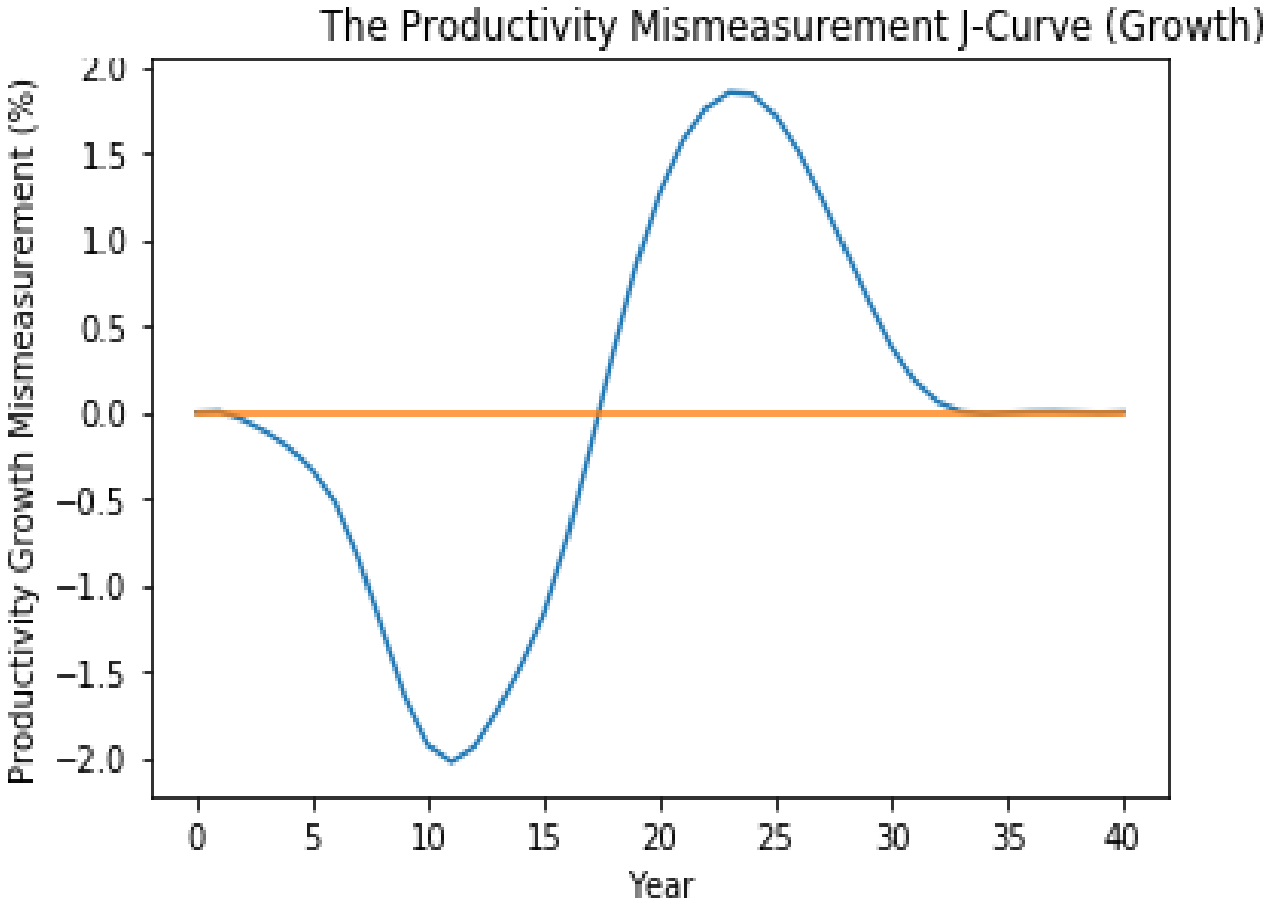


Image by Ralph Clevenger

Source: Brynjolfsson, Hitt and Fitoussi, 2008

MIT INITIATIVE ON THE DIGITAL ECONOMY

The Productivity J-Curve



Source: Brynjolfsson, Rock and Syverson. "AI and the Modern Productivity Paradox" (2017); and Brynjolfsson, Rock and Syverson. "The Productivity J-Curve" (2019)

