Work of the Future:
Hype, Reality and Unknowns

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https://workofthefuture.mit.edu

Super Bowl 2019 Ads: The Robots are Coming

Michelob

Prudential Life Insurance Billboard on Mass Pike

MIT Work of the Future is Addressing Three Primary Questions

1.

How are emerging technologies transforming the nature of human work and the set of skills that enable humans to thrive in the digital economy?

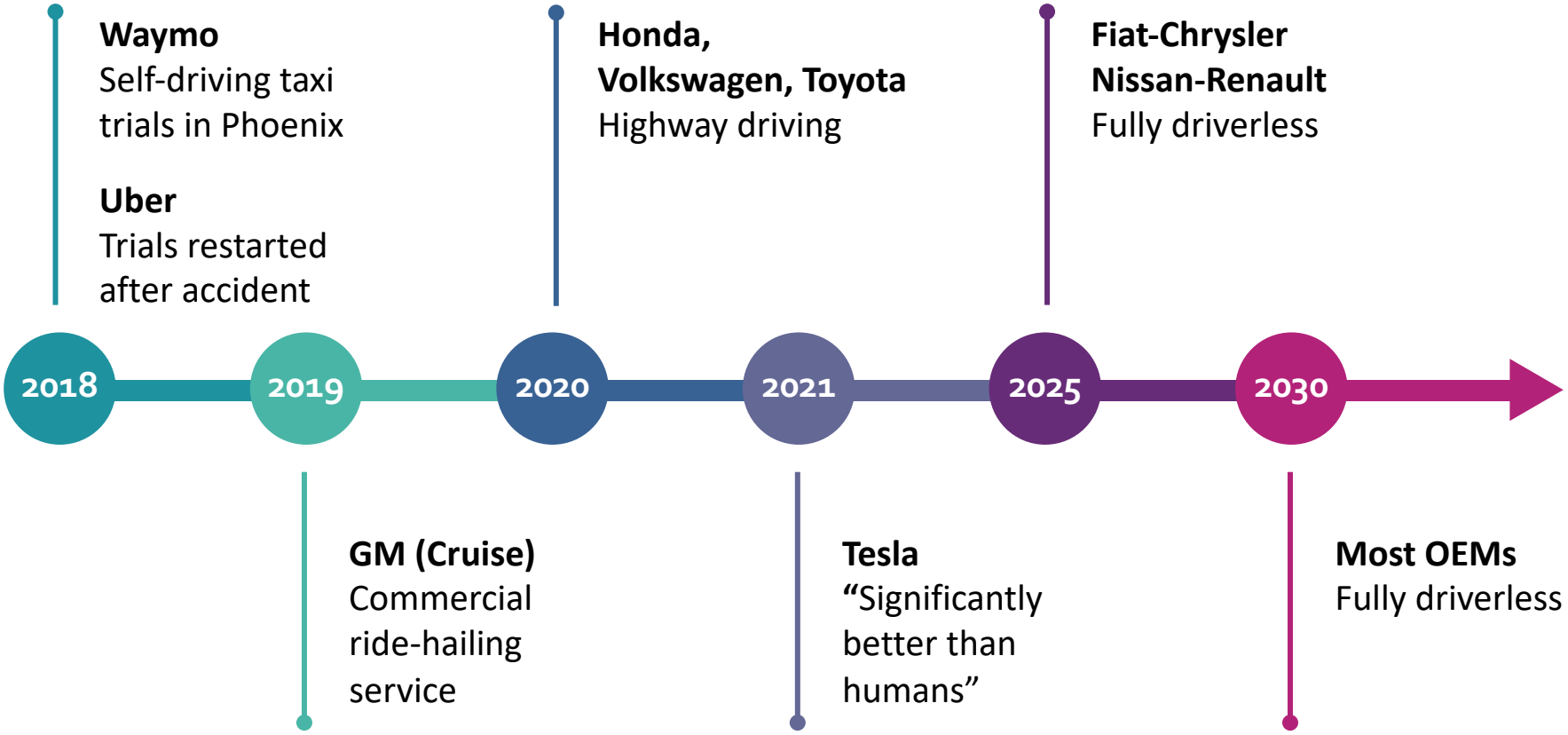
2.

How can we shape and catalyze technological innovation to complement and augment human potential?

3.

How can our civic institutions ensure that the gains from the emerging innovations contribute to equality of opportunity, social inclusion, and shared prosperity?

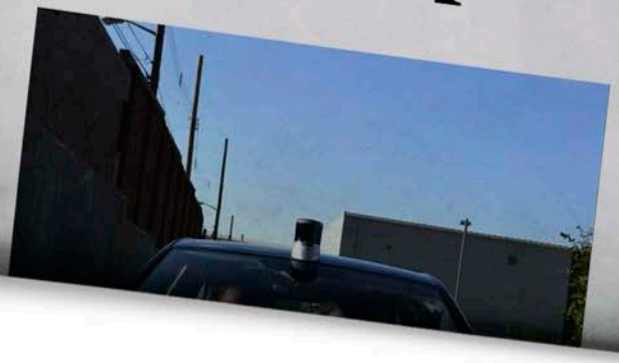
Autonomous Vehicles: a large amount of uncertainty related to AV technology



The Washington Post

The Switch

Shaken by hype, self-driving leaders adopt new strategy: Shutting up



OCTOBER 18, 2018

Three former executives at Google, Tesla and Uber who once raced to be the first to develop self-driving cars have adopted a new strategy: Slow down. And shut up.

