

Spreading the benefits of economic growth when AI robots do more work and earn more income

1. Challenge of AI/Robots to Human Work and Earnings
2. Individual Responses: From HC to HETC
3. Before vs After Societal Responses: Ownership vs Welfare State
4. Time for Reforms

Richard B. Freeman, Harvard and NBER

Inclusive Korea Conference, Seoul

Session 4: Tasks for Inclusive Welfare State in the Era of
Transformation, May 25 15:30-17:30

1. The Challenge

Half a century ago when wages increased with productivity; inequality of pay was stable/falling; and machines substituted for humans at physically demanding jobs, Herbert Simon dissed fears of automation: "The bogeyman of automation consumes worrying capacity that should be saved for real problems."(which) *in this generation and the next* are problems of scarcity, not of intolerable abundance."(Simon, The Shape of Automation 1966)

Today's economy is different. Labor's share of income is falling; inequality of pay and of capital income are rising; and AI robotic technology challenges humans at cognitively demanding tasks. AI-robotic-driven technology is sufficiently different from past technologies that the real problems go beyond scarcity to distributing the benefits of technology widely so that all can enjoy tolerable abundance, if not Simon's intolerable abundance.

Is AI Robot Technology Really Different?

Futurists impressed by advances in AI expect the technology to disrupt job markets in unprecedented ways. AI experts expect machines to dominate humans in most jobs by 2050, leading to complete automation by 2120 or so.

Traditionalists impressed by current modest rates of productivity growth and tight job markets dismiss the notion of AI robotics ending human employment as a false alarm comparable to the 1960s automation scare that sparked Simons' bogeyman comment.

The most relevant economic theory on the effect of automation on human work, *comparative advantage*, predicts that AI robotics will alter the division of work and income between humans and machines, exacerbating income inequality without necessarily reducing jobs.

My assessment is that the technological evidence offers a greater guide to the future than current aggregate economic evidence. If this is correct, the big task for economic policy in the age of AI robotics will be to distribute technology's benefits widely.

Why? Because Robots Can Out-Think Us

1997 Deep Blue beats Chess champion Kasparov

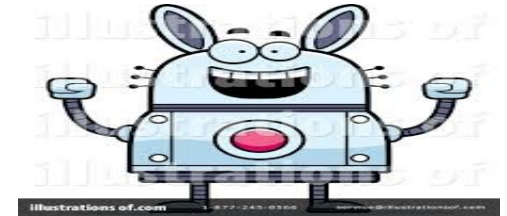
2011 Watson defeats human Jeopardy champions

2016 Google's Alpha Go defeats Lee Sedol

2016 Carnegie Mellon's Libratus beats poker pros

2016 U of Alberta's Deep Stack wins poker Tournament

2017 Starting from random play, and given no domain knowledge except the game rules, AlphaZero achieved within 24 hours a superhuman level of play in ... chess and shogi ...as well as Go, and convincingly defeated a world-champion program in each case..



But AI algorithms/robots do only one thing while we can do many. Our comparative advantage is in human versatility



Ha! My AI portfolio has one algorithm/robot that can do anything better than you. Yes it does!

Why? The Robots Everywhere Doing Work Cheaper/Better Than You!

