Will a Robot Take Your Job? 2.0

June Zaccone[1]

Columbia Seminar on Full Employment, April 2018, slightly revised 10/18

ABSTRACT: Advances in workplace technology are announced almost daily. What effect are they having on job availability, and which jobs are threatened? Some question the impact of automation, citing slow productivity growth. Others see an immanent jobless world, a world without work. Why has automation apparently lagged, with new technology emerging far more rapidly than its use? What are the policies being proposed to provide income for those without work in a jobless future? This presentation will provide some tentative answers.

[Slide1-evol] We are at the beginning of a new industrial revolution. When I wrote the first version of this paper about a year ago, the evidence was murkier. Since then, there has been a wave of technical advances confirming this. These could lead us to effortless production matched with social disaster: workers without income, output without buyers, and much more. Computers are making decisions that once were subject to human judgment, like stock trading[2] or deciding whether a defendant gets bail. [Slide2-drone] They have changed the way we shop, get hired, and make war.[3] However, there is little evidence yet that they have created mass joblessness.[4] [Slide3-Prod] The expected speedup of productivity growth, which measures how fast output per worker is rising, has not happened.[5] Rather, according to the Bureau of Labor Statistics, [BLS], we are "in one of its slowest-growth periods since the end of WWII."[6] Europe's record[7] is even worse. China's productivity growth has fallen, too, though it exceeds rates elsewhere. If technology is rapidly displacing workers, it should show up here. Why doesn't it? More on this later.

First, a few definitions. Automation, the broadest term, has been in use since the 1950's. It can be as simple as an embroidery machine or as complicated as industrial robots[8] that build cars or software that plays games.[9] The latter use artificial intelligence [AI]—computer programs which simulate human thinking.[10] AI you might use includes Google search or Facebook. Robots are "automatically controlled, reprogrammable, and multipurpose," but the term can be used somewhat loosely, to include both devices that make cars or unload ships and those that choose stocks for hedge funds.[11] Once installed, these can work 24/7 at little cost without breaks, benefits, or grievances. With such breakthroughs as Alphagozero, which in 2017 beat the program[12] that had, [Slide4-KoreanGo] in 2016, defeated the 5th ranked master of Go, the world's most complicated board game, "Machines have crossed a threshold. They've transcended what humans can do."[13] [Slide5-alphagozero] Alphagozero learned strategy in 40 days by analyzing games and playing millions against itself. [Slide6-brakes] The potential for social upheaval of such advances has as little place on our political agenda as climate change. Like climate change, far more expect it to happen than expect it will impact them. Though three-quarters of Americans expect AI to destroy jobs, only one-quarter expect that it will be theirs.[14] Young people see it differently: a future dominated by AI, so that "Some Millennials aren't saving for retirement because they don't think capitalism will exist by then."[15]

Software can now perform tasks formerly deemed impossible: it translates foreign languages and drives cars. Assessments of the risks to human labor vary. Daniela Rus, who directs MIT's Computer Science and Artificial Intelligence Lab, has an optimistic take: the aim of robots is to assist workers, not replace them.

Doctors working with AI were better than either working alone in detecting cancer. [16] [Slide7-SanFran] Another example is a robot, that with human help, rents someone a house, just as tax software has supplemented the work of accountants. McKinsey consultants[17] agree that technology will replace tasks rather than entire occupations.

Her colleagues, Andrew McAfee and Eric Brynjolfsson,[18] while conceding a wage problem, are similarly optimistic: previous dire predictions have been wildly wrong, and a focus on jobs lost neglects those "new jobs and job categories" that will be created by technological change.[19] Who anticipated video game programmers; social media consultants; telemarketers; or those fighting robo calls? And illegal jobs: drug dealing empowered by cell phones;[20] or [Slide8-Atlanta] new forms of crime, like cyber-fraud.[21] Think of the promise of an MIT system that transcribes words only internally verbalized. In one test, it reported opponents' chess moves and got computer-recommended replies silently.[22]

Others, like an analyst at the OECD, believe that during the 21st century, it will be possible to automate virtually all work.[23] Stephan Hawking was one expecting an ultimate threat within the next century called "singularity," when computers replace human intelligence for everything and we become economically superfluous.[24] [Slide9-no-one] This slide sums it up: no one knows.

Estimates of transition speed vary widely.[25] According to a much-cited, extensive study by Frey and Osborne,[26] up to 47% of American jobs are at high risk of total automation in the next decade or two, especially low-wage jobs. The authors estimated the impact on several hundred occupations. Routine jobs are at risk; those involving human interaction or social intelligence are not.[27] So office support jobs, transportion, sales, construction and production workers are most at risk. Work requiring originality, negotiation, persuasion, manual dexterity, social perception and caring for others are all low risk.[28] Most management, business, and finance occupations, which require social intelligence, are low risk as are most occupations in education, healthcare, arts and media.

[Slide10-Bloom] Bloomberg mapped their predictions. Probability of being automated is on the horizontal axis; pay on the vertical. For example, physicians and surgeons are highest paid and least likely to be automated, and cashiers are low-paid and most likely.[fn1] Their site provides wages and probabilities for each occupation. [Slide11-Fed-skill] Thus far, only the share of middle-skill jobs has contracted.[29] A more recent study[30] reduced the Frey-Osborne numbers from 47% to just 10%, though others will require retraining. The authors tried to capture more variability within occupations, and consider "tasks that are difficult for computers to manage even within highly automatable jobs."[31] A recent MIT survey found US job loss projections for years 2025 to 2030 that range from 3.4 to 80 million, and concluded, "There is really only one meaningful conclusion: we have no idea how many jobs will actually be lost…."[32]

[1]Their average pay is $210 thousand; probability, 0.42%; cashiers: average pay $21, 680, probability, 97%.

Acemoglu and Restrepo estimated the effects of our relatively few manufacturing robots: every robot per thousand workers reduces wages up to three-fourths of one percent and replaces up to six workers, especially blue-collar men, resulting in the loss of an estimated 360 and 670 thousand jobs between 1990 and 2007.[33] In 1990, the manufacturing labor force was aboiut 17.5 million, so maximum loss was less than 4%. [In 2016, there were 18.9 robots per 1000 US workers,[34] so pay loss would be up to 14 percent.[35]] Manufacturing productivity grew rapidly in this period—over 4% a year.[36] Though these authors find the effect of machines more important than imports or offshoring, others[37] found that between 1999 and 2011, Chinese imports cost far more jobs—an estimated 985 thousand manufacturing jobs—about 17% of the 5.8 million manufacturing jobs lost during that time. Some researchers find little job effects from robots.[38] Spence and Hlatshwayo found nearly 98% of jobs added between 1990 and 2008 were in sectors that did not compete with imports, suggesting their importance.[39]

[Slide12-supply] The question may become more pressing as the supply of industrial robots rises, especially in Asia. China is by far the largest purchaser,[40] and leads the world in robot patent applications.[41] One global expert jokes that that the main difference between the US and China is not capitalism vs communism. "It is that one is run by lawyers and the other by engineers,"[42]

On a per worker basis, South Korea greatly outpaces it. China's drive reflects factories looking for skilled labor and college graduates who don't want these jobs, a shrinking labor force, and rising wages.[43] Chinese and foreign factory owners have a reputation as stingy and killing bosses.[44] Foxconn, producer of iphones, where some workers committed suicide by jumping out of factory windows, has a long-term plan of replacing most workers with robots, already underway.[45] Their interim plan is suicide prevention nets.

[Slide13–Mercedes] Robot manufacturing like that used by Mercedes-Benz auto is spreading from heavy industry to consumer electronics, clothing and others requiring greater precision.[46] Mercedes itself is retreating a bit, having learned that workers using more flexible robots beat full automation for smaller production runs.[47] [Slide14-cellphone] The incentive is production efficiencies. A Chinese cell phone factory more than doubled production and reduced defects despite firing most workers. Robots are also showing up in such services as medicine, cleaning, and inspection.[48]

This paper aims to explore the threat. What can robots do, and what can't be automated yet? What are some problems of computer-assisted decision-making? Why aren't there major job losses? How best to help those displaced?

Capitalism has chronic problems of unemployment. Even without recessions, the drive to lower cost replaces jobs. Concern that machines would degrade work has a long history. [Slide15-Ludd] The resistance of English textile workers known as Luddites is the most famous.[49] The deprivation of many workers led them to attack machines. Even if long term job creation more than offsets short-term job loss, the experience of 19th century Britain shows that the transition can be traumatic. Decades passed before factory wages and conditions

improved. Similarly for the US: "about six decades for … wages to recover ... after the first industrial age automation of the 1810s."[50] Governments, despite popular struggle,[51] took up to a century to respond with new education and welfare systems. This time the transition is likely to be more disruptive:[52] transfer speed is faster, and effects are global. The US version of worker resistance is the Trump victory, according to a study by British researchers. With robot adoption 2 percent lower during 2011-15, Michigan, Wisconsin, and Pennsylvania would have gone Democratic.[53]

The threat of automation dates from the 1950's,[54] with cars, steel and other industries.[55] Another wave began in the 1980s, with computers replacing secretaries. Each time, automation threatened jobs. Each time, technology created more jobs than it destroyed. Will it be different this time?[56] ATMs replaced bank tellers, but made new branches cheaper. Their spread created more jobs in sales and customer service. Only now are jobs for bank tellers declining.[57] E-commerce at first increased overall retail employment, though it is now stagnant. Unfortunately, most jobs created are for people other than the ones who lost them. Male English artisans lost their jobs to children, about half the textile workforce in the 1830's.[58] The teller unqualified for a job with Google may be demoted to one at McDonalds. Some industries have already been transformed. The Blockbuster video chain disappeared completely, with new ways of delivering films. Physical formats of music, especially cd's, have been decimated, though recorded music revenues, especially from streaming, have risen since 2010.[59]

Unlike early automation, which replaced hand labor, AI affects professions—loan officers, lawyers, and journalists. When jobs were destroyed in agriculture, others were created in factories; later, factory automation was offset by service jobs. Today there is no such obvious replacement sector, though we have a poor record in predicting new industries.[60]

Let's look at some of what computers already do.