A different approach to Automated vehicles at Toyota Research Institute

1 System, 2 Modes for those who want to drive and those who do not or cannot drive

Guardian

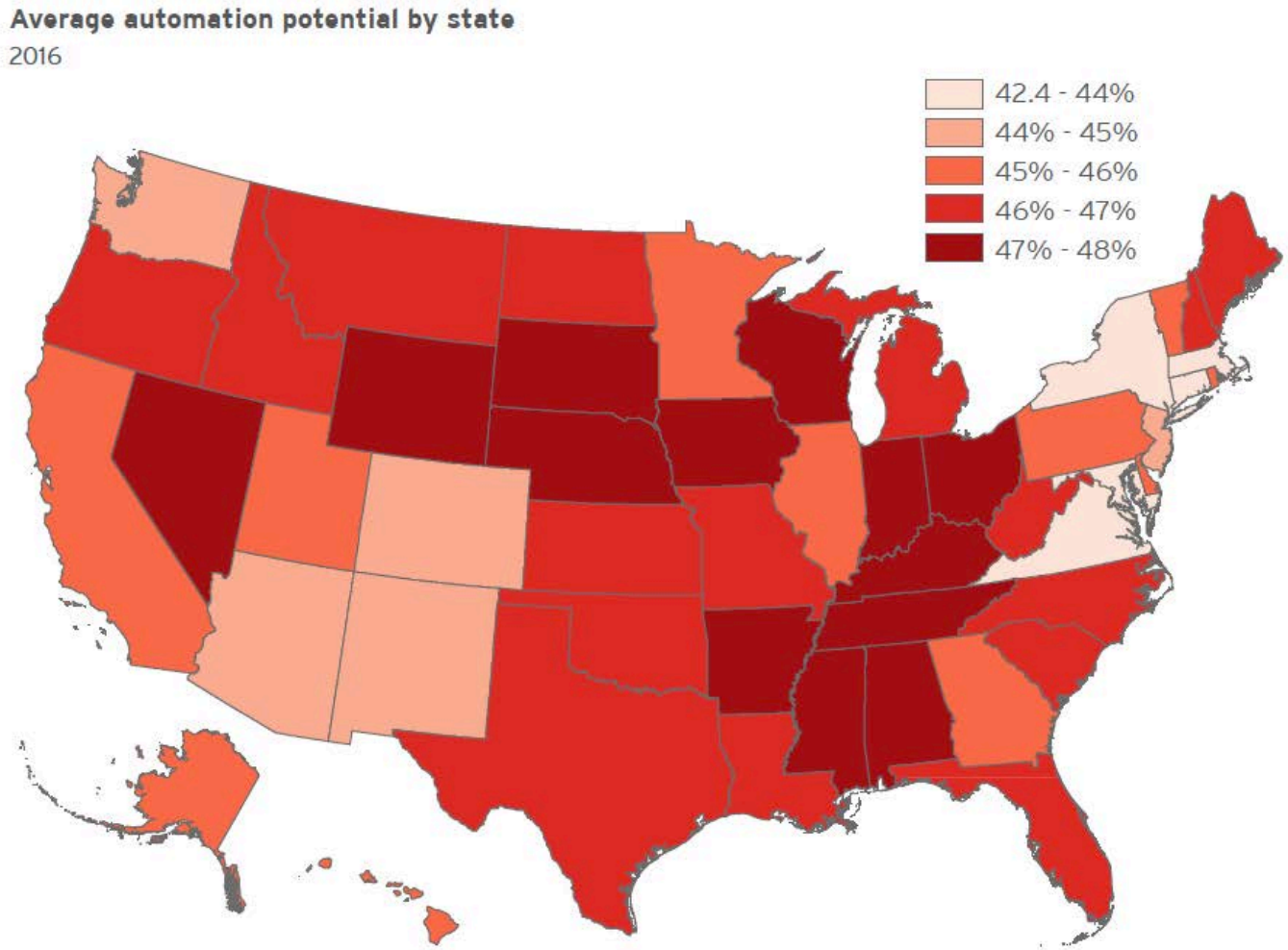
Chauffeur

TOYOTA RESEARCH INSTITUTE

Research by Professor John Leaoard, Dept. of Mechanical Engineering

MIT work OF THE FUTURE

Average Automation Potential by State Ranges from 42 – 48%



Source: Brookings analysis of BLS, Census, EMSI, Moody's, and McKinsey data

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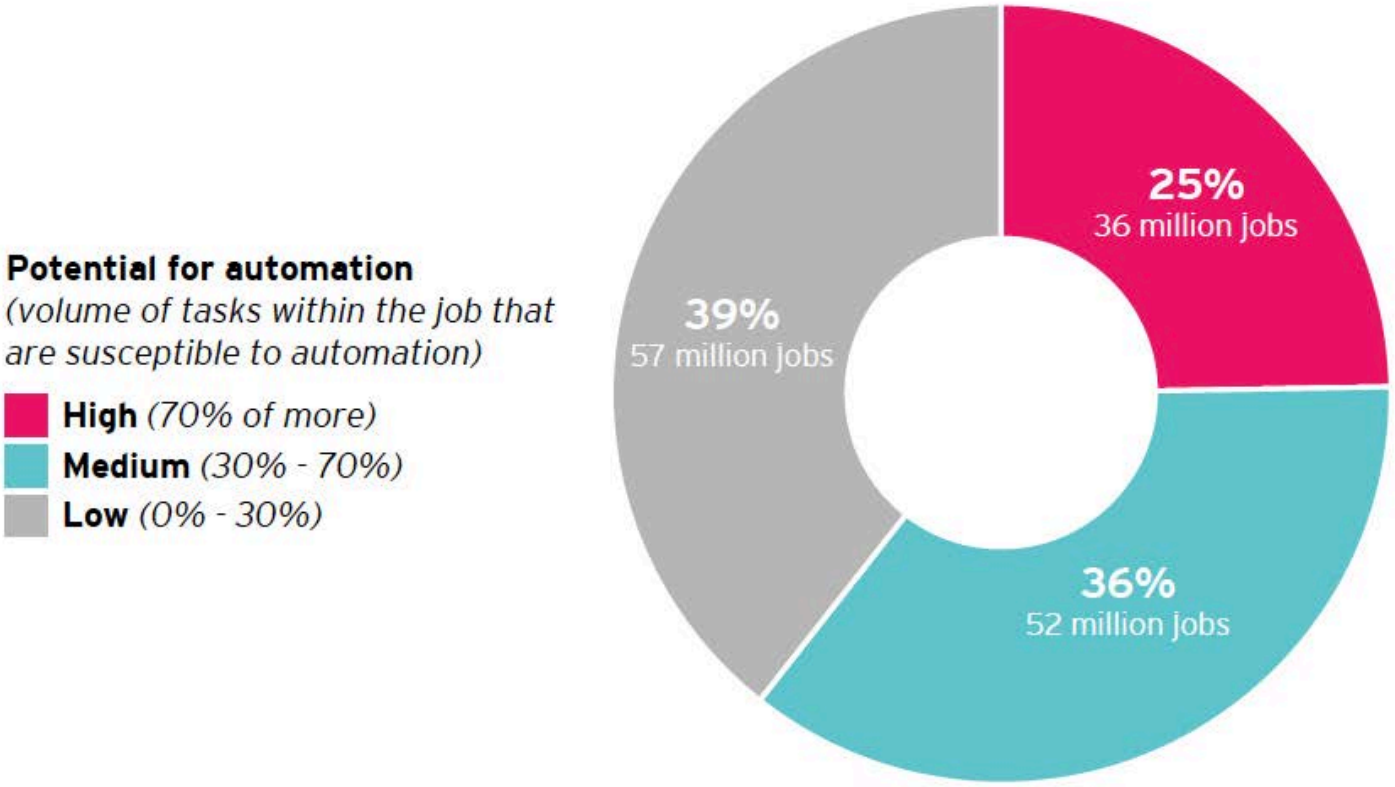