Robot noodle chef



Amazon Kiva robot



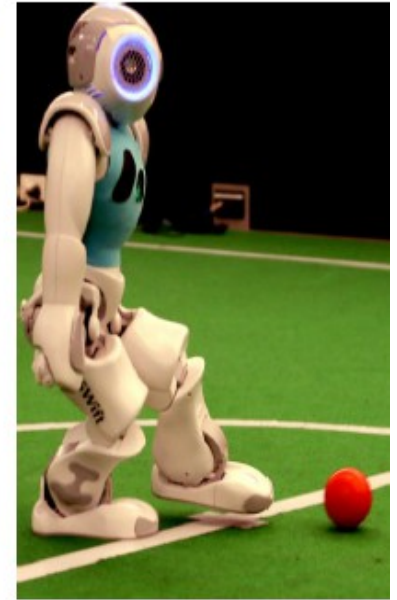
Robot boss,



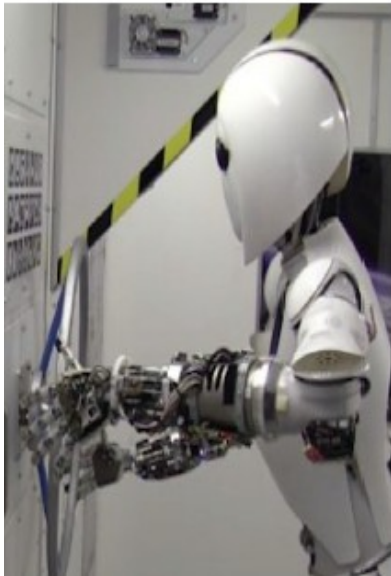
Pizza-delivery-Au



Soccer robot



Space Robot,



IBM Watson



Delivery dog- Boston



Humanoid robot-



Sex robot



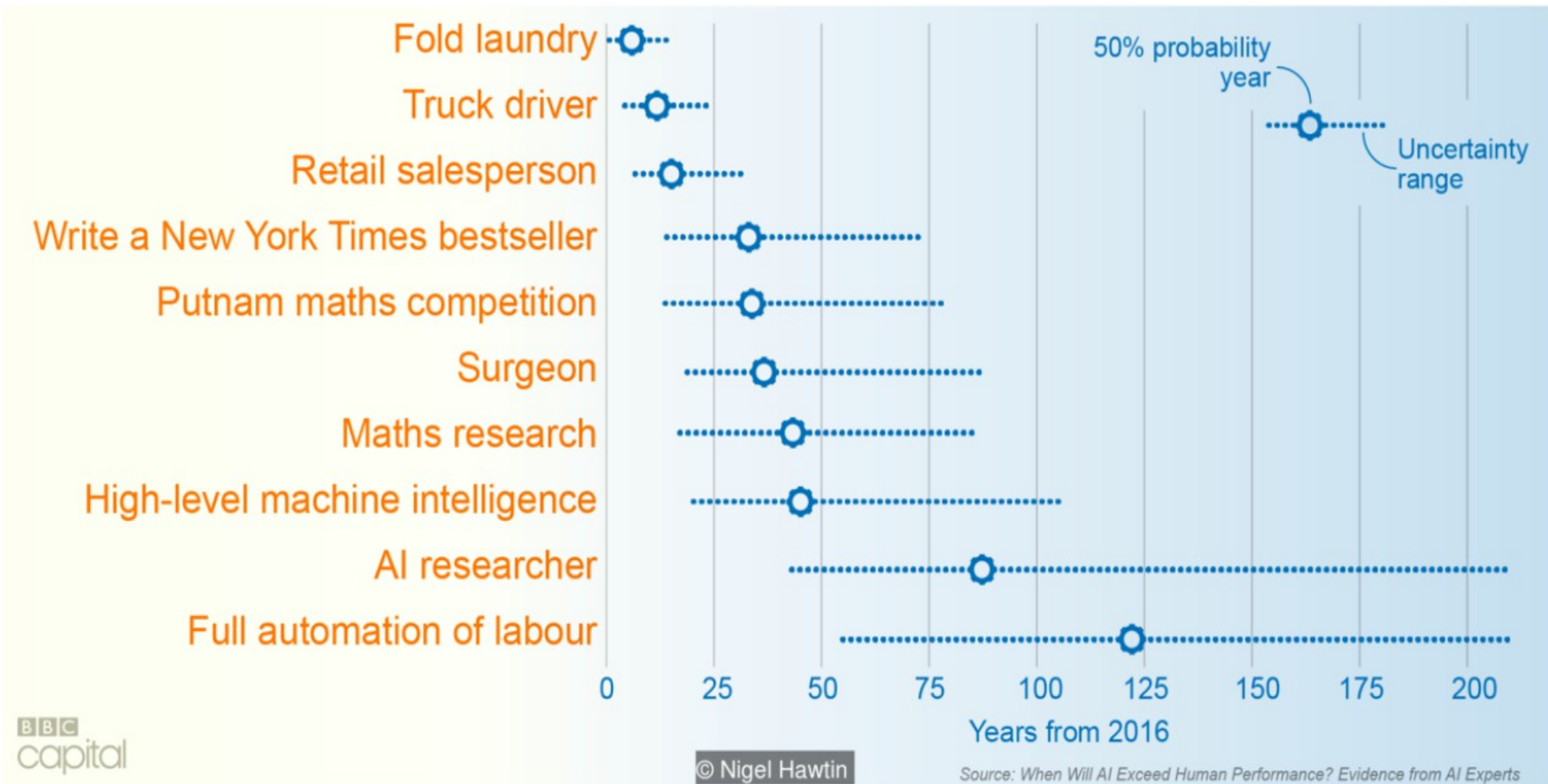
Which Occupations/Work When ?

