Unemployment in the AI Age

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"Work saves us from three great evils: boredom, vice, and need" Voltaire said (Johnson & Indvik, 2004). Work is essential to the meaning of human life. To many people today, work means having a job. However, artificial intelligence (AI) will soon be able to take over many human jobs. A significant amount of social unrest will be caused by unemployment before the ethical issues of AI can be addressed. Thus, unemployment will be the most pressing social issue with respect to AI technologies.

AI has already surpassed certain human capabilities. In 1997, IBM's supercomputer Deep Blue defeated world chess champion Garry Kasparov (Newborn, 2012). In 2011, IBM's Watson stunned the technology industry with its victory against two of Jeopardy's greatest champions (Best, n.d.). In 2016, Google's DeepMind AlphaGo defeated the number one-ranked human Go player Lee Se-dol (Byford, 2016/n.d.). AI is no longer only a science fiction fantasy or a simple computer program that plays games; it has developed certain cognitive characters of the human brain that can learn and generate its own responses without explicit programming. Hence, with continued investment, AI will grow exponentially and dramatically transform society. Job automation with AI is becoming the prevailing trend across different industries. Some have even called AI the fourth industrial revolution, after steam power, electricity and electronics (Schwab, 2017). But, unlike past revolutions, this revolution could leave up to 35% of all workers in the UK, and 47% of those in the US, at risk of being displaced by technology over the next 20 years, according to Oxford University research (Stewart, 2015/n.d.).

In the past, many jobs have been lost due to technological advancements and large amounts of social upheaval were created. One classic example of this occurred during the 19th century's Industrial Revolution in England. As the use of automated looms and knitting frames increased, British weavers and textile workers who spent years training in their craft feared that less skilled workers were robbing them of their livelihood. However, the artisans' appeals for government assistance were ignored, so a few desperate weavers began breaking into factories and destroying textile machines. The people called themselves the Luddites and resistance against automated weaving spread across the English countryside. Resistance was so fierce that sledgehammer-wielding Luddites attacked and burned factories... in some cases they even exchanged gunfire with company guards and soldiers (Andrews, 2015/n.d.). The workers set upon these raids in hopes that the British government may ban weaving machines, but the government quashed the movement and made machine breaking punishable by death.

There also were many jobs lost between the 60s to 80s due to automation and outsourcing overseas for cheap labor. The consequences were significant. The Rust Belt in the US is the result of this mass job loss. In a discussion about his book "The New Minority: White Working Class Politics in an Age of Immigration and Inequality", Justin Gest described the pain and downward spiral of damage caused by job loss when many steel mills closed in Youngstown, Ohio. He stated that the city lost 50,000 jobs in about five years. During that time, suicide and divorce rates skyrocketed, and the city became the murder capital of the US by the late 80s. The city population dropped from 170,000 to about 65,000. As a result, many people felt they were marginalized and that they no longer had a voice in public policy, business interests and government (Gest, 2016). "If you look back to the first machine age the vast majority of Americans worked in agriculture. Now it's less than two percent," says economist Erik Brynjolfsson (Heath, n.d.). Today, the Luddites are simply remembered as technophobes, but they are a real example of the fear the threat of structural unemployment creates. And as demonstrated by Youngstown, that fear is not unfounded.

However, Brynjolfsson also states that "The computer processor doubles in power every 18 months, 10 times greater every five years, it's a very different scale of advancement and it's affecting a broader set of the economy than the steam engine did, in terms of all the cognitive tasks. It's happening a lot faster and more pervasively than before" (Heath, n.d.). Because of the swiftness of technology development, AI unemployment is a looming problem that needs to be confronted now.

In the near future, AI will cause unemployment as other technology did in the past, and dangerous social unrest will be provoked, perhaps at an even faster pace according to Brynjolfsson: "Unlike much of the 20th century we're now seeing a falling ratio of employment to population and that's something that concerns us. We don't think it's inevitable but we do think that many of the underlying trends in technology are likely to accelerate this so it's something we need to pay some serious attention to" (Heath, n.d.). Displaced workers are a political force that cannot be ignored, especially in elections. What they want are well-paid jobs that can support their families. Government, industries, and organizations should address unemployment issues caused by AI rather than brushing them off and claiming there will be more jobs created in the new technology revolution. Politicians in the past have promised to bring jobs lost due to outsourcing back to US. However, many traditional manufacturing jobs will never come back. According to research, while cheaper labor could cut cost by 60%, automation could cut labor costs by 90%. Even China, a country known for its abundant cheap labor and manufacturing jobs, has become a country with rising wages and labor shortages (Mahoney, n.d.). In 2017, China surpassed Japan as the number one country that uses the most industrial robots for manufacturing. Job automation is simply a natural choice for developed country to stay competitive in the global economy. With advances in automation and AI technology, some manufacturing factories will come back to US to get closer to the main markets. Unfortunately, moving back these factories will not create traditional manufacturing jobs; it will create more automated jobs instead. If unemployment continues, the income gap between the richest and the poorest