Most Jobs are Not Highly Susceptible to Automation

Most jobs are not highly susceptible to automation

Shares of employment by automation potential



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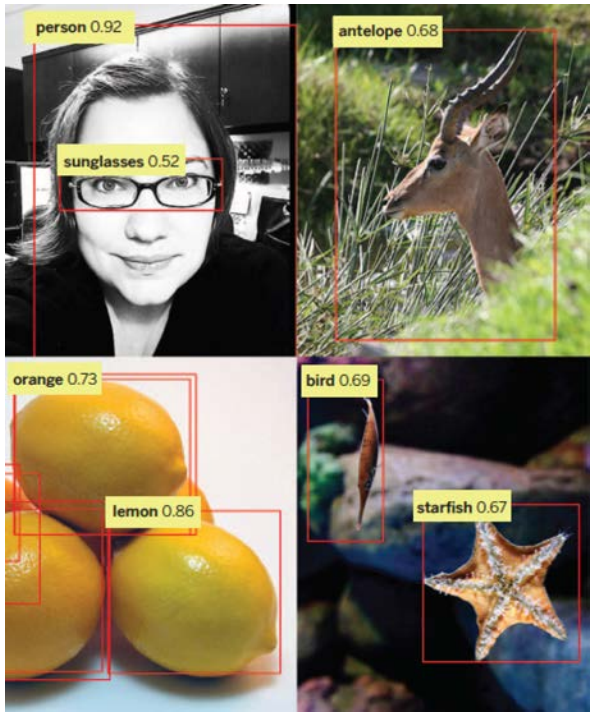
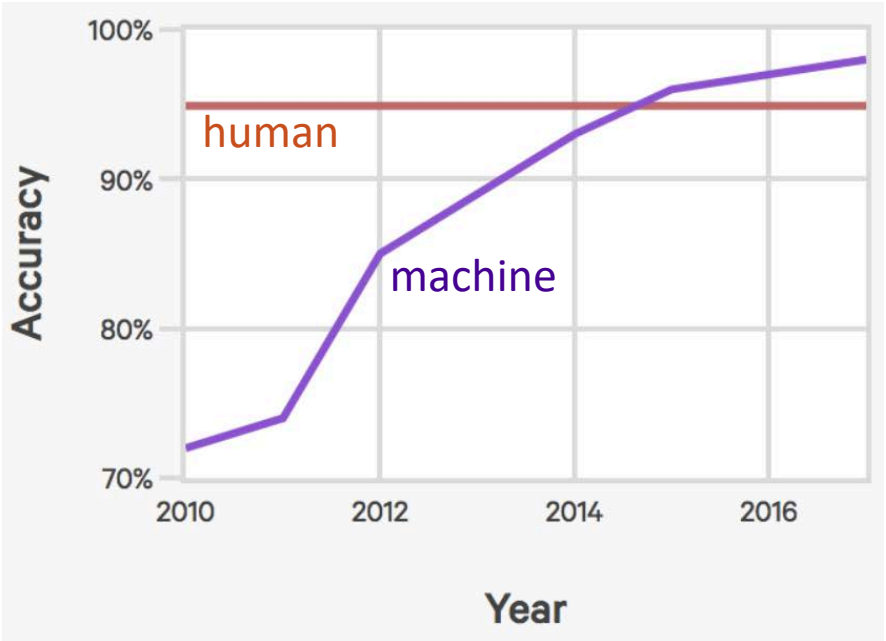
Example of Rapid Machine Learning Progress: Computer Vision



ImageNet Visual Recognition Challenge

Accuracy of AI system



source: http://aiindex.org/2017-report.pdf and MIT Initiative on the Digital Economy

Tasks Done by Radiologists (27 tasks)

Sample 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.