Survey of 352 AI Experts Who Published at 2015 NIPS, ICML Conferences <https://arxiv.org/abs/1705.08807>, May 30, 2017

When will AI outperform humans at work?



How many years until a machine can do our jobs better than us?



Bottom Line: The AI/Robots Earn the Money for the Owners of Technology-- "Who Owns the Robots Rules the World"

"We do the work and make the money"



"We own the robots that do the work and make the money"

the 1%

err – the 0.1%

err – the 0.01%

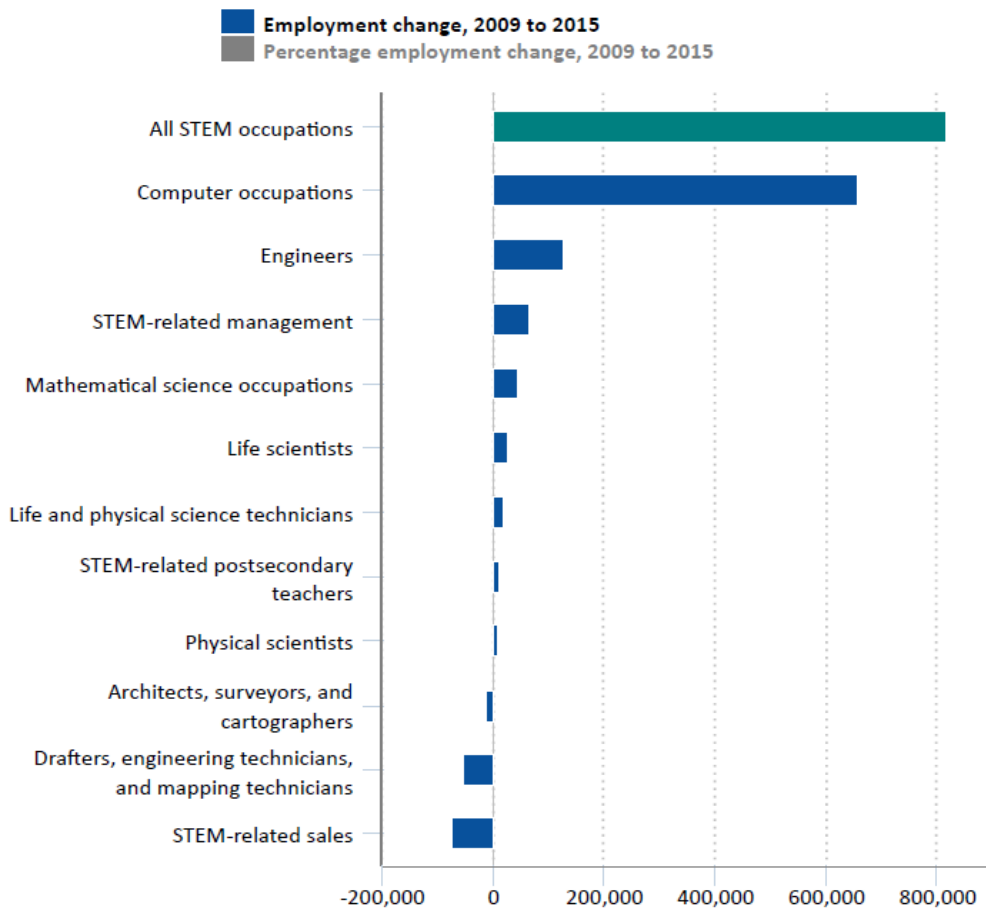


2. Individual Responses

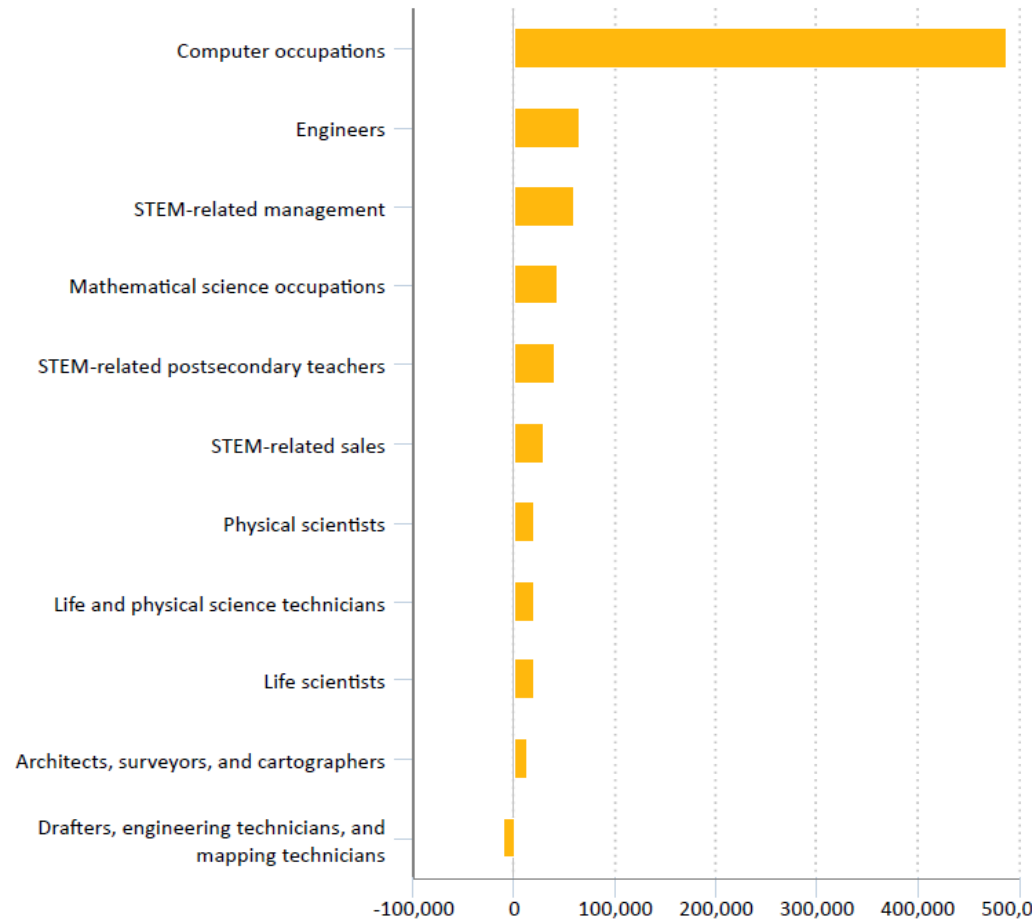


Human capital. But, sorry, Seonbi, not your education. Computer, Data Science, Machine learning. AI-literacy beyond swiping cell phones or computer screens. US BLS expects big growth computer and information jobs.