- [Slide16-surgical] In the medical field, they read images, stitch soft tissue, outperforming their teachers; [61] help with knee replacements,[62] and do intial diagnosis. [63] [Slide17-Rehab] Robots have helped to provide physical therapy for decades. Here one guides limb movements of recovering stroke victims,[64] [Slide18-frail] or moves patients.
- Computer programs write copy faster than writers, so Associated Press publishes quarterly earnings reports for 4,000 companies, up from 400.[65] [Slide19-sports] Though sports reports provide the facts, they lack the human interest of the writer [in blue].
- Chatbots, robots simulating human speech, are coaching call-center workers. The software might recommend talking more slowly or warn that the customer seems upset. They can also be used for customer service themselves.[66] Robots clone a voice after listening to a few brief samples and can fool a voice-recognition system most of the time.[67]

- In Turkey, AI and robotics repair potholes. Replacing the usual patches, "the equipment precision-cuts out the pothole and an area around it and vacuums up waste. The hole is filled by a robotic arm with an exactly-size plug. This expands to form a smooth, tight-fitting bond. The repair takes less than two minutes, and at far lower cost, outlasts traditional methods.[68]
- [Slides20-hotel] Japan's scarce labor encourages robot use: a hotel mostly staffed by robots;[69] another has self-parking slippers;[70] [Slide21-JapanTab] drones supplement scarce construction workers. [71] They do site surveys, add results to blueprints which are downloaded to construction equipment via satellite. The system guides operators--even the inexperienced.[72] Collaborative robots, "cobots," save labor without replacing it in small-batch manufacturing and simple processes like packing rice balls.[73]
- {Slide22- Security] Security robots—fortunately, still problems.[74]
- Autonomous trucks threaten 3½ million drivers.[75] Michigan allows them, traveling in fleets at electronically coordinated speeds.[76] An Uber self-driving car has already killed a pedestrian. In California, they violated traffic laws, like going through red lights.[77] China is testing "smart roads for [its] smart cars," including electric-battery rechargers.[78] [Slide23-Taxi] An autonomous flying taxi is being tested in New Zealand.[79]
- [Slide24-Rembrandt] With help from Dutch art historians,[80] AI and 3-D-printing produced a portrait similar to a Rembrandt. [Slide25-Furness] More useful, robotic tools aid artists, but put assistants out of work.
- A robot lawyer, DoNotPay,[81] which began as an aid to contest parking tickets. It's free, and in its first 21 months, won neaerly two-thirds of thousands of appeals it accepted in London and New York.[82] It now functions across the US, and has extended its services to make people aware of their legal rights. Refugees can file immigration applications,[83] and others can deal with "data breaches, late package deliveries, and unfair bank fees," or sue corporations. It is still free.[84]
- Walmart's shelf-scanning robots check missing labels, prices, and update inventory.[85] Here is Amazon's warehouse operation. [Slide26-AmazonWareh]
- [Slide 27-McDonald] McDonald's app lets diners place orders for pickup. Ordering kiosks store customer choices and check the weather so menus can highlight items preferrd on hot, cold or rainy days.[86] These gave McDonald's 50% more revenue per worker than the previous year but overwhelmed with extra work, workers are quitting.[87]
- You'd think actors or weather reporters would be safe. They're not. In a 2006 film, Superman lands a plane in a crowded baseball stadium. 50,000 people were portrayed by 200 extras; everyone else was digital. [Slide28-Hepburn] A new technology permits the use of dead actors,[88] like Audrey Hepburn: computer-generated imagery was imposed on a young actor's body.[89] Not great acting yet, but perhaps a future

threat.[90] A Microsoft robot reports on the weather on live TV in China, using "big data to learn about and interpret weather readings." It scored as nearly human in tests of linguistic naturalness.[91]

- A Chinese-owned Arkansas factory combines machine vision and robots to sew a projected 23 million T-shirts a year, one each 26 seconds for 33 cents. One worker managing robots replaces 17. The software was developed by American engineers with a DARPA grant.[92]
- A few hundred traders on the New York Stock Exchange replaced thousands working in 2000, with algorithms making trading decisions. Goldman-Sachs warns[93] that greater "financial fragility" results.[94]
- An algorithm "trained on millions of reactions" permits chemists to create organic compounds, like new drugs, with much less research.[95]

Computer programs can plow through massive data sets—loan applications, résumés, or teacher evaluations—and choose the top candidates, making decisions once performed by professionals.[96] AI is a major force driving new technology, such as speech recognition, used by Apple's Siri; machine translation; and expert systems. These are programs which embody the knowledge of experts, such as those making high-risk credit decisions.[97] [SLIDE29-Simon78%] Herbert Simon,[98] an economics Nobelist, all-round genius, and a supporter of NJFAC, and Allen Newell invented the field of AI in the 1950s. [Slide30-AIDeep] It is embodied in algorithms, which are a step-by-step set of operations that guide a computer in problem-solving. Alan Turing, the British mathematician who broke the enigma code, wrote the first ones.[99] At first, programmers had to write programs defining the task accurately and completely. This is limiting, as tasks such as translation are too complex for definition.[100]

Some algorithms now allow computers to learn on their own, called machine learning.[101] This type of AI permits algorithms to improve their own performance.[102] Programmers choose the right algorithm and train it with large data sets, say hundreds of thousands of images labeled "this is a dog; this is a cat."[103] These permit it to learn a task, as simple as spam filters for email.[104] The software then creates rules on how to analyze new data. Machine learning guides Facebook's news feed,[105] and data mining, used for directed marketing. The software corrects itself through trial and error, made rapid with current computing power.[106] It discovers which answer has the highest probability of being right.[107]

Deep learning is an advanced form of machine learning that requires less programmer intervention, and is inspired by the way the brain understands new information. It is now being used to design other software—so software designers, too, will lose jobs.[108] Google Translate,[109] facial recognition,[110] and teaching self-driving cars to merge on a 4-lane highway also come from deep learning.[111] Given sufficient images, it can recognize a pedestrian at a crossway,[112] and "can now text jaywalkers a fine."[113]

No one could program computers to do this,[114] and in fact the programmers don't know how the algorithm works.[115] "They are difficult (sometimes impossible) to understand, tricky to debug, and harder to control."[116] Researchers are now trying to reverse engineer the process, to find out where a choice was made,

and how much it influenced the results.[117] This is important, as algorithms, guided by racially-based training data provided by insensitive or biased programmers, can make biased or erroneous decisions.[118]

Algorithms that determine what an object is–say, a dog or a pedestrian–have a vulnerability called an adversarial example.[119] The object looks one way to the human eye, but the algorithm sees it differently: for example, a 15 mph road sign interpreted as a yield sign. Google researchers convinced a computer that any object is a toaster. With the method available online, hackers can duplicate it, and as yet there is no defense.[120]

Google Translate was highly inaccurate and almost useless when it was launched in 2006. The latest version is a smartphone app that permits both typing and speaking text. The user can then either read or hear the answer. Not yet perfect, it's a threat to translators and a boon to travelers who don't know Czech, Yoruba, or others of more than 100 languages. Scanning text with the phone's camera permits reading street signs, all for free. Its improvement shows off deep learning. Translate has absorbed "gigantic quantities of parallel texts." One particularly good source has been the European Union's official publications, available in all member languages.[121] The system translates not only what it has been directly instructed to do, but once it could translate English into Korean and back, as well as English to Japanese, it was able to translate Korean directly into Japanese.[122]

[Slide31-Translate] Here are three versions of a passage of Hemingway. The first is a translation from the Japanese done before the recent advance; the second is Hemingway, and the third is the current version of Translate, almost perfect with a few exceptions in red.

If jobs of the future are only those that computers can't do,[123] which skills are best to cultivate? Brynjolffson and Mcafee sum up three areas where we still beat machines:

- **Creative endeavors** such as writing, entrepreneurship, and scientific discovery. Though computers have written music in the style of Bach, and painted in the style of Picasso,[124] this is not artistic creation.
- **Social interactions** depend on tacit knowledge, most difficult for robots. People sensitive to the needs of others make good managers, salespeople, nurses, and teachers. Consider, for example, the plight of a robot giving a pep talk to a sports team. Digital assistants lack the range of human speech and knowledge of what it means. This might require computers that match human intelligence.[125] Jobs for those with both cognitive and social skills are expanding.[126] However, just as we prefer a handmade pot or gourmet cuisine, but sometimes end up with a plastic plate or food from McDonald's, so too we may prefer the care of humans but end up with online courses or robot care when their relative cost plummets.
- Even a child is better than a robot at picking up a pencil. Humans have **great agility and physical dexterity**. Gardening and housekeeping are mostly not well done by robots. A robot can't do the work of a skilled hair cutter, which combines dexterity with creativity. Bricklayers seemed safe, according to a report[127] in March, contradicted by another report less than two weeks later:[128] that machines can lay brick

several times faster than workers. Robots to replace burger makers are so far unsuccessful—they require too much human help and are too slow.[129]

But robot dexterity is improving: [Slide32-backflip] A robot developed for the military can now do backflips, a technical marvel, indicating that robots can become as agile as we are.[130] It's not clear what job this flip will replace, but killer robots seem to be on the agenda. Human-robot interaction is overcoming some limitations of robot physical dexterity. The human operator sees what the robot sees through special googles, then makes the movements required of the robot. This is useful for disaster intervention, or operating in a toxic environment.[131]

It is cheering news that the humanities may make a comeback. Of Google's ranked list of traits of its best managers, technical skills is the 8th—after human relations skills, such as empowering and listening to others,[132] though of course all Google employees have high technical skills. A labor economist agrees—skills that will endure are understanding people and cultural sensitivity rather than narrow technical training, and these are best developed studying the humanities.[133]

The new technologies threaten more than jobs. They have increased inequality, reduced privacy and sometimes discriminate. Critic Cathy O'Neill[134] warns, "Decisions [on]—where we go to school, whether we get a car loan, how much we pay for health insurance—are being made …by mathematical models. In theory, this should lead to greater fairness: Everyone ...judged ...[by]the same rules…. But… the opposite is true. The models …are opaque, unregulated, and uncontestable…. Most troubling, they reinforce discrimination: …"[135] An example: "in Florida, adults with clean driving records and poor credit scores paid an average of $1552 more [for auto insurance] than [similar people] with excellent credit and *a drunk driving conviction.*"[136] Judges in more than 45 states use algorithms to rule on parole, "or even influence jail sentences."[137]

Evaluating criminal defendants with algorithms raises serious issues. The data come partly from police reports, often race-biased. The other source, usually a questionnaire, also poses problems. Some ask defendants for their family history of trouble with the law, unconstitutional if asked in court. When embedded in a defendant's score, it is considered "objective."[138]

A Harvard PhD with an African-American name was shocked to find a Google search with ads asking, "Have you ever been arrested?"—ads not appearing for white colleagues. Her study found that Google's algorithm was inadvertently racist—it linked names likely for black people to ads relating to arrest records.[139] [Slide 33-Hair] Algorithms can easily encode prejudice and misunderstanding. These images of "unprofessional hairstyles"[140] featuring predominantly black models are a good example. Some algorithms wait for a weather forecast before setting work schedules, making it impossible for workers to plan for childcare, schooling, or a second job.[141]