*Erik Brynjolfsson, Initiative for a Digital Economy, 2018; based on O*NET Data*

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

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Erik Brynjolfsson, Initiative for a Digital Economy, 2018

MIT work OF THE FUTURE

What if we knew definitively that 40% of all jobs were going to disappear?

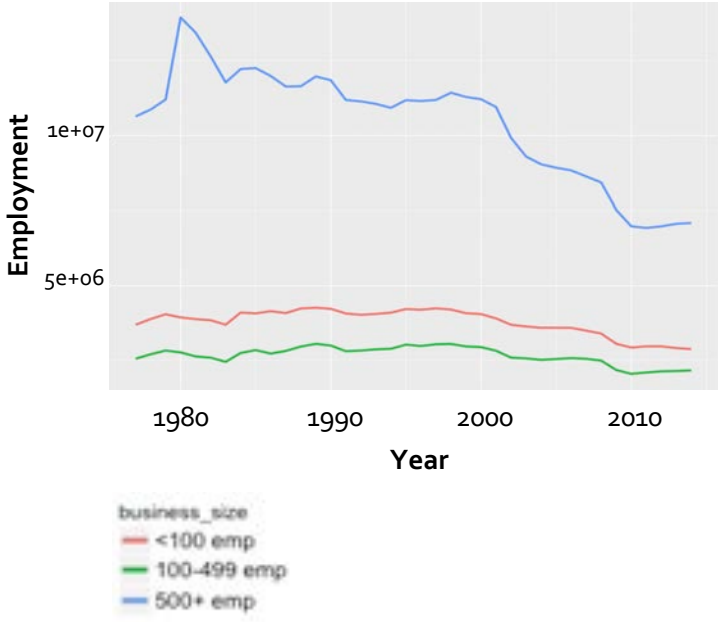
Unknowns: Building a Better Research and Evidence-Base for WotF

1. The effect of the current wave of technologies (AI, robotics, sensors, etc) on workers, firms, regions and the economy as a whole
    - Better data collection
    - Industry/regional case studies

Interviews with Ohio Manufacturers Suggest Complementarity and Skills Acquisitions

Manufacturing, Technology and Skills: Preliminary Insights from the Midwest (Berger, Reynolds, Traficonte, Waldman-Brown)

- New technologies being acquired by SMEs, both traditional (CNC machines) as well as new (3D printers); upgrading of software
- New technology is more complex requiring higher skills (more than a high school degree) but also more user friendly and accessible
- Many institutions involved in skills training and tech diffusion
- Very few jobs are being "replaced" by new technologies
- Research will explore different pathways of large manufacturers vs SMEs



Source: Business Dynamics Statistics

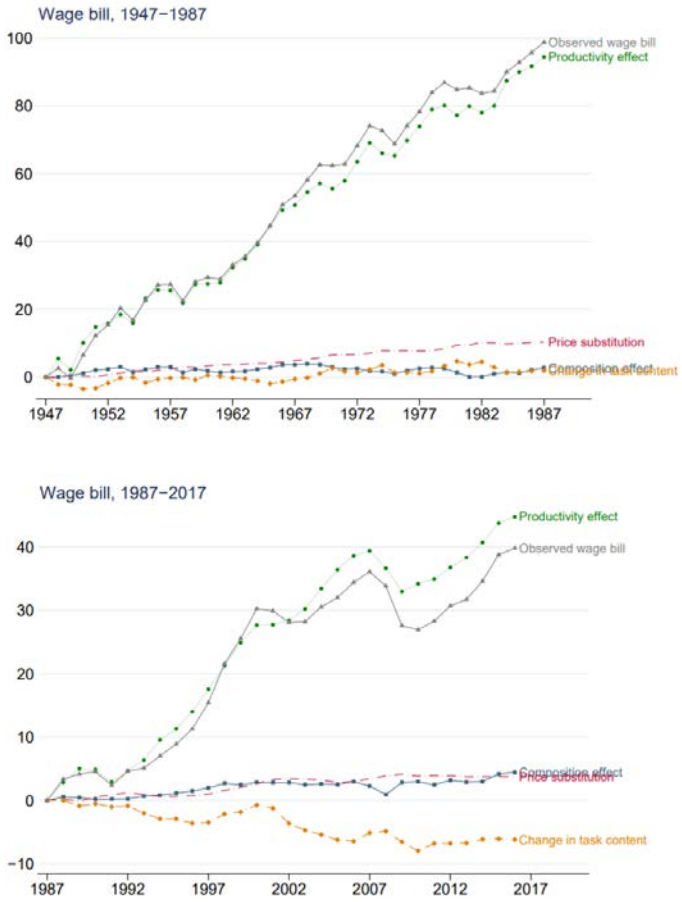
Building a Research and Evidence-Base for WotF: Topics that need more attention:

1. The effect of the current wave of technologies (AI, robotics, sensors, etc) on workers, firms, regions and the economy as a whole
   - Better data collection
   - Industry/regional case studies
2. Using AI /robotics to complement workers as well as meet societal needs (e.g., lowering the cost of medical diagnosis and coordination) rather than substituting labor with so-so machine replacements (e.g., phone menus)

Productivity vs Task Displacement: A Case of So-So Technologies?