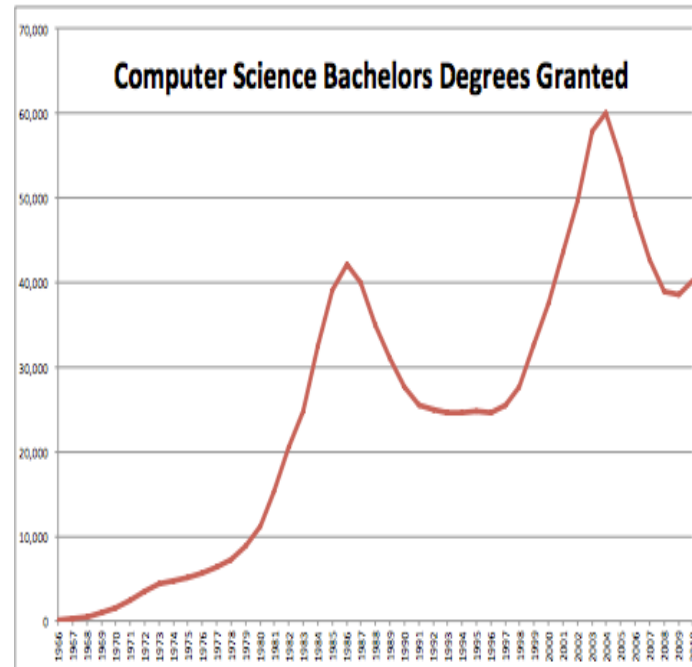
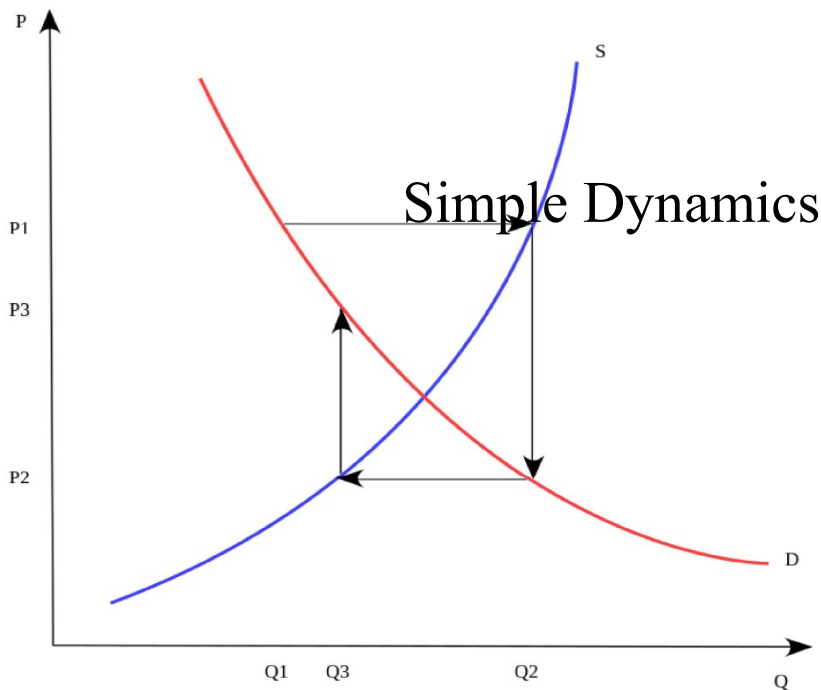
Employment change and percentage employment change by type of STEM occupation, May 2009 to May 2015



Projected new jobs for types of STEM occupations, 2014 to 2024



Computer Science is an exemplar of the cobweb dynamics and “oversupply” problems of S&E education