Despite their power over our lives, their verdicts are beyond appeal, and frequently punish the poor.[142] McDonalds is more likely to choose employees with software than Goldman Sachs. Virginia Eubanks, who wrote *Automating Inequality*, warns that AI provides "the emotional distance that's necessary to make what are

inhuman decisions."[143] She describes the Indiana welfare system, which assumes that most people in the system are frauds and don't need help. AI rules reflect that, so any mistake in a multi-page application threatens eligibility.[144] The drive to raise efficiency creates a drive to automate thinking.[145]

Computer decision-making has the potential to overcome individual prejudice, say that of judges, but only if algorithms are transparent and there is some scope for changing them to correct their shortcomings. There are some limited attempts now to do this.[146]

Machine learning combined with big data is very powerful. [Slide34-faceAd] Facebook, Twitter and other platforms monetize our data by creating detailed user profiles to help advertisers target us. Facebook collects data on non-users, too.[147] Retired Harvard Business School professor Shoshana Zuboff describes this as 'surveillance capitalism.'[148] These services derive value from their invasion of privacy.[149] "Free" electronic toothbrushes beam brushing data to insurance companies.[150] Robotic vacuum cleaners collect data about our rooms, so that companies like Amazon can ply us with advertisements for furnishings we currently lack.[151] It is telling that Amazon spent more on R and D last year than Google, Apple or Microsoft. [152] A psychometrics researcher using Facebook responses claims that his model, using only ten "likes" could judge someone's character more accurately than the average coworker; with seventy, more knowledge than a friend, and with 300 likes, predict behavior better than a partner.[153] This program helped Trump.[154] AI provides managers with unusual control of employees, like monitoring their online social activity or every computer keystroke. Amazon has patented a wristband that can track worker hand movements, and vibrate "to nudge them" into greater efficiency.[155] Surveillance contributes to killing workplaces.[156] Social media and tracking apparently have created such problem for human agents trying to live under assumed identities that the CIA is moving from humans to computers.[157]

Facial recognition is useful for verifying some financial transactions. However, Facebook, Instagram, and Twitter have already given access to a surveillance company used by law enforcement as a tool targeting activists and protestors.[158] An FBI Database including photos of half of US adults has a nearly 15% error rate, and is more likely to misidentify black people.[159] Cameras at facilities such as Madison Square Garden and NASCAR Raceway scan faces for an age range, gender and sometimes attention to get a better idea of audience demographics. Then an algorithm compares faces to a database to help identify the person, and if for security, to determine if there is a risk.[160] US airports have begun this, despite a report that it "is not so good at identifying ethnic minorities" because most subjects that trained it were white, nor those wearing glasses, hats or scarves.[161]

Miracle technologies don't always work. [SLIDE35-Facial] In 2016, Carnegie-Mellon researchers used glasses costing 22 cents to fool facial recognition systems. These rely on facial details, like the shape of a nose. The glass frames were printed with patterns read by the computer as details of another person. This achieved up to 100% success in misidentification. In one test, a white male subject was identified as a female actress with

"with 88% accuracy." Colin Powell, and John Malkovich were also misidentified.[162] The systems have had a chilling improvement—Chinese police used such glasses to catch a fugitive in a crowd of about 50,000.[163]

Consider the decisions that must be built into self-driving cars, such as who should be sacrificed in an impending accident?[164] People want other drivers to use ethics codes that could sacrifice passengers, but they want cars that protect themselves at all costs.[165] And then, how to thwart mischievous hackers?[166] These questions are urgent, as these cars are already on our roads. [167]

There is also an issue of spurious search results. [Slide36-google] A student asked a history professor whether Warren Harding had been in the Ku Klux Klan. The professor was mystified until another student pulled up a report[168] headlined, "Google's Featured Snippets Are Worse than Fake News." The problem stems from a system change to give direct answers to questions above the usual list of web pages. Mass murderer Dylann Roof claimed a Google search on "black on white crime" led him to massacre nine people in a South Carolina church. Matches on "black on white crime" rather than "statistics on crime rates by race" give links to racist sites with their own facts.[169] These have been corrected. [Slide37-Hawaii] As we hand more tasks to computers, malfunctions are more disruptive, like the false report of a missile attack. Philosopher Daniel Dennett recommends that AI developers be licensed and required to accept liability for their product, forcing them to divulge known problems.[170] Europeans are already battling over robot personhood: should robots be held responsible for damages they cause or manufacturers?[171]

As previously noted, productivity growth has slowed while technological change is faster.[172] Robert Solow's 1987 quip still holds: "You can see the computer age everywhere but in the productivity statistics." What is the problem—are productivity measures wrong? Or is implementation of available technology impeded? Some contest our productivity measures as failing to capture all improvements. Free services from Google, Spotify and others are paid for by advertising, not consumers. The free digital economy is valued at production cost, so undervalued.[173] Others challenge the mismeasurement thesis,[174] as there have been parallel slowdowns in many countries, with varying engagement in the digital economy.[175] They also point to new costs, like a cell phone and internet connection, necessary because everyone you know is connected and public phones don't work, or antivirus programs, unnecessary before we were continuously on-line, also improperly counted.[176]

Economist Robert Gordon is an outlier, arguing that today's innovations are less transformational than those in the past. [177] Manufacturing, a major use of robots, accounts for only eight percent of U.S. employment; warehouses, a little more. He predicted robots won't soon replace us in services or construction.[178] In 2016, he said, "Robots are having trouble standing up without falling over. Robots are having trouble walking up and down stairs. Robots don't have the dexterity to open bottles of pills."[179] [Slide38-dishes,stairs] All these have been solved.[180]

Economist Dani Rodrik's answer is that technology's major impact has been on media, information and communications technology. These don't employ a major part of the labor force and affect less than 10% of output. [181] The average American spends more than a fifth[182] of waking hours watching tv or using a computter for leisure, like gaming. "The robots aren't taking our jobs; they're taking our *leisure.*"[183] There has been little innovation where consumers spend the most, like health, education, transportation, and housing. Government and health care, for example, have had almost no productivity growth. These two sectors account for more than a quarter of output.[184] Until technology spreads, job loss will be limited.

Brynjolffson and co-authors[185] conclude that implementation lags are the most likely reason. The full realization of AI technologies requires complementary changes, some of which are costly. These include other investments, redesign of supply chains, and retraining. And it is not only the cost of capital—overhauling systems to use robots is complicated and risky. *Economist* editor, Ryan Avent, has a convincing explanation: robots have pushed workers into the low-productivity, low-wage service sector because of our weak safety net. And "workers are too cheap" to improve technology elsewhere.[186]

[Slide39-growth] Extending Brynjolffson's and Avent's insights, another likely barrier is growth constraints stemming from weak demand and other causes. Growth has slowed since 1991, and our current expansion is the weakest of the postwar era. [Slide40-emratio] A recent study[187] of the decline in the ratio of employment to population [the emratio] between 1999 and 2016 finds that a decline in labor demand, in particular, the effects of imports and robots, had the greatest effect, with trade the largest. These two accounted for 35% of the decline.[188] Autor and colleagues found that Chinese imports reduced US firms' research spending, global sales and jobs in manufacturing, a major source of innovation.[189]

[Slide41-Investment] Slow growth reflects sluggish investment. Reasons are various—for example, weak consumer demand and rising industrial concentration, cited by the *Economist*, an unlikely source of business critique.[190] Monopoly firms make entry of startups more difficult, and have themselves little incentive to innovate, despite record high profits.

Weak demand is related to austerity, stagnant wages, and rising inequality. [Slide42medianpay] These are median wages for recent college and high-school graduates, both now slightly lower than in 1990**.** Wage stagnation has endured for so long that it has finally captured important attention. [Slide43-saving%] The rich save more and spend less. McKinsey recently concluded that "weaker demand leads to weaker investment and creates a vicious cycle for productivity and income growth." They attributed weak demand to inequality as well as wages, but recommended only wage increases.[191] Real minimum wages are below their level 50 years ago, and men's median wages have been stagnant[192] nearly as long. "… why would businesses *en masse* invest in automation …if they can find desperate workers willing to be paid minimum wage?"[193] "Willing" or not, many have little choice. Weak wages reflect primarily weak worker power[194] and weak growth. A recent study found wages are kept low by employers' excessive power in labor markets. For example, "one in five workers with a

high school education or less are subject to a noncompete" agreement, meaning that they can't work for a competitior.[195] Nor can they move from one Burger King to another.[196]

There have been investment problems since at least 2000, and probably before, helping to explain the push for privatization of government services, like education, which accelerated with the Reagan Administration.[197] What is safer for investors than buying an already existing revenue base? Government investment as a share of output has also declined, reinforcing the problem. What also changed with Reagan was a rule change permitting stock buybacks.[198] Of the S&P 500 companies, 461 used 54% of total profits between 2007 and 2016 to buy back their stock. An additional 39% went to dividends.[199] It is hard to claim they need tax cuts to finance investment when these uses absorbed of 93% of profits. The financial sector prefers consumer apps like Snapchat over hardware. Some startups reported that "Chinese money was sometimes the only available funding."[200] Perhaps after Chinese entrepreneurs take the risks that new technology requires, their success will inspire US companies to imitation. However, our lack of either social supports for workers or prudence in adopting technology makes slow innovation a saving grace.

[Slide-44TechDeg] Workers, often blamed for lacking skills, are urged to get more education, despite graduates with technical degrees exceeding projected jobs for them. [Slide45-educjobs] The role of education either in explaining unemployment or protecting jobs is much exaggerated: in 2016, 63% of jobs, highlighted, required only a high-school degree or less, according to the BLS. Though jobs requiring at least a college degree are projected to grow faster, the majority of jobs in 2026 is still projected to be for high-school or less.[201] [Slide46-ColGradWages] For nearly three decades, roughly one-third of college graduates have worked in jobs not requiring a college degree,[202] [Slide46sharegood] and the share of those in"good" non-college jobs has diminished.[203] A "good" job is described as paying at least $45 thousand, a rather low bar. There is so far no evidence of a skill shortage except perhaps in specialized areas.

It's not only wages that evidence the deterioration of work. Katz and Krueger conclude that 94 percent of net job growth between 2005 and 2015 apparently came from the gig economy, now nearly 16 percent of jobs. [204] These are powered by AI.