Automation and New Tasks (Acemoglu and Restrepo 2018)

- Before 1990s innovation boosted U.S. productivity substantially
  - From 1947 – 1987 productivity rose by 100%
  - Net change in task content roughly zero
  - Wage bill tracked productivity growth
- Since then, innovation has focused on automating tasks without boosting productivity as much
  - From 1987 – 2017 productivity only grew by 40%
  - Net losses in task content
  - Wage bill has been below productivity growth
- So-so technologies that barely improve on status quo depress wages



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3. The changing geography of work: rural-urban; within urban

Challenging Outlook for US Non-College Workers

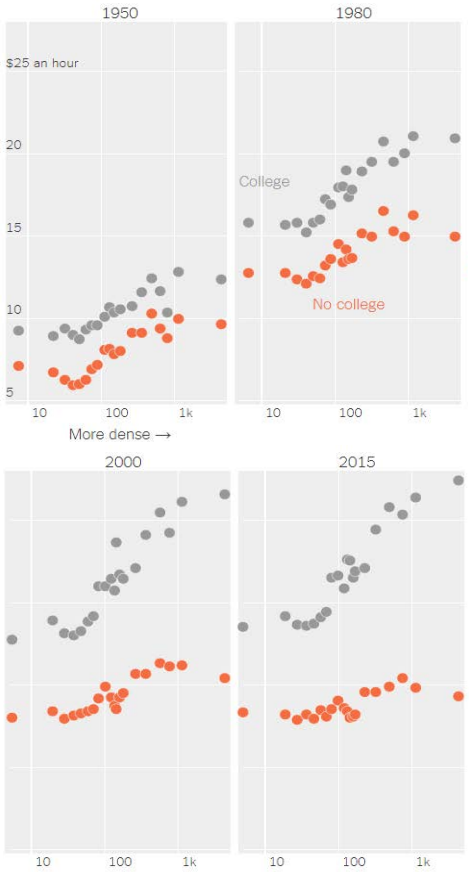
Richard T. Ely Lecture, AEA Annual Meeting (Autor, 2019)

- Medium-skill jobs are declining
- Since 1960s the share of workers without a college education has decreased, yet their wages have also decreased

Cities Offer Less Opportunity for Uneducated

- Urban areas have seen a growing wage gap for those with vs. without some college education; cities no longer offer better paying jobs for lower skilled workers
- Share of medium-skill jobs has decreased, now more prevalent in rural than urban areas for the first time

Wages vs. Population Density Over Time by Education



New York Times, Janury, 12,2019

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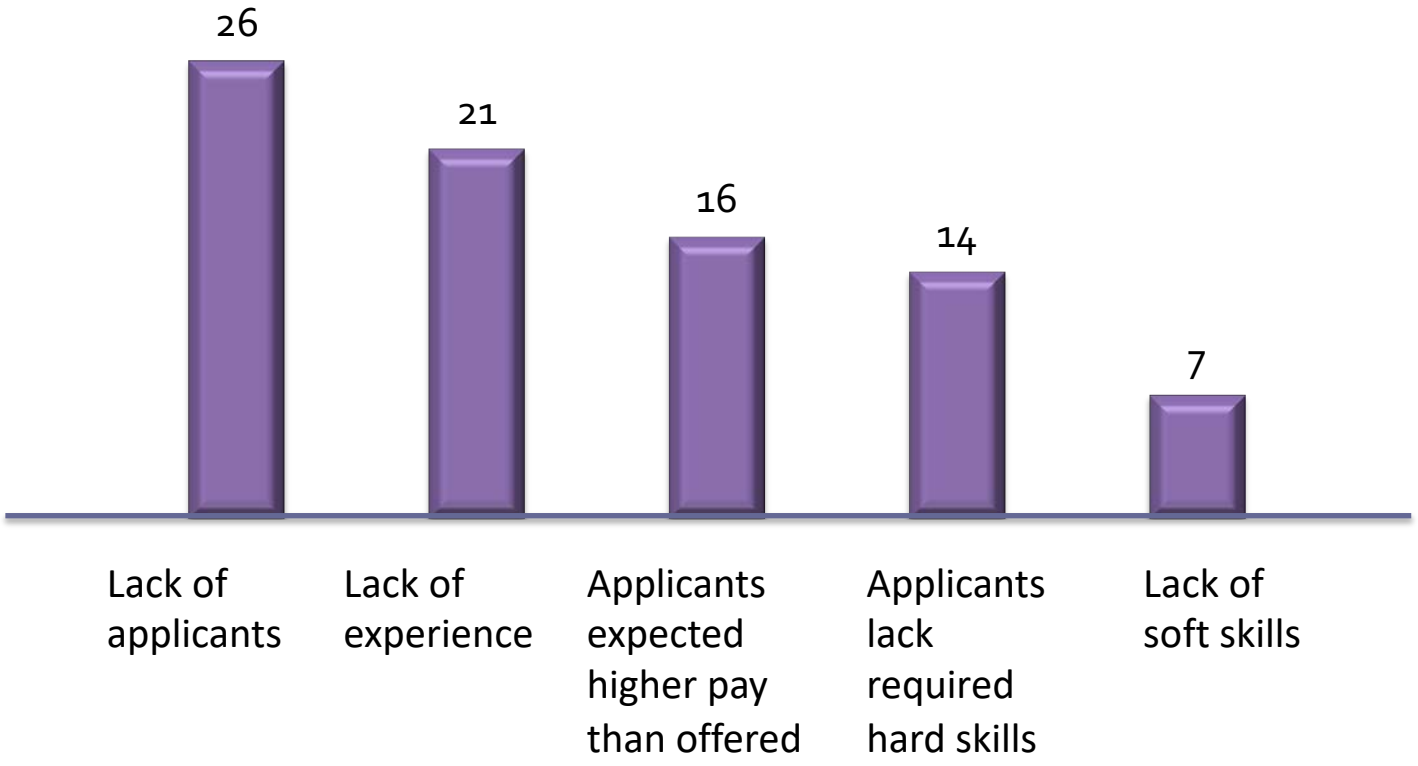
3. The changing geography of work: rural-urban; within urban
4. Rigorous evaluation of new training and education programs, particularly private-sector programs