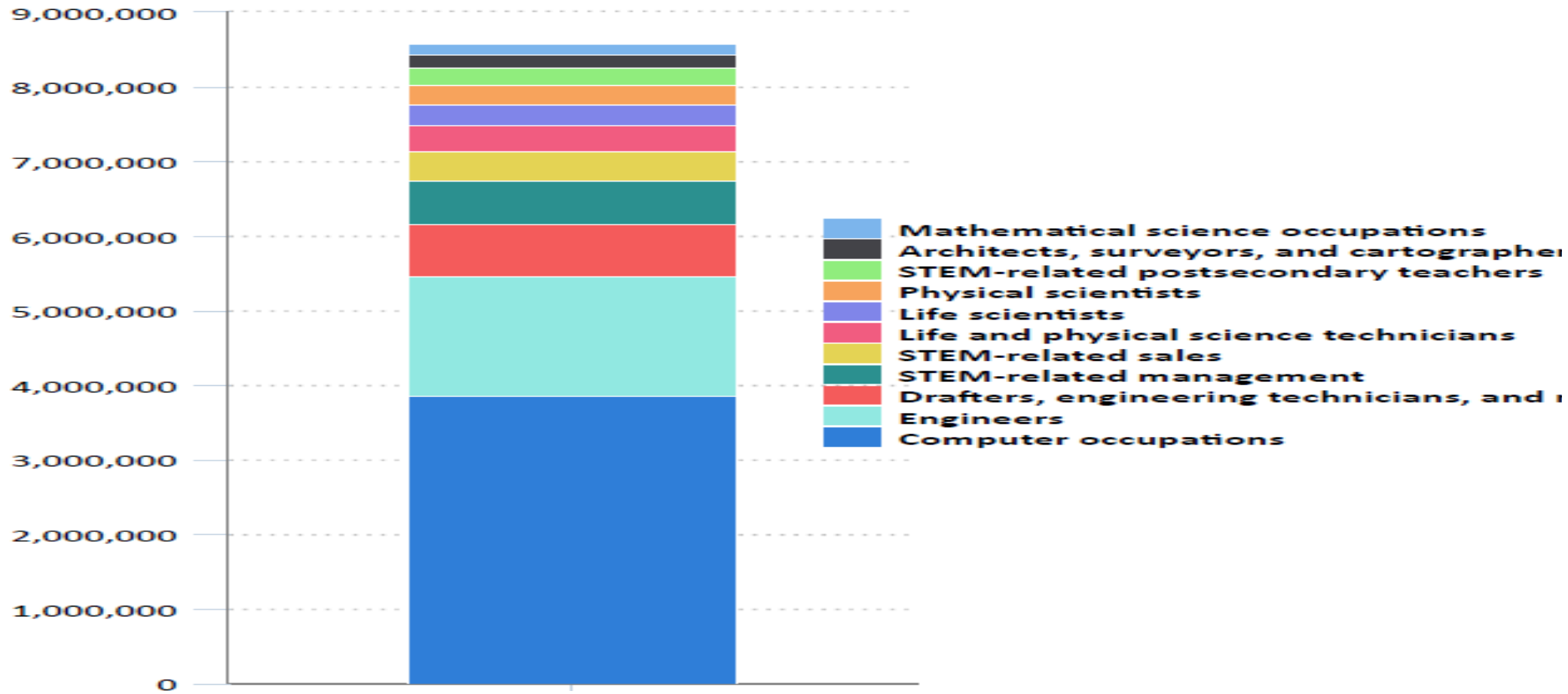
Graph ends in 2010. From 2010 to 2015 CS degrees increased by 50% to 59,600 just above the 2003 peak

Will current boom overshoot? Probably, but overshooting unlikely to create big job problem. As long as grads can apply their skills in other occupations as CS/AI become language of business, they should do well.

New supply concern from business poaching faculty vide Uber's 2015 raid of 40 researchers and scientists CMU's robotics department.

Korean BS computer science degrees given in Science and Engineering Indicators 2018 do not show such fluctuations. Why?

Computer Science Occupations Dominate STEM Employment, May 2015



Many CS workers from other majors; Many CS majors in other occupations, 2015

**Employed in computer, information science and math 3,156,000
of whom 1,280,000 (40%) have degree in area**

**Degrees in computer and mathematical sciences 2,346,000
of whom 1,280,000 (55%) work in area**

More employed in area than have degrees. Very high percent with degrees work in field

Near future: more Human-Robot teams → “cobots”

Elon Musk@elonmusk Yes, excessive automation at Tesla was a mistake. To be precise, my mistake. Humans are underrated. 3:54 PM Apr 13, 2018



A **cobot** – a collaborative robot that works with humans in a shared workspace rather than machine designed to operate autonomously in own space.

Robotonomics Estimattess for Co-Bot unit sales

	2012	2013	2014	2015
Universal Robots	550	800	1 400	2 200
Rethink Robots	50	250	280	350
ABB	40	70	150	500
Fanuc	-	50	80	120
Others including Yaskawa, KUKA, Nachi)	100	150	200	500
Total Co-Bot units	740	1 320	2 110	3 670