people will get even wider. Income inequality will increase as owners of AI capital will expand their wealth while many workers may not receive benefits. Additionally, the wage gap between skilled and unskilled workers will increase. Long term unemployment cannot be risked as less income for families means low consumer demand that reduces income for businesses in other markets, gradually leading to a vicious cycle of economic downturn. A loss of dignity for workers may also accompany the unemployment AI will cause. Social unrest, crime, homicide, riots, race tension, and other current social problems could be exacerbated. However, the root cause of these problems can often be attributed to unemployment and lack of career opportunities. AI has the potential to cause many economic and social issues by automating many jobs and leaving millions of workers unemployed.

Companies have already begun to develop AI technology that will become the new engine of the old and continued process of job automation. Many countries have already used basic automation technology to replace labor. For example, industrial robots are widely used in automobile production lines across North America, Europe, Japan, South Korea, etc. However, with AI, job automation will be accelerated and it will have a broader impact. That is because traditional automation involves explicit programming, which requires a lot of human labor, and consequently increases production costs. In contrast, AI can utilize machine learning without explicit programming by evolving itself with the empirical data it collects from experimentation. For instance, Google's AI, AlphaGo, played Go against itself millions of times before competing with the best human player (Byford, 2016/n.d.). AI's capabilities can be improved dramatically and swiftly through repetitive training and around-the-clock experimentation through trial and error. Such a powerful learning system can be easily applied in many areas of life. One example of today's usage of machine-learning AI is the self-driving car (Giarratana, 2016). It would be extremely difficult and inefficient to develop self-driving technology through a traditional explicit programming method. It would require software engineers to account for all possible scenarios that could happen during real-life driving. Such conditions are

unlimited and are impossible to cover completely. But with AI technology, the car's system could make decisions that mimic a human driver's and learn from driving data shared from other self-driving cars. Google, Tesla, Uber, Ford, GM, BMW and most major automobile manufacturers are developing self-driving technologies. Many of them have already conducted hundreds of thousands of miles of real road testing. Such technology in certain aspects has surpassed human drivers because they have long-range radar, LIDAR, cameras, short/medium-range radar, ultrasound, and GPS, giving self-driving cars a multitude of senses that are superior to a human's (Giarratana, 2016). Self-driving cars can also communicate with each other wirelessly to know each other's driving intentions, make decisions and reactions much faster than a human, and do not get distracted or tired like a human. Therefore, self-driving cars are safer and could significantly diminish traffic fatalities. In fact, self-driving cars could produce a crash rate reduction of up to 90 percent (Ramsey, 2015). It is certain in the near future that many drivers' jobs will eventually be replaced by self-driving AI technology. However, today's progress in developing self-driving cars also demonstrates that AI has the potential to be ready to take over many other jobs very soon.

Even just a big loss of driving jobs will create a large impact on society. An estimated five million professional drivers' jobs, including truck drivers, taxi drivers, school bus drivers, and transit bus drivers, could be lost to self-driving technology (Greenhouse, 2016; Fahey, 2016). These drivers usually do not have higher education or other skills to find better replacement jobs. Their possible alternative jobs are limited and shrinking as the bar for education and skills to enter the future job market rises. Many families rely on the driver as the main income provider of the family. If 3/5 of the 5 million drivers have a family of four people, it would amount to about 12 million people's lives being affected by unemployment. Permanent displacement of these drivers would have devastating effects on families and their children. This negative impact on drivers' lives could ripple through multiple generations without external help. Additionally, many jobs areas supporting drivers such

as driving schools, gas stations, and car dealerships may also disappear. For instance, lower accident rates would lead to less frequent visits to auto body repair shops, and that would leave a significant portion of the 445,000 auto body repairers in the US without a job (Lee, 2015). If losing jobs in one sector can cause this much damage, then society must prepare itself carefully for the unemployment AI could create.