Why its hard to fill Positions (Percentage of Responses, 2016)

Overall, 46% of employers have difficulty filling jobs



Source: ManpowerGroup – more than 2,000 hiring managers' survey responses, 2016. Published by Bain & Company, 2019

Recent Innovations in Education and Training in Ohio

- **Lorain County Community College's 4-year Bachelor of Applied Science in microelectronic manufacturing**
  - First 4-year Bachelor offered by an Ohio community college
  - Developed from 2-year vocational degree to create "super-technicians"

- **Mahoning Valley Manufacturers Coalition's regional partnerships in Youngstown**
  - Founded by frustrated metal-forming factory owners
  - Created sponsored apprenticeship programs to boost community college attendance
  - Inserted recognized credentials into high school programs

- **University of Akron's partnership with Stark State Community College**
  - Dual admission: students cross-register for Akron courses without paying full tuition
  - Students can transfer to Akron after 2 years at Stark State

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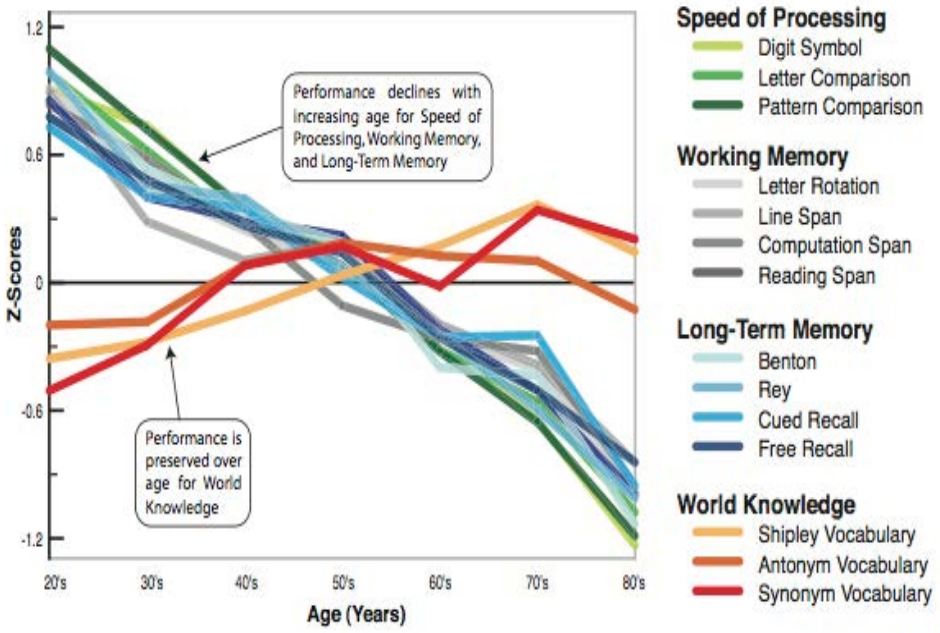
5. How adults learn and how we can improve learning capacity as people age

Skills Retraining Informed by Science of Learning

John Gabrieli et al, PLOS ONE, 2018

Advances in psychology, neuroscience, education research allow us to better understand the process of learning. Findings suggest:

- Social interaction improves language learning
- Frequent practice problems & feedback, including online quizzes, may double learning attainment
- Frequent practice tests dramatically improve information retention
- "Fluid" skills decline with age; "crystallized skills" or domain knowledge peak at 70