Robotonomics Estimates for Co-Bot revenue US\$ Millions

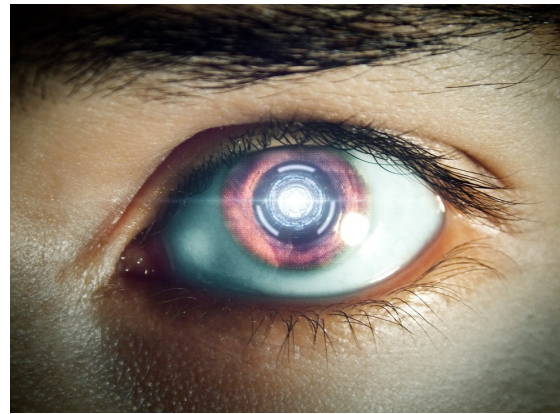
	2012	2013	2014	2015
Universal Robots	11,41	19,22	32,76	52,40
Rethink Robots	1,00	4,0	6,50	8,50
ABB	1,00	1,00	6,00	20,00
Fanuc	-	1,25	2,40	3,60
Others including Yaskawa, KUKA, Nachi)	4,00	6,00	8,00	20,00
Total Co-Bot sales in millions	17,41	31,47	55,66	104,50
Average selling price	23 527	23 841	26 379	28 474



Human Enhancement Technology



RFID Chips



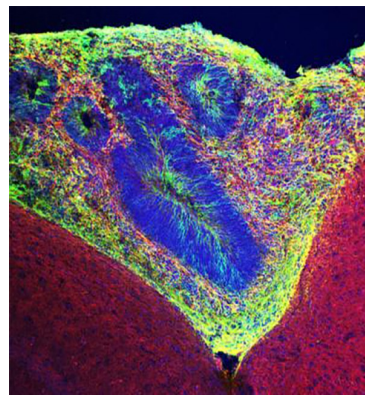
Smart Contact Lens/
Augmented Vision
Samsung



Exoskeletons
Hyundai



3D Printed body parts

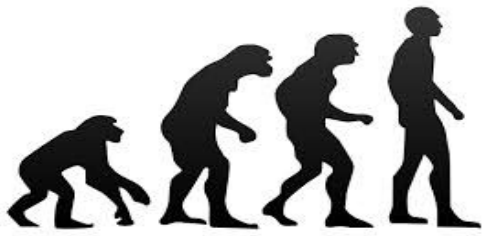


Brain Organoids
Grown in Mice

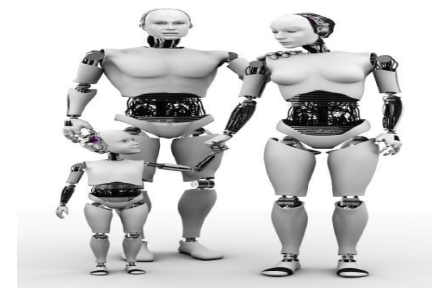


Brain-computer
Interfaces – *SOSO*
H&D, Daegu

And MORE on the way: Gene editing; Designer Babies. Personalized drugs and more [https://futureofsex.net/...](https://futureofsex.net/)



Evolution to Cyborg?



Life question
in days of radio



Mugger: Your money or your life. (long, awkward pause)
Mugger: Look bud. I said, your money or your life.
Jack: I'm thinking it over!
Jack Benny radio program, 28 March 1948. Sourced from audio recording.

Life question
today



Mugger: Would you rather be human or robot?
(long, awkward pause)
Mugger: Look bud. I said, human or robot.
Me: I'm thinking it over!
You???



3. Before and After Societal Responses

A society can use *before* or *after* policies or some mix thereof to distribute the benefits of AI robot technology widely even as technology shifts income toward the machines/capital.

Before policies seek to establish a level playing field for market economics by increasing citizens' ownership/control of business capital and labor rights. Policies range from employee ownership and profit-sharing to broad-based financial ownership of business to laws that enhance workers rights in labor markets to anti-trust policies.

After policies redistribute incomes from market transactions through progressive tax and spend policies. Tax policies include Gate's suggested robot tax, Picketty's global capital tax, other tax reforms. Spending policies encompass welfare state spending for national health care, schooling, or job training to the Universal Basic Income benefit.

I will focus on before policies pertaining to ownership of capital, which have received less attention than they deserve.

The Case for Ownership of One's Own Firm

- 1) Logic: If AI robotics shifts work and income to machines, the natural solution is to widen ownership of machines. “In the AI robotics economy workers own the means of production and gain income from the machines.”
- 2) Evidence: Studies show that employee ownership raises the productivity and value of firm, so that ownership can in some cases “pay for itself”. Ownership reduces the pay gap between executives average workers and the wealth/capital income gap between workers and non-worker shareholders. It improves the well-being of workers and reduces turnover.
- 3) Policy: In the US public has a generally positive attitude toward ownership that transcends ideology/party partisanship. By increasing tax benefits modestly, giving worker-owner firms, preference in government contracting, and “bully pulpit” publicity, the government could spread the ESOP form quickly.