Besides driving jobs, a variety of other labor positions could be replaced by AI automation. According to McKinsey & Company, five factors determine if a job can be automated: technical feasibility, cost to automate, relative scarcity, skills required, and cost of workers (Chui, Manyika, & Miremadi, 2015/n.d.). There are a wide range of job areas that are subject to AI takeover, such as transportation and logistics, office and administrative support, personal and domestic service, accounting, and construction (Rotman, 2013). Production lines that manufacture large quantities of fixed design are also candidates because they usually contain jobs that are repetitive. Many of these jobs are already automated or in the process being automated with consideration of the 5 factors mentioned above. Additionally, AI technology in image and sound recognition has surpassed humans, so many security jobs will be replaced by AI. Also, there are already robots that can flip burgers. Food preparation could be replaced by AI that is capable of controlling multiple factors precisely, including temperature, cooking time, color, smell and taste. In construction, there are already bricklayer robots that are in use. A company called Apis Cor used a 3D printing robot and built a house in Moscow in 24 hours (Cor, 2017). The house can last up to 175 years and costs only $10,134 to build. With AI technology, a machine may be able to understand a building plan without requiring a human programmer to program the building plan into the system. Warehouse workers can be replaced by AI robots that know the precise location of stocked goods and executes orders tirelessly and efficiently. In farming, AI technology could also help farmer detect plant diseases earlier to take preventive actions. It is possible that AI will become a powerful general-purpose tool that is used every day for work and study like today's personal

computers and smart-phones. Therefore, in low or medium skilled labor, AI automation will push wages lower than ever, making the less-educated work force even poorer.

Unlike previous industrial revolutions, AI could automate a multitude of jobs throughout the occupation spectrum, including intellectual jobs. But, there are not enough jobs that could quickly absorb displaced workers without extensive retraining. Breakthroughs in AI-based voice recognition have made automated voice search and personal assistants practical to use. Siri, Cortana, Alexa and Google Now are current examples of such systems. When these technologies mature, jobs such as personal assistances and foreign language translators will be eventually replaced by AI. Traditional high-paying jobs such as Wall Street traders could also lose their jobs. For example, Goldman Sachs used AI to replace 600 traders and left only two traders remaining, who were supported with 200 computer engineers (Byrnes, 2017). IBM's Watson AI system has already replaced 34 workers in a Japanese insurance company called Fukoku Mutual Life Insurance to calculate payouts to policyholders. The system is based on IBM's Watson Explorer, which possesses cognitive technology that can think like a human, enabling it to analyze and interpret all of your data, including unstructured text, images, audio and video according to the company (Asia, 2017). While IBM's Watson system has more knowledge than most humans, even its abilities to use knowledge is no match for a human's yet; however, it is powerful enough to automate a lot intellectual work to help human to make decisions. Some routine data collection and processing jobs such as legal assistant and accounting clerk are also subject to replacement by AI. Many other traditional white-collar jobs such as financial advisor, bank teller, and insurance underwriter could be largely automated or replaced by AI. As a result, it is not just the low wage, less educated work force, that will be affected, as many careers that require higher education could also be eliminated. According to 2013 government statistics, the US has 36 million (27.2% employment share) jobs that require less than high school diploma, and 51 million (39% employment share) that require a high school diploma (Williams-Grut, 2016).

In total, 87 million (66% employment share) jobs require a high school education level or higher, making it difficult for workers to climb up the employment ladder even if AI does create new job opportunities while replacing traditional jobs. In conclusion, the impact of AI-caused unemployment should not be underestimated.

To confront this issue and reduce unemployment caused by AI, it is largely a matter of looking at the issue economically and adjusting the supply and demand of labor so that employment levels will have room to grow. Demand for labor comes from employers and is derived from consumer demand for goods. Supply for labor comes from how many workers are willing and able to work in the job market. Jobs that can be replaced by AI will have their demand of labor lowered due to improvements in capital, causing unemployment. Organizations and governments could find ways to increase demand of labor in other job areas to prevent structural unemployment from becoming permanent. On the demand side, common economic policies to raise employment includes injecting more money into the economy to increase consumer demand and therefore labor demand, giving government subsidies to companies that hire the long-term unemployed, and lowering employment taxes. On the supply side, employment can be raised through increasing investment in human capital to lessen occupational immobility and decreasing housing costs to reduce geographical immobility (Pettinger, 2017). These common policies and similar ones can be implemented by governments, industries, and organizations to prepare for the new wave of unemployment AI will create. Organizations can also discuss how to encourage the economy to allow job automation to lead to more profit, consumer demand, and therefore labor demand, instead of letting AI cut work too drastically. The funds for these methods can be raised through private sector contributions, taxes, or donations. These standard economic policies' applications, if considered within the specific context of the AI industry, will then help prevent AI-induced unemployment.