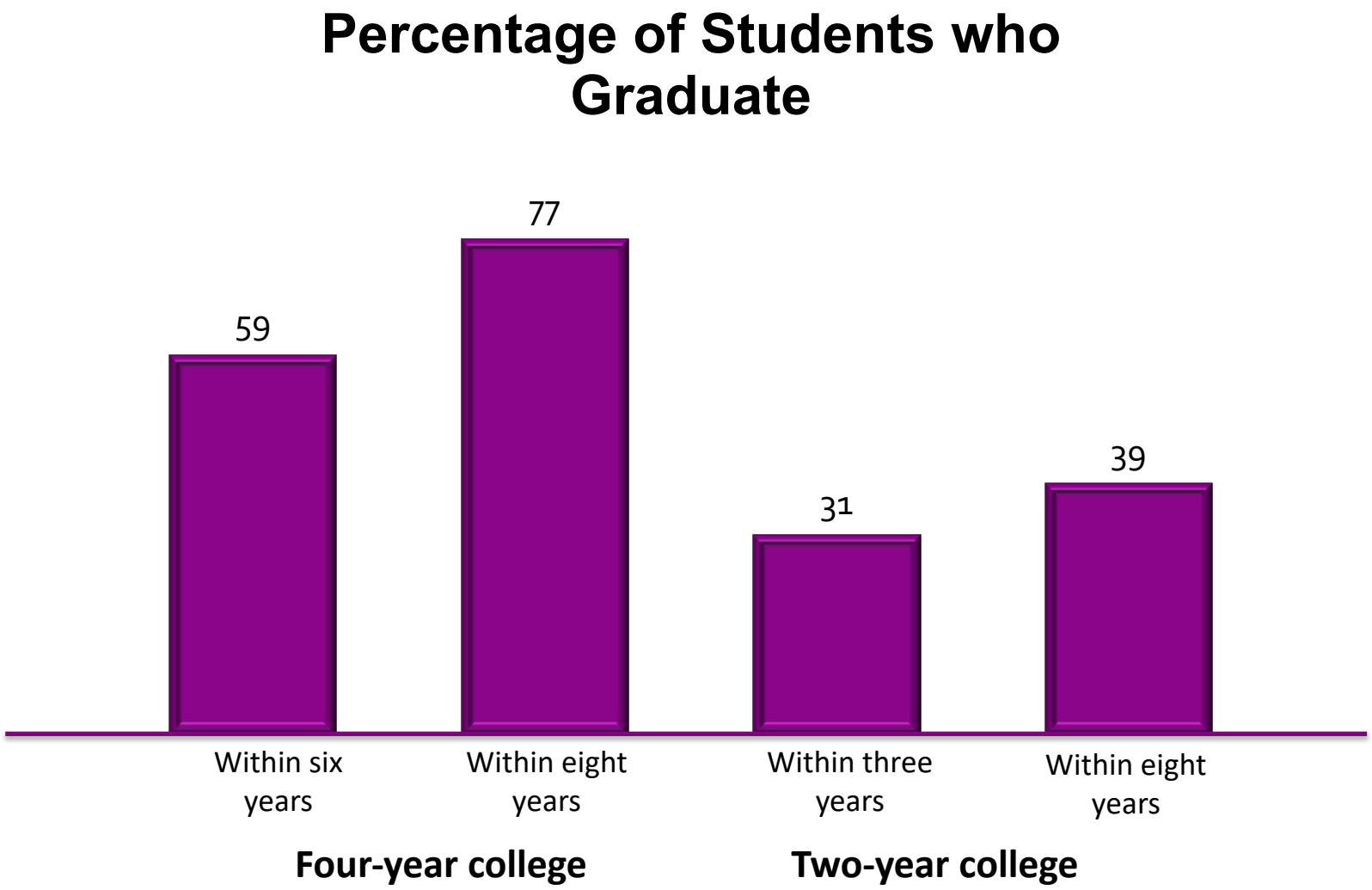


Park et al., 2002, *Psychology and Aging*

MITx Course: Shaping Work of the Future – Launching March 19

- Co-taught by Liz Reynolds and Tom Kochan
- Course explores the relationship between new technologies, work, and society—with the aim of developing plans of action for improving the job and career opportunities for today and tomorrow's workforce.
- For more details and to register: https://www.edx.org/course/shaping-the-future-of-work-0

College Matriculation does not guarantee a Degree



Source: US Dept. of Education, Education Longitudinal Study. As Published by Bain & Company, 2019

Challenging Outlook for US Non-College Workers

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- Medium-Skill Jobs are Declining
- Since 1960s the share of workers without any college education has decreased, yet their wages have also decreased

Cities Offer Less Opportunity for Uneducated

- The urban wage premium for non-college workers in middle-skill jobs has collapsed
- Share of medium-skill jobs has decreased, now more prevalent in rural than urban areas for the first time

New Jobs Being Created:

- Frontier: high wage, high education, mostly male, e.g. Programmer-Analyst
- Wealth Work: low to medium wage & education, mostly female, e.g. Barista
- Last Mile: low wage, low education, rural, e.g. Inspector-Hand Packager

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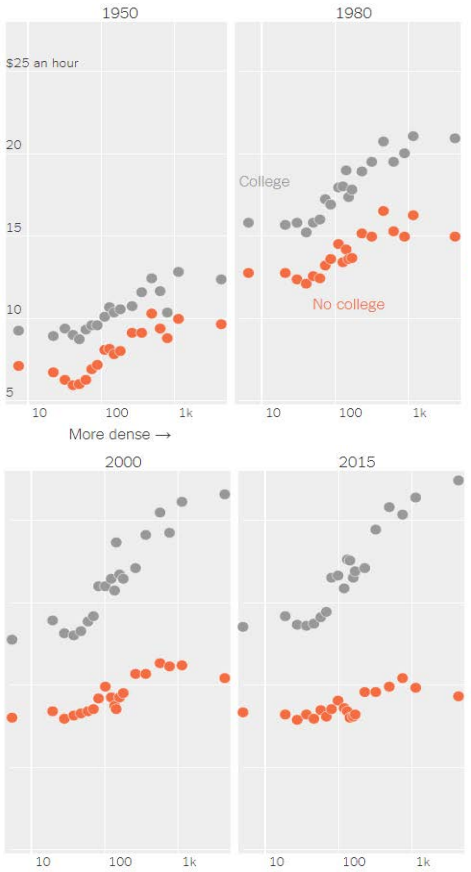


New York Times, Janury, 12,2019

Skills, Education and Training: Returns to Social Skills Have Increased in the US

The Growing Importance of Social Skills in the Labor Market (Deming 2017)