But ...

1. If workers' only business capital was in their own firm, they would lose security of diversification. If earnings stagnate due to AI robots pressures on job market, most would not make enough capital income to keep pace with productivity growth.

2. Workers outside the private for-profit sector could participate in gain-sharing incentive systems but not in direct ownership, stock options, and profit-sharing. Unemployed and all persons outside the labor force limited to capital income outside employment relation.

3. Employee ownership has ambiguous effects on income inequality. It narrows within-firm pay inequality but increases the dispersion of worker incomes among firms by raising worker incomes in good performing firms relative to that in poorly performing firms.

Conclusion: Ownership must go beyond own firm to stakes in business more broadly for workers to maintain a proportionate share of economic growth when wage growth falls short of productivity growth.

Three paths to broad-based ownership of capital

1) **Pension funds.** Big in US, where Peter Drucker (1976) declared that pension fund ownership made US “the first truly socialist country”. Share at 36% in 2015. President Bush's 2005 effort to privatize part of Social Security System failed. Sweden succeeded with PPM surcharge of 2.5% of income for investments into private accounts.

2) **Individual Ownership.** In US share of corporate assets owned by individuals outside of tax-privileged pension or other vehicles fell from 84% in 1985 to 29% in 2015 (Rosenthal & Austin 2016) so without changes in taxes unlikely to expand. Has virtue since can use funds outside of retirement. ³

3) **Sovereign wealth funds.** Doubled in past decade to over 7 trillion dollars in assets in 2017. Initially created by US states from public assets – land/oil, etc – with mandate to spend on citizens but today many created by general government for “macroeconomic purposes ...to achieve financial objectives, ... which include investing in foreign financial assets.” (IMF). Nearly half of funds non commodity-based.

Sovereign Wealth Fund Capitalism

Largest* is Norway's “Oil Fund”, valued at \$1.03 trillion in 2017 or \$193,000 per citizen. Supplements government budget by 4% of fund assets each year so helps welfare state but pays no dividends.

Korea Sovereign Wealth Fund worth \$122.3b in 2017 16th on list by value, with no dividends to citizens.

US Alaska Permanent Fund paid residents annual dividend of \$1,000 to \$2,000. Other US state sovereign wealth funds dedicated to public education (Texas Education Fund and) or other public goods.

UK Child Trust Fund - gave a bond worth £250 at birth and spendable at age 18 to children born in 2002 to 2011. Replaced by Junior ISAs, long-term, tax-free savings accounts for children. In 2018 Resolution Foundation proposed £10,000 lump sum to 25 yr olds funded by larger inheritance tax.

Missing Big Fish – A wealth fund based on the stock of intangible capital created by public R&D spending. Needs lots of thinking about designing something here.

* www.sovereignwealthcenter.com puts Japan's new Government Pension Investment Fund as largest)

4. Time to worry and plan for AI/robot future



What, me worry? About work! You are MAD. I have funner things to do. If this time is different, it's the baby's problem, not mine. Google Alpha20 will be out when you hit the job market, kiddo. Good luck!

Alpha20? I hear it's smarter than me, works harder than me and is connected to the Cloud and the new quantum computer. And it never cries or makes dirty diapers. What am I going to do?



Party all the time?

Virtue all the time?

VR games all the time?

Act Sooner or Later?



Oh, Great C in the sky
Quantum Supremacy wiser,
By far than you or I
Should we act sooner
Or wait until later?



Factors that favor “sooner”

Need large fund paying citizens to compensate for stagnant/falling wages so start building funds. On order of of one years' GDP so would take 25-35 years to build from added savings.

Commitment creates pressure to keep investing in knowledge to resolve big global problems and raise output.

Later inequality will be higher, giving the few more power to oppose changes, reducing chances for success

Later machines will have less need for human co-workers, so capital owners less likely to agree, reducing chances for success.