MIT INITIATIVE ON THE DIGITAL ECONOMY

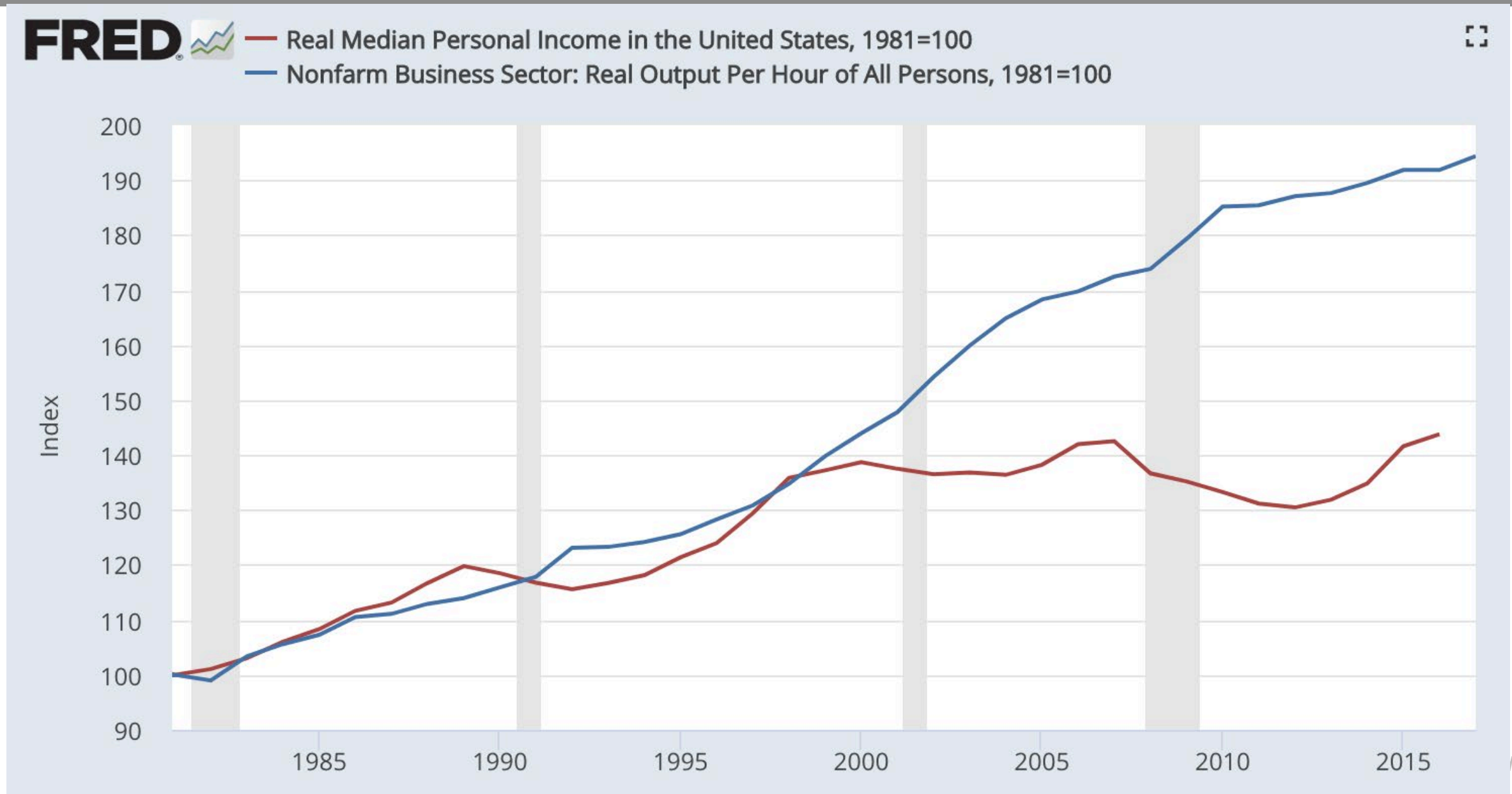
Good News, but Also Challenges

Digital progress makes the economic pie bigger.