The unanswered question is, will the jobs available absorb the whole work force? The *New Yorker*'s Elizabeth Colbert[205] warns, "if it's unrealistic to suppose that smart machines can be stopped, it's probably just as unrealistic to imagine that smart policies will follow." Our problem is politics; not technology. We could plan for those deprived of a job, *either* as growth lags *or* innovation speeds up.[206] The prospect of robots taking over much work, especially drudge or dangerous work, "should fill us with joy."[207] If we could find ways of distributing the new wealth, AI could be a challenge rather than a disaster. Unfortunately, even our data sources are deficient for tracking and predicting AI impacts.[208]

Change is inevitable, but its speed and whether those losing are made whole determine the level of misery.[209] Something is clearly necessary, given the catastrophe already faced by some: the rise in death rates

for less educated whites since 2001 rivals the AIDS epidemic.[210] Many pundits recommend that workers get better training.[211] However, with rapid change, improving education will always be "too little, too late," [212] with students and workers having to "reinvent themselves over and over and faster and faster."[213]

According to Brian Arthur, production is now sufficient for everyone to have "a decent middle-class life," but access is "tightening."[214] He doubts that jobs lost will be replaced, so access to goods for those without earned income will be contentious. The late Stephen Hawking agrees, "Everyone can enjoy a life of luxurious leisure if the machine-produced wealth is shared, or most people can end up miserably poor if the machine-owners successfully lobby against wealth redistribution. So far, the trend seems to be toward [misery] …."[215] Arthur reminds us that Keynes in "Economic possibilities for our grandchildren," [1930] predicted technological unemployment by 2030. Here Keynes described the coming era of plenty as one in which we can recognize "the love of money as… a somewhat disgusting morbidity."[216] The major problem he saw was "how to occupy the leisure," not access to livihood.

What policies are worth fighting for? Libertarians, especially, favor a basic income guarantee. Finland[217] and Canada have conducted trials, but Finland has recently cancelled theirs.[218] Everyone would receive it, so its cost would be enormous. $10,000 a year for every American over 18, not exactly a life of luxury, would cost an estimated $2.5 trillion a year[219]—as a measure of its size, consider that it amounts to three-quarters of all taxes collected by the federal government in 2016.[220] Some supporters of a basic income propose a services guarantee, such as education, health, housing, and transport, a good beginning.[221] Many, including the National Jobs for All Coalition, the Modern Money Network, the Center for American Progress,[222] and politicians such as Senators Bernie Sanders and Kirsten Gillibrand, prefer a job guarantee over an income guarantee. [The recent California Democratic Party platform favors both.[223]] This would provide useful and necessary goods and services, cost less, maintain morale and skills of those who would be otherwise unemployed, and provide standards for good work and its satisfactions.

As taxes based on income will fall with jobs,[224] how can social programs be financed? The Modern Money Theorists have shown that so long as resources are unused, governments, like that of the U.S., which controls a currency internationally accepted can fund projects through credit creation. There is a resource constraint on such economies but not a funding constraint. So long as real resources are available, there is no economic reason to use taxes to fund spending.

However, taxes on the rich remain highly useful for other reasons—in particular, curbing their political and economic power and reducing inequality. Warren Buffett agrees with Herbert Simon that social capital has fueled a major portion of individual wealth: "If you stick me down in the middle of Bangladesh..., you find out how much this talent is going to produce in the wrong kind of soil." Simon estimated that at least 80 percent of what we earn comes from "being a member of an enormously productive social system."[225] Yet the fruits of our common inheritance aren't broadly shared. They flow mostly to owners of capital. These social benefits–-a

publicly-trained work force, public infrastructure, global technology created over centuries—more than justify generous social programs, jobs for those who can work, and cash for those who can't.

[Slide48-iphone] Mariana Mazzucato argues in favor of socializing both risks and rewards of government-sponsored research rather than privatizing the rewards. Government ownership of a small share of the intellectual property it has helped create would let the public share in an "innovation dividend."[226] Public wealth, then, would grow with robots. Like the iphone, my Roomba vacuum cleaner benefitted from publicly-finded research. It uses an algorithm similar to a bomb disposal robot.[227] The inventor also created the multi-purpose robot Baxter.

Let's begin the innovation dividend with vacations—what about a month for everyone—[Slide49-hours] and shorter work hours, starting with stressful jobs. Our yearly work hours are about the longest in the industrial world.[228] Work for many is monitored and intense. New Deal programs that restored the environment and provided infrastructure and other public goods are a fine model for jobs programs. Even Clinton's Treasury Secretary, Robert Rubin, now supports one.[229] So long as there is work that needs doing, we should favor a government guarantee of a job at a decent wage, with shorter work time, generous pensions, healthcare, and support for life-long learning.

---

[1]The author is Assoc. Prof. Emerita of Economics, Hofstra University, Board Member Emerita, National Jobs for All Coalition, and former co-chair, with Prof. William Vickrey, of the Seminar.

[2] "After propelling the market to historic highs, passive investment strategies — which follow a simple set of rules and are carried out by sophisticated computer programs, not humans — are among the factors fueling the market's recent plunge." https://www.nytimes.com/2018/02/09/business/etf-index-funds-market.html

[3]"Some AI is already on the battlefield. The F-35, one of America's most advanced jet fighters, uses AI to evaluate and share radar and other sensor data among pilots, expanding their battlefield awareness." https://www.wsj.com/articles/the-new-arms-race-in-ai-1520009261#comments_sector https://www.techemergence.com/military-robotics-innovation/ "The module would receive intelligence data from the field, determine the strength of the enemy, run through air assets available, identify the best ordinance to employ and feed options back to a field commander along with the risks….The program has applicability beyond field use, however, and has been used to sift through "documents that interrelate, but are not obvious. It can relate it by topics, let's say, rather than keywords… All of this helps speed up the process of decision-making for the end user, he said. "The average is 400 times faster than the process that is being automated," https://www.armytimes.com/news/your-army/2017/10/11/artificial-intelligence-accelerates-decision-making-for-field-commanders-company-says/ Google is helping with AI for military: https://www.extremetech.com/extreme/265145-google-pentagon-project-maven-ai-military-drones

[4] http://www.epi.org/publication/robots-or-automation-are-not-the-problem-too-little-worker-power-is/

[5] "Information technology fueled a surge in U.S. productivity growth in the late 1990s and early 2000s. However, this rapid pace proved to be temporary, as productivity growth slowed before the Great Recession." http://www.frbsf.org/economic-research/publications/economic-letter/2015/february/economic-growth-information-technology-factor-productivity/

[6] https://www.bls.gov/opub/btn/volume-6/below-trend-the-us-productivity-slowdown-since-the-great-recession.htm

[7] https://www.mckinsey.com/global-themes/meeting-societys-expectations/solving-the-productivity-puzzle pg. 3; https://www.economist.com/blogs/graphicdetail/2013/02/focus-3

[8] https://www.techemergence.com/global-competition-rises-ai-industrial-robotics/

[9] https://www.computerscienceonline.org/cutting-edge/automation-ai/

[10] http://www.computerworld.com/article/2906336/emerging-technology/what-is-artificial-intelligence.html

[11] https://www.cognizant.com/whitepapers/the-robot-and-I-how-new-digital-technologies-are-making-smart-people-and-businesses-smarter-codex1193.pdf and http://seekingalpha.com/article/3965499-hedge-fund-employs-robot-analysts-pick-stocks-financial-advisors-daily-digest

[12] AlphaGo Zero 40 days to teach itself to best the program that beat the Korean Go master, and is now apparently beyond any human player. https://deepmind.com/blog/alphago-zero-learning-scratch/ "Over the course of millions of AlphaGo vs AlphaGo games, the system progressively learned the game of Go from scratch, accumulating thousands of years of human knowledge during a period of

just a few days. AlphaGo Zero also discovered new knowledge, developing unconventional strategies and creative new moves that echoed and surpassed the novel techniques it played in the games against Lee Sedol and Ke Jie."

[13] What the AI Behind AlphaGo Can Teach Us About Being Human, http://www.wired.com/2016/05/google-alpha-go-ai/

[14]https://www.nytimes.com/2018/03/06/us/artificial-intelligence-jobs.html 69% believe that climate change is happening; 52% believe it won't affect them. http://climatecommunication.yale.edu/visualizations-data/ycom-us-2016/?est=happening&type=value&geo=national

[15] https://safehaven.com/article/45181/Millennials-Are-Waiting-For-The-End-Of-Capitalism Quoted from https://www.salon.com/2018/03/18/some-millennials-arent-saving-for-retirement-because-they-do-not-think-capitalism-will-exist-by-then/

[16]"Jobs Are Going Extinct. But That Doesn't Mean We Have To,"https://futurism.com/jobs-extinct-doesnt-mean-we-have-to/ 2/13/18

[17] https://www.technologyreview.com/s/603370/robots-will-devour-jobs-more-slowly-than-you-think/ McKinsey estimates that 60% of jobs will be affected, but only 5 percent will be completely lost. The Future of the Professions: How Technology Will Transform the Work of Human Experts

[18] https://www.linkedin.com/pulse/why-how-many-jobs-killed-ai-wrong-question-andrew-mcafee

[19] https://www.socialeurope.eu/2016/09/robotics-fascination-anthropomorphism/

[20] https://ursulahuws.wordpress.com/2017/01/29/the-future-of-work/

[21] http://fortune.com/2018/03/28/city-of-atlanta-cyber-attack-cybersecurity-risks/https://hbr.org/2014/12/what-happens-to-society-when-robots-replace-workers

[22] http://news.mit.edu/2018/computer-system-transcribes-words-users-speak-silently-0404

[23] http://www.vice.com/read/every-job-could-be-a-casualty-of-the-robot-revolution

[24] https://futurism.com/stephen-hawking-ai-replace-humans/

[25] http://www.computerworld.com.au/article/594562/u-sees-robots-taking-well-paying-jobs/ 51% earned $20/hr or less [2014] http://www.marketwatch.com/story/a-majority-of-americans-make-less-than-20-per-hour-2014-11-14

[26]"we rely on the 2010 version of the DOT successor O∗NET–an online service developed for the US Department of Labor….O∗NET has the advantage of providing more recent information on occupational work activities." Frey and Osbourne Tasks are not included. P.43 http://www.oxfordmartin.ox.ac.uk/downloads/academic/future-of-employment.pdf

[27] http://www.lrb.co.uk/v37/n05/john-lanchester/the-robots-are-coming and http://www.businessinsider.com/jobs-that-robots-will-take-2016-8

[28]Frey et al, Table I, p. 31http://www.oxfordmartin.ox.ac.uk/downloads/academic/future-of-employment.pdf

[29]Bain consultants recently estimated 20% to 25% of current jobs by 2030, with middle- to low-income workers hit hardest. *Automation's impact on inequality*, http://www.bain.com/publications/articles/labor-2030-the-collision-of-demographics-automation-and-inequality.aspx#chapter3 *Jobs Lost, Jobs Gained*, 12/17, https://www.mckinsey.com/global-themes/future-of-organizations-and-work/what-the-future-of-work-will-mean-for-jobs-skills-and-wages 23% of work by 2030. Exhibit E2, p. 3, World Bank and McKinsey, and p. 11.