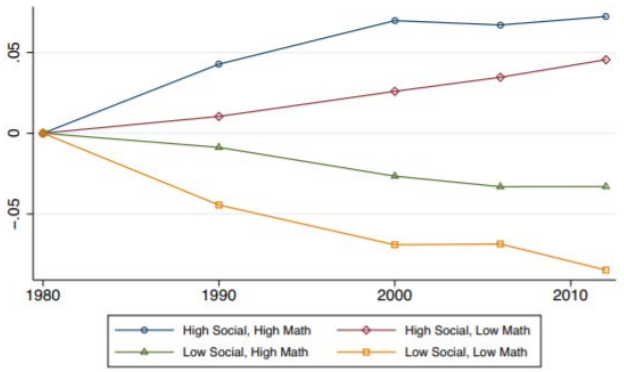
Theory & Static Empirical Findings:

- Social skills enable workers with different abilities to collaborate
- Social and cognitive (e.g. math) skills are complements
- Workers with high social skills sort into higher-paying non-routine work

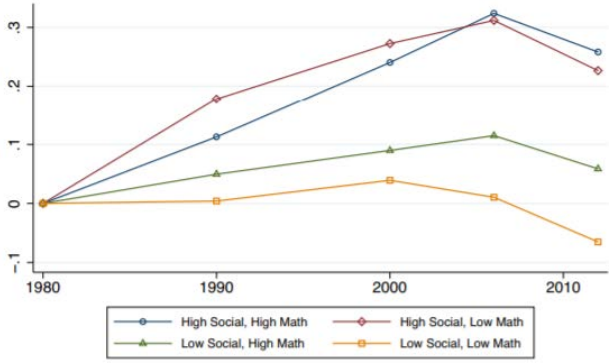
Dynamic Empirical Findings, 1979 - 1997:

- Over time social skills have come to generate more wages and a higher chance of employment
- Math skills have not improved chance of employment, and generate 25% lower wages

Cumulative Changes in Employment Share



Cumulative Changes in Hourly Wages



MIT Work of the Future: Goal and Vision

Concrete goal

To bring MIT's perspective to the discussion of work and technology: a voice that is empirical, realistic, and constructive

Aspirational vision

To transform public discourse around work and technology *from* assuming technological determinism *to* shaping innovation and rising productivity to foster opportunity and shared prosperity for all

Benefits of Machine Learning Require Redesign of Jobs (Brynjolfsson, Mitchell & Rock 2018)

- Study applies machine learning (ML) suitability to 965 occupations, 18,000 tasks; answers crowdsourced. Results:
  - ML is a specific technology with impacts distinct from general automation
  - Tasks with good measures of effort & outcome more suitable for ML
  - Affects high and low wage earners, high variability of impact across each occupation's tasks
  - Redesign of jobs will be vital to capture ML productivity gains

LOWEST AND HIGHEST 5 SUITABILITY FOR MACHINE LEARNING 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

A different approach to Automated vehicles at Toyota Research Institute

Professor John J. Leonard, Dept. of Mechanical Engineering

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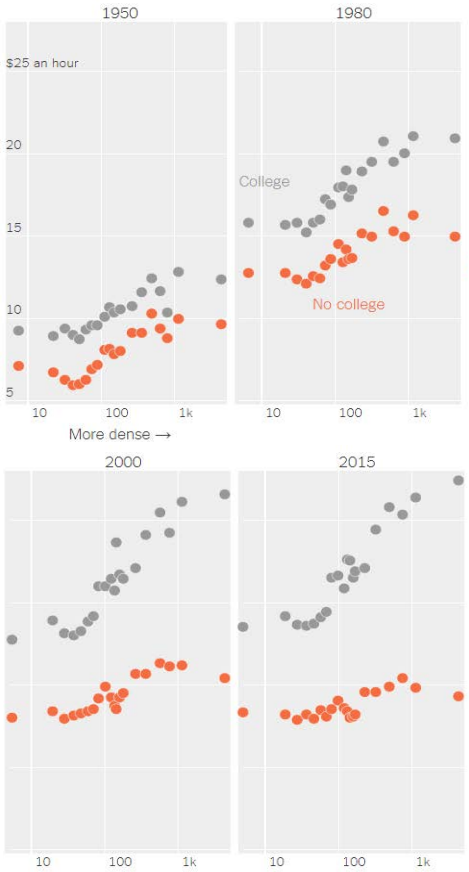

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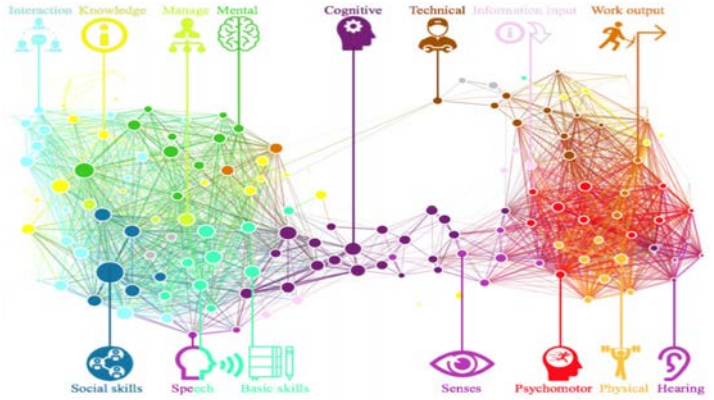
The Geography of Work Has Important Implications for Work Opportunities

- Rahwan et al. (2018) find there are two major skill groups, cognitive and physical
  - Hard to move from one side to the other
  - High-paying cognitive skills concentrated in coastal cities
- Autor (2019) shows urban areas have seen a growing wage gap for those with vs. without some college education; cities no longer offer better paying jobs for lower skilled workers

Network of Job Skills



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