But there is no economic law that everyone, or even most people, will benefit.

MIT INITIATIVE ON THE DIGITAL ECONOMY

The Great Decoupling



IDE Seeks Corporate Research Partners for RCTs

- **To understand the causal effects of machine learning, we need to conduct Randomized Controlled Trials (RCTs)**
- **Requirements**
  - Staged implementation of AI or ML
  - Dozen or hundreds of locations (randomized for fidelity of treatment/control)
  - 12-24 month timeframe
  - Sectors such as retail or manufacturing with good metrics are often good candidates

MIT INITIATIVE ON THE DIGITAL ECONOMY

MIT Initiative on the Digital Economy

Technology is racing ahead. Our organizations are not keeping pace.

The IDE is partnership addressing the grand challenges of the digital economy via four research themes

PRODUCTIVITY, EMPLOYMENT + INEQUALITY

BIG DATA + HUMAN-AI

NEW DIGITAL BUSINESS MODELS

SOCIAL ANALYTICS + DIGITAL EXPERIMENTATION

THE MIT IDE ENGAGES IN FIVE PRIMARY ACTIVITIES: RESEARCH, CONVENINGS, EDUCATION, VISITING FELLOWS, AND THE INCLUSIVE INNOVATION COMPETITION.

MIT INITIATIVE ON THE DIGITAL ECONOMY

CEO Discussion:
Multi-Stakeholder Benefits
(Societal Focus)

Discussion Leaders: Jim Breyer, *Founder & CEO Breyer Capital & CGE Board Member*
Dave Kappos, *Partner, Cravath, Swaine and Moore & CGE Board Member*
Michael Spence, *Nobel Laureate & CGE Board Member*

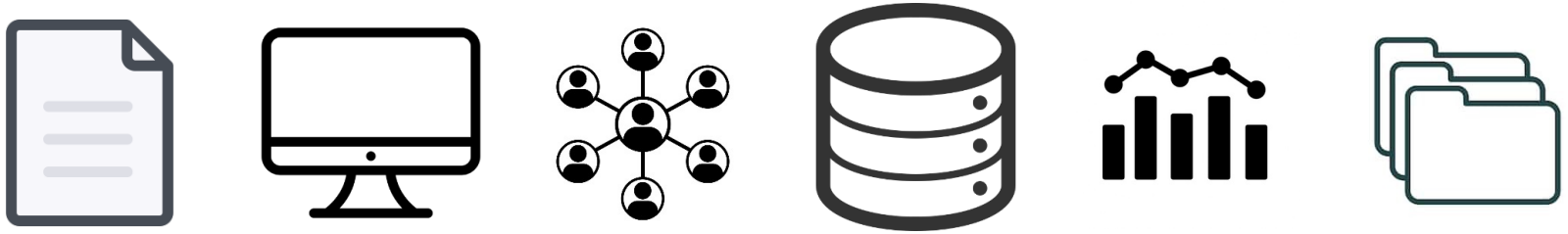
The Transformative Power of AI

NOVEMBER 6, 2019

David J. Kappos

AI is already transforming companies.

- **Data is at the core of the AI revolution.**



- **AI touches every business, albeit in extremely different ways.**

CENTURY INTELLIGENT LEARNING™

afiniti®

- **Embracing AI must be a proactive strategy.**

AI is already transforming deals.

AI is poised to transform regulations.

- **GDPR has already transformed how companies deal with personal data ...**

- **... and there's much more regulation to come.**

CEO Discussion:
The Reorganization of Work
(Management Focus)

Discussion Leaders: Sam Palmisano, *Chairman, CGE*
Doug Haynes, *CGE Board Member*
Shelly Lazarus, *Chairman Emeritus, Ogilvy & CGE Board Member*

Closing Luncheon Discussion:
Bringing Value to You & Your Industry

Sam Palmisano, *Chairman, CGE*
Erik Brynjolfsson, *Director, MIT Initiative on the Digital Economy*