[30] Nedelkoska & Quintini, "Automation, skills use and training," OECD http://dx.doi.org/10.1787/2e2f4eea-en p. 48

[31] https://www.theverge.com/2018/4/3/17192002/ai-job-loss-predictions-forecasts-automation-oecd-report

[32] https://www.technologyreview.com/s/610005/every-study-we-could-find-on-what-automation-will-do-to-jobs-in-one-chart/

[33] Acemoglu & Restrepo, Robots And Jobs: Evidence From Us Labor Markets, p. 36, http://www.nber.org/papers/w23285 "The paper adds to the evidence that automation, more than other factors like trade and offshoring …has been the bigger long-term threat to blue-collar jobs. The researchers said the findings …remained strong even after controlling for imports, offshoring, software that displaces jobs, worker demographics and the type of industry." Labor force in 3/18 was 155 million, 127 mill full-time. [Table A-9] https://www.bls.gov/news.release/empsit.nr0.htm . https://www.nytimes.com/2017/03/28/upshot/evidence-that-robots-are-winning-the-race-for-american-jobs.html

[34] https://ifr.org/ifr-press-releases/news/robot-density-rises-globally "Industrial robots really are gaining ground. Their use has grown more than fivefold since the early 1990s, adding up to about 1.75 robots for every 1,000 workers." https://www.bostonglobe.com/business/2017/05/05/why-aren-robots-boosting-economic-productivity/GnrAb7Lx1HCtrjMiD1KY5J/story.html

[35] My calculation.

[36]https://www.bls.gov/lpc/prodybar.htm

[37] Autor, Dorn, & Hanson, 'The China Shock: Learning from Labor-Market Adjustment to Large Changes in Trade," www.annualreviews.org 2016. 8:205–40, about 2.4 million jobs in total.

[38]David Autorand David Dorn found only a slight net effect on jobs, though technology has polarized the labor market, expanding jobs for the educated and less-skilled and increasing earnings inequality. "The Growth of Low-Skill Service Jobs and the Polarization of the U.S. Labor," http://hdl.handle.net/1721.1/82614 His recent study finds no employment effect, but a decline in labor's share from robots. Autor & Salomons, "Is Automation Labor-Displacing? Productivity Growth, Employment, and the Labor Share," https://www.brookings.edu/wp-content/uploads/2018/03/1_autorsalomons.pdf 2/18

[39]Sectors like government and health. M Spence & S Hlatshwayo, "Evolving Structure of the US Economy," https://link.springer.com/content/pdf/10.1057%2Fces.2012.32.pdf

[40] https://ifr.org/downloads/press/Executive_Summary_WR_2017_Industrial_Robots.pdf
[41] https://www.google.com/patents/US7369686 apparently includes pure AI, like facial recognition https://www.weforum.org/agenda/2016/05/the-rise-of-the-robots-how-the-market-is-booming
[42] http://www.scmp.com/business/global-economy/article/2081771/be-afraid-china-path-global-technology-dominance
[43] qz.com/599508/charted-chinas-rapidly-shrinking-working-age-population/
[44] http://www.nytimes.com/2013/01/25/business/as-graduates-rise-in-china-office-jobs-fail-to-keep-up.html
[45] http://www.ubergizmo.com/2017/01/iphone-manufacturer-foxconn-replace-all-human-workers-with-robots/
[46] http://www.wsj.com/articles/chinas-factories-count-on-robots-as-workforce-shrinks-1471339805
[47] https://www.technologyreview.com/s/600913/mercedes-sees-fewer-robots-in-its-future/ Tesla is also reported as having over-automated final assembly. http://www.businessinsider.com/tesla-robots-are-killing-it-2018-3
[48] https://ifr.org/downloads/press/Presentation_PC_11_Oct_2017.pdf
[49]"They confined their attacks to manufacturers who used machines in what they called 'a fraudulent and deceitful manner' to get around standard labor practices. 'They just wanted machines that made high-quality goods,' says Binfield, 'and they wanted these machines to be run by workers who had gone through an apprenticeship and got paid decent wages. Those were their only concerns.'" https://www.smithsonianmag.com/history/what-the-luddites-really-fought-against-264412/?no-ist=&page=2 "The workers tried bargaining. They weren't opposed to machinery, they said, if the profits from increased productivity were shared. The croppers suggested taxing cloth to make a fund for those unemployed by machines. Others argued that industrialists should introduce machinery more gradually, to allow workers more time to adapt to new trades." https://www.smithsonianmag.com/innovation/when-robots-take-jobs-remember-luddites-180961423/
[50] https://www.axios.com/a-long-disruption-is-ahead-with-low-paying-jobs-4a5bd5f5-0afb-49ef-a10b-1d6e15cbc541.html "Between 1800 and 1820, additional industrial tools emerged that rapidly increased the quality and efficiency of manufacturing. In the first two decades of the 1800s, the development of all-metal machine tools and interchangeable parts facilitated the manufacture of new production machines for many industries. Steam power fueled by coal, …water wheels, and powered machinery became common features of the manufacturing industry. … domestic trade also expanded with the introduction of canals, improved roads, and railways. In 1807, Robert Fulton built the first commercial steamboat, which operated between New York City and Albany…..Subsistence farming declined…. The transition away from an agricultural-based economy…led to a great influx of population from the countryside…" https://courses.lumenlearning.com/boundless-ushistory/chapter/the-industrial-revolution/
[51]See, for example, http://www.striking-women.org/module/rights-and-responsibilities/claiming-rights-role-trade-unions-uk
[52] http://www.economist.com/news/leaders/21701119-what-history-tells-us-about-future-artificial-intelligenceand-how-society-should https://www.socialeurope.eu/2015/10/how-technology-can-eradicate-unemployment-and-jobs-at-the-same-time/
[53]" Pitching technology against a host of alternative explanation—including workers exposure to globalization, immigration, manufacturing decline, etc.—we document that the support for Donald Trump was significantly higher in local labor markets more exposed to the adoption of robots. Other things equal, a counterfactual analysis shows that Michigan, Wisconsin, and Pennsylvania would have swung in favor of the Hillary Clinton if robot adoption had been two percent lower over the investigated period [2011-15], leaving the Democrats with a majority in the electoral college." Frey et al, Political Machinery: Did Robots Swing the 2016 U.S. Presidential Election? https://www.oxfordmartin.ox.ac.uk/publications/view/2576
[54]"[United Auto Workers president] Walter Reuther was being shown through the Ford Motor plant in Cleveland recently. A company official proudly pointed to some new automatically controlled machines and asked ': 'How are you going to collect union dues from these guys?' Reuther replied: 'How are you going to get them to buy Fords?'– Nov 1954 UAW-CIO conference report published in Jan. 1955" https://uaw.org/walter-reuther-quote-collection/
[55] https://www.encyclopedia.com/science-and-technology/technology/technology-terms-and-concepts/automation
[56] Some predict the effect of robots will be similar. http://www.economist.com/news/special-report/21700761-after-many-false-starts-artificial-intelligence-has-taken-will-it-cause-mass Others predict disaster for most workers. http://www.defenddemocracy.press/its-the-robots-stupid/
[57] http://www.ft.com/cms/s/0/cb4c93c4-0566-11e6-a70d-4e39ac32c284.html#ixzz49mNOrFW0
[58] Frey et al, Political Machinery: Did Robots Swing the 2016 U.S. Presidential Election? https://www.oxfordmartin.ox.ac.uk/publications/view/2576
[59] https://www.statista.com/statistics/186710/digital-music-revenue-in-the-us-since-2008/ https://www.riaa.com/riaa-releases-2017-year-end-music-industry-revenue-report/
[60] https://www.asme.org/engineering-topics/articles/technology-and-society/robots-at-work-where-do-we-fit
[61] https://www.technologyreview.com/s/601378/nimble-fingered-robot-outperforms-the-best-human-surgeons/ using 3-D imaging and precise force sensing
[62] https://www.mayoclinic.org/tests-procedures/robotic-surgery/care-at-mayo-clinic/pcc-20394981
[63] https://qz.com/1244410/faced-with-a-doctor-shortage-a-chinese-hospital-is-betting-big-on-artificial-intelligence-to-treat-patients/
[64] http://www.apa.org/monitor/2015/06/robo-therapy.aspx Paris even has a robot brothel. https://www.rt.com/news/417645-sex-doll-brothel-france/
[65] https://mishtalk.com/2016/09/10/sports-writer-robots-will-an-ai-robot-writer-win-a-pulitzer-prize/
[66] https://www.technologyreview.com/s/603529/socially-sensitive-ai-software-coaches-call-center-workers/

[67] https://techxplore.com/news/2018-03-deep-voice-mimic-mere-seconds.html
[68] https://www.desmoinesregister.com/story/money/business/columnists/josh-linkner/2018/04/07/josh-linkner-creative-business-solutions/493144002/
[69] http://www.h-n-h.jp/en/ http://www.vice.com/read/japan-is-opening-a-hotel-staffed-almost-entirely-by-robots
[70]"The slippers at the hotel, located outside of Tokyo, are powered with Nissan's autonomous self-driving technology that allows them to drive up to you at a push of a button. Equipped with two small wheels, sensors and a motor, not only can they drive themselves, but they can also park themselves neatly back in their designated spots after being used. If the slippers weren't enough, the inn even has cushions, furniture and television remotes scuttling around the place, all geared with the same technology." https://scroll.in/video/867996/watch-forget-self-driving-cars-these-slippers-at-a-japanese-hotel-drive-themselves-to-your-feet
[71] https://www.japantimes.co.jp/news/2017/03/16/business/tech/japans-labor-scarce-building-sites-automating-turning-robots-drones/
[72] http://undiscovered-japan.ft.com/articles/japan-tackles-construction-worker-shortage/ Over 5,000 building sites have used drones to map construction sites. Drones scan a site in 15 minutes and map its terrain: a team of humans would take several days. machine learning to map sites, plan work, and even guide autonomous construction vehicles on building sites. https://www.newscientist.com/article/mg23731694-100-ai-drones-are-controlling-self-driving-diggers-on-building-sites/
[73] https://www.reuters.com/article/us-japan-cobots/japanese-companies-see-big-things-in-small-scale-industrial-robots-idUSKBN1HR0DM
[74] https://techcrunch.com/2017/12/13/security-robots-are-being-used-to-ward-off-san-franciscos-homeless-population/ https://twitter.com/bilalfarooqui
[75] https://www.theguardian.com/technology/2016/jun/17/self-driving-trucks-impact-on-drivers-jobs-us
[76] http://www.govtech.com/fs/Michigan-Governor-Signs-AV-Rules-Eliminating-Human-Driver-Requirement.html The Army is testing them. http://www.dailymail.co.uk/sciencetech/article-4561740/US-Army-test-self-driving-trucks-Michigan.html An Uber truck with a human monitor has delivered beer driving on an interstate. https://qz.com/943899/a-timeline-of-when-self-driving-cars-will-be-on-the-road-according-to-the-people-making-them/
[77] https://www.theguardian.com/technology/2016/dec/16/uber-self-driving-cars-california-illegal-unethical-tactics
[78]"The road has three vertical layers, with the shell of see-through material allowing sunlight to reach the solar cells underneath. The top layer also has space inside to …monitor temperature, traffic flow and weight load." The project began 10 yrs ago. https://www.bloomberg.com/news/features/2018-04-11/the-solar-highway-that-can-recharge-electric-cars-on-the-move
[79] http://www.nzherald.co.nz/business/news/article.cfm?c_id=3&objectid=12012006 and https://www.nytimes.com/2018/02/27/technology/flying-taxis.html
[80] https://www.nextrembrandt.com/
[81] http://www.donotpay.co.uk/
[82] https://www.theguardian.com/technology/2016/jun/28/chatbot-ai-lawyer-donotpay-parking-tickets-london-new-york See also http://venturebeat.com/2016/06/27/donotpay-traffic-lawyer-bot/
[83] https://www.theguardian.com/technology/2017/mar/06/chatbot-donotpay-refugees-claim-asylum-legal-aid
[84] https://www.theverge.com/2018/10/10/17959874/donotpay-do-not-pay-robot-lawyer-ios-app-joshua-browder
[85] https://www.technologyreview.com/the-download/609225/walmart-is-unleashing-shelf-scanning-robots-to-peruse-its-aisles/
[86] https://www.techemergence.com/fast-food-robots-kiosks-and-ai-use-cases/
[87] https://www.bloomberg.com/news/articles/2018-03-13/worker-exodus-builds-at-mcdonald-s-as-mobile-app-sows-confusion
[88]http://www.cleveland.com/entertainment/index.ssf/2016/12/how_rogue_one_incorporated_a_d.html
[89] http://bigthink.com/hybrid-reality/do-we-need-actors-cgi-and-the-future-of-hollywood and http://www.today.com/id/40548535/ns/today-today_entertainment/t/tron-legacy-reverse-ages-jeff-bridges/
[90] https://www.npr.org/sections/alltechconsidered/2018/03/05/590238807/in-the-future-movie-stars-may-be-performing-even-after-their-dead Computer graphics used for early crowds, AI for later.
[91] https://www.engadget.com/2015/12/29/microsoft-xiaoice-ai-china-weather-host/
[92]"A $1.8 million grant from the Pentagon's Defense Advanced Research Projects Agency funded the work." https://www.bloomberg.com/news/articles/2017-08-30/china-snaps-up-america-s-cheap-robot-labor See also https://spectrum.ieee.org/robotics/industrial-robots/your-next-tshirt-will-be-made-by-a-robot and https://www.ien.com/automation/video/20974527/this-robot-could-replace-17-production-workers
[93] Goldman Sees 'Financial Fragility' Rising in Markets https://www.bloomberg.com/news/articles/2018-03-19/goldman-sees-financial-fragility-rising-amid-market-breakdowns
[94] https://www.ft.com/content/f1ec9d80-2a15-11e5-8613-e7aedbb7bdb7 though "Hedge Funds That Use AI Just Had Their Worst Month Ever" https://www.bloomberg.com/news/articles/2018-03-12/robot-takeover-stalls-in-worst-slump-for-ai-funds-on-record
[95]"AI can now predict multi-step chains of reactions that produce increasingly complex molecules, without having any chemistry rules hard-coded into the algorithm." https://www.technologyreview.com/the-download/610722/ai-can-invent-new-ways-to-create-complex-molecules/
[96] https://www.foreignaffairs.com/articles/2016-06-13/human-work-robotic-future https://www.bloomberg.com/news/articles/2017-02-28/jpmorgan-marshals-an-army-of-developers-to-automate-high-finance One of the robots that seemed threatening to jobs is Baxter, which costs just $24,000 and doesn't require changing factory settings to perform new tasks. Someone with no robotics

experience simply moves Baxter's arms around and follows prompts on the robot's face. However, it has not been very successful, especially with manufactures requiring highly accurate motions. The current version, Sawyer, is more promising. http://spectrum.ieee.org/robotics/industrial-robots/rethink-robotics-baxter-robot-factory-worker Baxter now can operate on mind signals. https://www.youtube.com/watch?v=Zd9WhJPa2Ok&feature=youtu.be [This company has now failed. Oct.2018]

[97] http://www-formal.stanford.edu/jmc/whatisai/node3.html

[98] http://amturing.acm.org/award_winners/simon_1031467.cfm

[99] https://www.wired.com/insights/2014/09/artificial-intelligence-algorithms-2/

[100] https://www.nytimes.com/2016/12/14/magazine/the-great-ai-awakening.html

[101]"Facebook's news feed uses machine learning in an effort to personalize each individual's feed based on what they like. The main elements of traditional machine learning software are statistical analysis and predictive analysis used to spot patterns and find hidden insights based on observed data from previous computations without being programmed on where to look.... compared to deep learning ... it requires manual intervention in selecting which features to process... deep learning does it intuitively.... to use machine learning for computer vision, you need image processing experts to tell you what are the few (tens or hundreds) of most important features in an image. But if you use deep learning for computer vision, you just feed in the raw pixels, without caring much for image processing or feature extraction, which offers 20-30 percent improvement in accuracy in most computer vision benchmarks.For example, assume you saw a clear image of a dog, and assume that if the pixels of the image were modified just a few per cent, it is still easily recognized that there is a dog in the image." https://betanews.com/2016/12/12/deep-learning-vs-machine-learning/

[102] https://www.wired.com/insights/2014/09/artificial-intelligence-algorithms-2/

[103] https://www.technologyreview.com/s/610621/emtech-digital-oren-etzioni-brenden-lake-timnit-gebru/

[104]"...AI has exploded, and especially since 2015. Much of that has to do with the wide availability of GPUs that make parallel processing ever faster, cheaper, and more powerful. It also has to do with ... practically infinite storage and a flood of data ...Big Data movement)" https://blogs.nvidia.com/blog/2016/07/29/whats-difference-artificial-intelligence-machine-learning-deep-learning-ai/

"Machine learning algorithms come in two main flavors: supervised and unsupervised. Supervised algorithms need a teacher (us). A spam filter learns what spam is by generalizing from example emails that have been labeled "spam" or "not spam." Most learning algorithms in use today are of this variety. Big data makes them very powerful—lots of examples to learn from—but they learn to do one very specific job at a time…. Unsupervised algorithms learn on their own, like children at play, but even they are guided by a control signal…. And the control signal is determined by us." https://medium.com/@pedromdd/ten-myths-about-machine-learning-d888b48334a3

[105] https://betanews.com/2016/12/12/deep-learning-vs-machine-learning/

[106]http://www.slate.com/articles/technology/bitwise/2015/09/pedro_domingos_master_algorithm_how_machine_learning_is_reshaping_how_we.html

[107] AlphaGo's historic victory against one of the best Go players of all time, Lee Sedol, a landmark for AI, and especially for "deep reinforcement learning.""[it] takes inspiration from [how] animals learn that certain behaviors tend to result in a positive or negative outcome. Using this, a computer can, eg, figure out how to navigate a maze by trial and error and then associate the positive outcome—exiting the maze—with the actions that led up to it. so a machine learns without instruction or even explicit examples. The idea is not new, but combining it with large (or deep) neural networks provides the power needed to make it work on really complex problems (like Go). Through relentless experimentation, as well as analysis of previous games, AlphaGo figured out for itself how play the game at an expert level." https://www.technologyreview.com/s/603216/5-big-predictions-for-artificial-intelligence-in-2017/

[108] https://www.technologyreview.com/s/603381/ai-software-learns-to-make-ai-software/

[109] http://techreport.com/news/30722/google-translate-gets-a-boost-from-deep-neural-networks and http://www.nature.com/news/deep-learning-boosts-google-translate-tool-1.20696

[110] https://www.technologyreview.com/s/602094/ais-language-problem/ "A software engineer would write a thousand if-then-else statements [to identify a dog]: *if* it has ears, and a snout, *and* has hair,. . . and etc. But that's not how a child learns.... ...she learns by seeing dogs and being told that they are dogs, makes mistakes, corrects herself. She thinks that a wolf is a dog—but is told that it belongs to an altogether different category. And so she shifts her understanding bit by bit: this is 'dog,' that is 'wolf.' The machine-learning algorithm, like the child, pulls information from a training set:... Here's a dog, and here's not a dog. It then extracts features from one set versus another. And, by testing itself against hundreds and thousands of classified images, it begins to create its own way to recognize a dog—again, the way a child does."http://www.newyorker.com/magazine/2017/04/03/ai-versus-md" April 3, 2017, issue, with the headline "The Algorithm Will See You Now."

[111] https://www.technologyreview.com/s/603501/10-breakthrough-technologies-2017-reinforcement-learning/

[112] https://www.technologyreview.com/s/610253/the-ganfather-the-man-whos-given-machines-the-gift-of-imagination/ GANs [generative adversarial network] can be used to generate new images.–"two neural nets [trying to best each other.] Both networks are trained on the same data set. The first one, known as the generator, is charged with producing artificial outputs, such as photos or handwriting, that are as realistic as possible. The second, known as the discriminator, compares these with genuine images from the original data set and tries to determine which are real and which are fake. On the basis of those results, the generator adjusts its parameters for creating new images…. until the discriminator can no longer tell what's genuine and what's bogus."

[113] https://nypost.com/2018/03/27/facial-recognition-technology-can-now-text-jaywalkers-a-fine/

[114] http://fortune.com/ai-artificial-intelligence-deep-machine-learning/

[115]"You can't just look inside a deep neural network to see how it works. A network's reasoning is embedded in the behavior of thousands of simulated neurons, arranged into dozens or even hundreds of intricately interconnected layers. The neurons in the first layer each receive an input, like the intensity of a pixel in an image, and then perform a calculation before outputting a new signal. These outputs are fed, in a complex web, to the neurons in the next layer, and so on, until an overall output is produced. Plus, there is a process known as back-propagation that tweaks the calculations of individual neurons in a way that lets the network learn to produce a desired output." https://www.technologyreview.com/s/604087/the-dark-secret-at-the-heart-of-ai/
[116]http://www.slate.com/articles/technology/bitwise/2015/09/pedro_domingos_master_algorithm_how_machine_learning_is_reshaping_how_we.html
[117]https://www.technologyreview.com/s/603795/the-us-military-wants-its-autonomous-machines-to-explain-themselves/ funded mil.
[118] See Cathy O'Neill, https://weaponsofmathdestructionbook.com, especially chps. 5, 6 & 8;
https://blogs.nvidia.com/blog/2016/07/29/whats-difference-artificial-intelligence-machine-learning-deep-learning-ai/
http://www.militaryaerospace.com/articles/2015/07/hpec-radar-target-recognition.html
http://www.sciencemag.org/news/2017/03/brainlike-computers-are-black-box-scientists-are-finally-peering-inside
[119] https://www.scientificamerican.com/article/intelligent-to-a-fault-when-ai-screws-up-you-might-still-be-to-blame1/
[120] https://www.fastcodesign.com/90153084/how-to-fool-a-neural-network
[121] http://www.lrb.co.uk/v37/n05/john-lanchester/the-robots-are-coming
[122] https://techcrunch.com/2016/11/22/googles-ai-translation-tool-seems-to-have-invented-its-own-secret-internal-language/
[123] http://www.forbes.com/sites/markcohen1/2016/09/06/artificial-intelligence-and-legal-delivery/
[124] http://www.vice.com/read/can-machines-write-musicals
[125] Richard Waters www.ft-weekend/looking-and-learning/bnl-ftweekend-20160924-75077
[126] https://scholar.harvard.edu/files/ddeming/files/deming_socialskills_august2015.pdf
[127] https://www.nytimes.com/interactive/2018/03/07/upshot/bricklayers-think-theyre-safe-from-automation-robots.html
[128] https://www.apnews.com/a4725a2c6cd347a6ba473590c3bf737a
[129] https://www.technologyreview.com/the-download/610424/flippy-the-burger-making-robot-has-started-its-shift robot monitors the grill, flipping and removing burgers. It needs people to lay out raw patties and add fixings to the burger.
http://www.bbc.com/news/technology-43343956
[130] https://www.theverge.com/circuitbreaker/2017/11/17/16671328/boston-dynamics-backflip-robot-atlas and for other types of agility, see https://youtu.be/fRj34o4hN4I
[131]Marc S. Lavine *Science* 23 Sep 2016: V. 353, Iss. 6306, pp. 1378-1379 http://spectrum.ieee.org/automaton/robotics/robotics-hardware/mit-humanoid-robot-teleoperation-dynamic-tasks http://www.bbc.com/news/technology-34175290
[132] These are, in order, "Be a good coach; empower your team and don't micromanage; express interest in employee's success and well-being; be productive and results-oriented; be a good communicator and listen to your team; help your employees with career development; have a clear vision and strategy for the team; and have key technical skills, so you can help advise the team."
https://www.ineteconomics.org/perspectives/blog/dont-want-a-robot-to-replace-you-study-tolstoy
[133] Morton Shapiro, ibid.
[134] Joan Hoffman has a fine review of MacNeil, explaining algorithms and their potential flaws.
https://www.jjay.cuny.edu/sites/default/files/contentgroups/economics/HoffmanAlgorithms.pdf
[135] https://weaponsofmathdestructionbook.com/ https://www.technologyreview.com/s/602933/how-to-hold-algorithms-accountable/
[136] https://blogs.scientificamerican.com/roots-of-unity/review-weapons-of-math-destruction/
[137] https://protect-us.mimecast.com/s/59TMCNkGkWTXpQonIy6I0W?domain=epic.org
[138] "Software that helps judges decide whether to jail a defendant while they await trial could cut crime and reduce racial disparities amongst prisoners" https://www.technologyreview.com/s/603763/how-to-upgrade-judges-with-machine-learning/
[139] https://www.digitaltrends.com/cool-tech/algorithms-of-oppression-racist/
[140] https://www.theguardian.com/science/2016/sep/01/how-algorithms-rule-our-working-lives Cathy O'Neill
https://www.jacobinmag.com/2016/09/big-data-algorithms-math-facebook-advertisement-marketing/
[141] https://phys.org/news/2017-02-algorithms-secretly-world.html
[142] https://www.theguardian.com/science/2016/sep/01/how-algorithms-rule-our-working-lives https://mathbabe.org/?s=algorithm
https://www.technologyreview.com/s/602933/how-to-hold-algorithms-accountable/
[143] https://www.theatlantic.com/business/archive/2018/02/virginia-eubanks-automating-inequality/553460/
[144] https://www.vox.com/2018/2/6/16874782/welfare-big-data-technology-poverty?platform=hootsuite
[145] https://thebaffler.com/salvos/blame-the-computer-pein "As islanders' panic subsided, the retired U.S. Army Lt. Gen. Mark Hertling, a CNN commentator, publicly chastised U.S. Rep. Tulsi Gabbard, who broke protocol by notifying her constituents via Twitter that the missile alert was mistaken. 'For the record, Congresswoman Gabbard inserting herself into the process . . . is NOT a good thing,' Hertling wrote."
[146] https://www.technologyreview.com/s/603915/tech-giants-grapple-with-the-ethical-concerns-raised-by-the-ai-boom/
[147] "When non-Facebook sites add a "Like" button (a social plugin, in Baser's terminology), visitors to those sites are tracked: Facebook gets their IP address, browser and OS fingerprint, and visited site."

http://www.theregister.co.uk/2018/04/17/facebook_admits_to_tracking_non_users/ https://gizmodo.com/how-facebook-figures-out-everyone-youve-ever-met-1819822691?IR=T

[148] https://www.opendemocracy.net/digitaliberties/ivan-manokha/cambridge-analytica-surveillance-is-dna-of-platform-economy

[149]"EarthNow aims to cover our entire planet in detailed, real-time video surveillance. And it has some big-name backers who like the idea. **The details:** The *Wall Street Journal* says the company will launch 500 satellites, each one equipped with huge computing power to interpret what its cameras are capturing in real time. There's no word on details like resolution or frame-rate.
Huge support: The firm revealed Wednesday that it's backed by Microsoft founder Bill Gates, SoftBank CEO Masayoshi Son, and Airbus. Cash figures remain secret. **Big brother is watching:** EarthNow users should get a live picture of anywhere on Earth with about one second of delay. That, says the firm, will help catch illegal fishing, track whale migration, and study conflict zones. And who knows what else." https://mailchi.mp/technologyreview/the-download-mainstream-metal-printing-old-nuclears-bad-news-and-trumps-mars-madness-762249?e=1ef4695dbc

[150] https://wolfstreet.com/2018/04/14/our-dental-insurance-sent-us-free-internet-connected-toothbrushes-and-this-is-what-happened-next/

[151] Ibid.

[152] https://www.recode.net/2018/4/9/17204004/amazon-research-development-rd

[153]http://www.cam.ac.uk/research/news/computers-using-digital-footprints-are-better-judges-of-personality-than-friends-and-familyPublished 2013

[154] https://motherboard.vice.com/en_us/article/how-our-likes-helped-trump-win

[155] https://www.theverge.com/2018/2/1/16958918/amazon-patents-trackable-wristband-warehouse-employees

[156] https://theoutline.com/post/3949/our-jobs-are-killing-us-and-companies-don-t-care

[157] https://thenextweb.com/artificial-intelligence/2018/04/23/cia-plans-to-replace-spies-with-ai/

[158] https://medium.com/@ACLU_NorCal/police-use-of-social-media-surveillance-software-is-escalating-and-activists-are-in-the-digital-d29d8f89c48#.n6t85ss2u The ACLU of California has obtained records showing that Twitter, Facebook, and Instagram provided user data access to Geofeedia, a developer of a social media monitoring product that we have seen marketed to law enforcement as a tool to monitor activists and protesters. https://www.aclunc.org/blog/facebook-instagram-and-twitter-provided-data-access-surveillance-product-marketed-target

[159] https://www.theguardian.com/technology/2017/mar/27/us-facial-recognition-database-fbi-drivers-licenses-passports

[160] https://www.nytimes.com/2018/03/13/sports/facial-recognition-madison-square-garden.html and https://jalopnik.com/the-video-boards-at-nascar-races-are-scanning-your-face-1823610364

[161] https://www.npr.org/2018/03/16/593989347/facial-scanning-now-arriving-at-u-s-airports

[162] http://boingboing.net/2016/11/02/researchers-trick-facial-recog.html

[163] http://www.scmp.com/news/china/society/article/2141387/facial-recognition-tech-catches-fugitive-among-huge-crowd-pop China is "building a system that will recognize any of its 1.3 billion citizens in three seconds." http://www.businessinsider.com/china-police-using-facial-recognition-glasses-2018-2

[164] "Under maximin, people should design and test cars, among other things, to prioritize pedestrian safety. … The crash in Arizona wasn't just a tragedy. The failure to see a pedestrian in low light was an avoidable basic error for a self-driving car. Autonomous vehicles should be able to do much more than that before they're allowed to be driven, even in tests, on the open road. https://theconversation.com/self-driving-cars-cant-be-perfectly-safe-whats-good-enough-3-questions-answered-92331

[165] http://www.nakedcapitalism.com/2016/10/self-driving-cars-how-badly-is-the-technology-hyped.html

[166] Since AI is a fundamental part of the concept of the Internet of Things, where machines and devices communicate with each other to get the work done, it's only AI and machine learning that will be incredibly useful to defend our network before anyone exploits them.Last year, Security researchers at MIT also developed a new Artificial Intelligence-based cyber security platform, called '**AI2**,' which has the ability to predict, detect, and stop 85% of Cyber Attacks with high accuracy. http://thehackernews.com/2017/01/artificial-Intelligence-cybersecurity.html

[167] https://medium.com/hult-business-school-draft/73-mind-blowing-implications-of-a-driverless-future-58d23d1f338d

[168] https://theoutline.com/post/1192/google-s-featured-snippets-are-worse-than-fake-news

[169] https://www.bloomberg.com/view/articles/2017-02-16/do-you-trust-big-data-try-googling-the-holocaust

[170] https://www.ft.com/content/96187a7a-fce5-11e6-96f8-3700c5664d30

[171] https://www.politico.eu/article/europe-divided-over-robot-ai-artificial-intelligence-personhood/

[172] http://www.nybooks.com/articles/2016/08/18/why-economic-growth-will-fall/

[173] http://www.forbes.com/sites/timworstall/2016/03/31/charlie-bean-says-im-right-but-just-how-right-remains-to-be-seen/ (Goolsbee and Klenow 2006, Brynjolfsson and Oh 2012 etc) "…by the mid-2000s labor productivity growth had slowed down to pre-1996 levels, and it has stayed relatively low since then," "many aspects of digital progress aren't counted in GDP. For instance, Wikipedia, unlike the old print version of Encyclopaedia Britannica, is free. That means that… it isn't included in GDP calculations…". https://hbr.org/2015/06/the-great-decoupling

[174] http://blogs.wsj.com/economics/2016/02/12/why-does-u-s-productivity-look-so-abysmal-not-mismeasurement-paper-says/ & http://faculty.chicagobooth.edu/chad.syverson/research/productivityslowdown.pdf "Challenges to Mismeasurement Explanations for the US Productivity Slowdown" 2016.

[175] www.nber.org/papers/w21974.pdf and https://www.brookings.edu/wp-content/uploads/2016/08/syverson.pdf
[176] http://cepr.net/blogs/beat-the-press/mis-measured-growth-will-our-children-be-rich
[177]http://blogs.piie.com/publications/papers/gordon20151116ppt.pdf
[178] http://www.nybooks.com/articles/2016/08/18/why-economic-growth-will-fall/
[179] https://www.vox.com/a/new-economy-future/robert-gordon-interview
[180]Robot developed for DARPA via Boston Dynamics. https://youtu.be/SD6Okylclb8?t=18 https://www.technologyreview.com/s/610229/how-to-teach-a-robot-to-screw/ http://www.skoltech.ru/en/2017/10/skoltech-shows-off-high-caliber-of-russian-robotics-at-a-major-international-youth-festival/ Russians have done good work on the screw problem.
[181]https://www.project-syndicate.org/commentary/innovation-impact-on-productivity-by-dani-rodrik-2016-06
[182] https://www.bls.gov/TUS/CHARTS/LEISURE.HTM
[183] http://www.vox.com/2015/7/27/9038829/automation-myth
[184]Total spending healthcare 17.8% GDP https://www.cms.gov/research-statistics-data-and-systems/statistics-trends-and-reports/nationalhealthexpenddata/nationalhealthaccountshistorical.html
185Brynjolfsson, Rock, & Syverson, op. cit. http://www.nber.org/papers/w24001
[186] https://medium.com/@ryanavent_93844/the-productivity-paradox-aaf05e5e4aad#.ypwpims0t
[187]Abraham & Kearney, Explaining The Decline In The U.S. Employment-To-Population Ratio: A Review Of The Evidence http://www.nber.org/papers/w24333
[188] Trade 1.04 and robots second at 0.55 percentage points. There may be structural reasons for the decline, too, like difficulties: "Nearly 40 million working-age people now live in parts of major American metropolitan areas that lack public transportation, according to an analysis by the Brookings Institution's Metropolitan Policy Program." "Between 2000 and 2012, the number of jobs within the typical commute distance for residents in a major metro area fell by 7 percent." Low wages reduce the ability to own a car.
[189] David Autor, David Dorn, Gordon Hanson, Gary P. Pisano, Pian Shu, "Competition from China reduced innovation in the US," http://voxeu.org/article/competition-china-reduced-innovation-us 3/17
[190] https://www.economist.com/news/leaders/21695392-big-firms-united-states-have-never-had-it-so-good-time-more-competition-problem
[191] https://hbr.org/2018/02/the-u-s-economy-is-suffering-from-low-demand-higher-wages-would-help. An *Economist* editor agrees: low wages and a weak safety net account for both weak consumer and limited business spending. Bain, another consulting company, also worries that inequality reduces spending, as the rich save more, and therefore discourages investment. http://www.bain.com/publications/articles/labor-2030-the-collision-of-demographics-automation-and-inequality.aspx
[192] https://twitter.com/gabriel_zucman/status/806533951875649537
[193]Kevin Cashman, https://theminskys.org/automation/
[194] Among other problems, employer monopoly: https://www.vox.com/the-big-idea/2018/4/6/17204808/wages-employers-workers-monopsony-growth-stagnation-inequality
[195] https://www.nytimes.com/2018/02/28/opinion/corporate-america-suppressing-wages.html Study is by Krueger and Posner. http://www.hamiltonproject.org/papers/a_proposal_for_protecting_low_income_workers_from_monopsony_and_collusion
[196]McDonald's recently let this lapse in response to a court case. https://www.nytimes.com/2017/09/27/business/pay-growth-fast-food-hiring.html
[197] http://talkingpointsmemo.com/features/privatization/one/
[198] http://prospect.org/article/time-to-ban-stock-buybacks
[199]Wm. Lazonick, $4 trillion in buybacks and $2.9 trillion in dividends…."
https://www.ineteconomics.org/perspectives/blog/congress-can-turn-the-republican-tax-cuts-into-new-middle-class-jobs
[200] https://www.nytimes.com/2017/03/22/technology/china-defense-start-ups.html
[201] http://www.bls.gov/emp/ep_table_education_summary.htm
[202] http://www.aei.org/publication/new-york-fed-highlights-underemployment-among-college-graduates/
[203] https://economicfront.wordpress.com/2017/04/14/college-education-no-ticket-to-financially-rewarding-job/
[204] https://qz.com/851066/almost-all-the-10-million-jobs-created-since-2005-are-temporary/ The Rise and Nature of Alternative Work Arrangements in the United States, 1995-2015, http://arks.princeton.edu/ark:/88435/dsp01zs25xb933 p.7
[205] http://www.newyorker.com/magazine/2016/12/19/our-automated-future
[206] http://www.nakedcapitalism.com/2016/02/satyajit-das-age-of-stagnation-or-something-worse.html
[207] http://www.ianwelsh.net/fixing-the-world-2-moral-calculus/
[208] An expert committee has called for this. "Information Technology and the U.S. Workforce: Where Are We and Where Do We Go from Here?" http://www.nap.edu/24649 See p. 163 for recommendations.
https://www.nap.edu/download/24649
[209] https://www.emptywheel.net/2016/03/14/the-problem-of-the-liberal-elites-part-1/
[210]Mortality data from Lancet study: http://www.thelancet.com/journals/lancet/article/PIIS0140-6736(17)30187-3/ppt
http://www.politico.com/magazine/story/2016/06/wall-street-2016-donald-trump-hillary-clinton-213931 "In large part, these differences [in incomes within any given society] must be attributed to differences in capital ownership, of which the largest part is social capital: knowledge, and participation in kinship and other privileged social relations..... I personally do not see any moral basis

for an inalienable right to inherit resources, or to retain all the resources that one has acquired by means of economic or other activities…..When we compare the poorest with the richest nations, it is hard to conclude that social capital can produce less than about 90 percent of income in wealthy societies like those of the US or Northwestern Europe. On moral grounds, then, we could argue for a flat income tax of 90 percent to return that wealth to its real owners." –Herbert Simon**,** Forum, Boston Review, A Basic Income for All, NJFAC, Quotes from the Advisory Board

[211] http://issues.org/30-3/stuart/ See an advanced strategy for counseling workers threatened by robots: https://www.fastcoexist.com/3067875/creating-career-advice-for-the-about-to-be-automated-worker

[212] https://hbr.org/2014/12/what-happens-to-society-when-robots-replace-workers

[213] https://www.theguardian.com/technology/2016/may/20/silicon-assassins-condemn-humans-life-useless-artificial-intelligence

[214] Arthur, https://www.mckinsey.com/business-functions/mckinsey-analytics/our-insights/where-is-technology-taking-the-economy

[215] https://www.reddit.com/user/Prof-Stephen-Hawking Also, "A.I. could be the worst invention of the history of our civilization, that brings dangers like powerful autonomous weapons or new ways for the few to oppress the many," Hawking said last year. "A.I. could develop a will of its own, a will that is in conflict with ours and which could destroy us. In short, the rise of powerful A.I. will be either the best or the worst thing ever to happen to humanity." https://www.vanityfair.com/news/2018/03/tech-geniuses-fret-that-ai-is-gonna-kill-us-all

[216] P. 5-6, http://www.econ.yale.edu/smith/econ116a/keynes1.pdf

[217] https://www.cnbc.com/2018/01/01/one-year-on-finland-universal-basic-income-experiment.html Finland's is apparently the oldest.

[218] https://safehaven.com/article/45330/Was-Finlands-Universal-Basic-Income-Program-A-Failure

[219]Finland will be testing such a program. http://www.nytimes.com/2016/12/17/business/economy/universal-basic-income-finland.html http://federal-budget.insidegov.com/l/119/2016-Estimate

[220] https://www.cbo.gov/publication/52411 $3.3 Tr

[221] https://www.counterpunch.org/2018/04/06/universal-basic-income-left-or-right/

[222] https://www.cbpp.org/research/full-employment/the-federal-job-guarantee-a-policy-to-achieve-permanent-full-employment

[223] https://www.recode.net/2018/3/8/17081618/tech-solution-economic-inequality-universal-basic-income-part-democratic-party-platform-california We support efforts to enact programs, such as a guaranteed government jobs program and a universal basic income/rent or housing to eliminate poverty while improving prospects to secure good jobs that help people climb the economic ladder; p. 16, CDP-Platform-2018.pdf

[224] http://www.independent.co.uk/voices/the-basic-income-is-a-dangerous-idea-that-gives-the-state-power-to-control-every-penny-their-a7030391.html

[225] "In large part, these differences [in incomes within any given society] must be attributed to differences in capital ownership, of which the largest part is social capital: knowledge, and participation in kinship and other privileged social relations." https://bostonreview.net/forum/basic-income-all/herbert-simon-ubi-and-flat-tax The rich are using resources that are significantly social in origin--the technology available to them, the educated workers they depend on, the transportation system, courts, etc they can assume to be available. I think he obscures his general point by adding kinship. See also simon_last_lecture.pdf

[226] http://www.policy-network.net/pno_detail.aspx?ID=4728&title=Smart-and-inclusive-growth

[227] "Our robot computes its algorithm 67 times every second, constantly stitching together information about its environment and recomputing its path. When it starts you'll notice a spiral pattern, it'll spiral out over a larger and larger area until it hits an object. When it finds an object, it will follow along the edge of that object for a time, and then it will start criss-crossing, trying to figure out the largest distance it can go without hitting another object, and that's helping it figure out how large the space is, but if it goes for too long a period of time without hitting a wall, it's going to start spiraling again, because it figures it's in a wide open space, and it's constantly calculating and figuring that out. It's similar with the dirt sensors underneath, when one of those sensors gets tripped it changes its behaviors to cover that area. It will then go off in search of another dirty area in a straight path. The way that these different patterns pile on to each other as they go, we know that that is the most effective way to cover a room. The patterns that we chose and how the algorithm was originally developed was based off of behavior-based algorithms born out of MIT studying animals and how they go about searching areas for food." http://www.aiqus.com/forum/questions/13167/algorithm-that-irobots-roomba-uses

[228] https://data.oecd.org/emp/hours-worked.htm

[229] "Why the U.S. Needs a Federal Jobs Program, Not Payouts," https://www.nytimes.com/2017/11/08/opinion/federal-jobs-program-payouts.html