Governments, industries, and organizations can furthermore discuss plans to expand new careers that will be created by AI to minimize

the impact of mass unemployment. For example, with more AI used in our society, there will be more demand for AI jobs and trainers of all kinds. AI safety engineers, maintenance engineers, machine designers, and ethics researchers are some examples of possible new jobs. Specialized skills such as data analysis will be needed to identify areas that can use data to train AI and prepare data to conduct the training. As more and more opportunities for AI applications appear, new jobs that are difficult to predict today will also be created. Humans will be able to focus on doing more rewarding work such as scientific discovery, problem solving, and innovative design. Jobs indirectly related to AI will also expand, such as educational content creation for people who will go into AI careers. Experts in careers that will benefit from AI technology will also be in demand as AI implementation needs deep knowledge of each field for successful specialization. For instance, a field as complicated as neuroscience will require experts to create a usable AI system, because AI systems are only as good as the people who design them. The decline of monotonous jobs will also allow for creative jobs to expand as people have more time to pursue less technical interests. However, Moravec's paradox predicts that manual jobs are sometimes more resilient to job loss than middle-skilled jobs (Heath, n.d.). As a result, job expansion may occur in low and high skilled jobs, but not in middle skilled jobs. Society must invest more in higher education to adjust to this new set of jobs.

9.5 million job openings are predicted to be generated by AI; however, most of these are only open to the well-educated (Williams-Grut, 2016). To solve the unemployment problem, education that teaches skills for AI professions will be the key. Similar to how in the 1950s, funding of secondary learning helped curtail the unemployment effects of the Industrial Revolution, funding of college-level learning will mitigate the negative effects of AI on the economy (Heath, n.d.). On the supply side, young people coming to join the workforce must be prepared through updated education. AI will likely become an essential tool that people use every day to work and study, like how computers are utilized today. Because how well people can work with AI

will become an important skill that gets people hired, schools need to teach students to understand how AI works and how humans and AI could complement to each other. In order to succeed in the future, young people should at least graduate from high school. Every high school and college could teach machine learning AI just like how people today are being taught computer skills and programming in school. Education will help develop people's problem solving and creative thinking skills. The education system should prepare the work force's critical thinking skills, skills to apply knowledge, skills to solve hard problems, and effective communication skills. These abilities are essential to adapt to the new economy supported by AI technology. Current college education can be transformed from focusing on transferring knowledge to train students to apply knowledge, solve hard problems. Student performance should not measure how well a student memorizes facts but how well they apply the knowledge they have learned. Training for jobs complementary to AI instead of competitive with AI should be promoted. Since most AI-related jobs lie in STEM areas, and demand for STEM workers will increase before the number of young people going into STEM jobs increases, governments, industries, and organizations should continue to encourage young people to pursue STEM careers. They could provide scholarships, grants, low-interest loans, or even waive the repayment of loans if students can graduate with a 4-year STEM degree from a public university. Education must be reformed to emphasize teaching students how to think and solve difficult problems so they can succeed as workers in the AI age.

For unemployed adult workers, governments, industries, and organizations can use AI to analyze job opening data and provide targeted, customized training in specifically demanded areas to the unemployed. AI can be used to create online skill profiles for every worker and then match workers with job openings across the country. In the current job market, there are job openings, but people who need jobs often do not find the best job for themselves. If AI could do the hard work to find a job that matches best for each person, it will boost the job market and bring supply and demand together more efficiently. Government programs

that provide funding for job training programs and unemployment support such as the US Department of Labor's Employment and Training Administration could also be considered in plans to increase employment. Loans provided by these programs can be earned back by the unemployed through paid work during training. The pay could include cost of training, basic food, housing, and child care if needed, so the unemployed can have the time and resources to go through the required training. Additionally, basic income and public works projects are also to be considered in preventing job loss by AI. For people who still have jobs, lifelong learning is needed to keep up with the advancements of technology. AI not only drives the change of education; it also provides a tool to adjust to such a change. Society should encourage more companies to provide high quality free online learning using AI technology to support adaptive learning. Some free online learning providers such as Khan Academy have already started experimenting with adaptive learning. That means AI could be used to understand how individual learns more effectively than the individual himself. Hence, these organizations will be able to provide high-quality, free public education and deserve direct funding from the government.

Education alone will not solve the unemployment problem if the long run goal to develop AI is to cut labor costs. Society can learn how to integrate AI and people together and produce even more powerful results. Humans and AI have been proven to achieve more than using just one or the other (McCorduck, 2004). AI is ideal for specialization, thus it can be a great tool for humans instead of a complete replacement for humans. As a result, AI will likely replace tasks rather than complete jobs. Humans will still cover jobs in areas where the morals required for tasks are not present in AI, as Joseph Weizenbaum says (McCorduck, 2004). This can allow for a more gradual and society-friendly transition into the AI age. Additionally, AI can allow people to flow between jobs with reserves of corporate knowledge available at all times for humans to apply. Ultimately, AI are machines created by humans and should be used as a tool by humans. Governments and companies will use AI to help to make strategic decision for policy changes, investment or marketing or esti-

mate risks. More and more intellectual work will require human to work with AI to form a team. For example, with AI diagnostic assistance, doctor could spend less time reading diagnostic images and data, spend more time with the patient, and refer to AI suggestions of diagnosis for disease and treatment to serve the patient better. Therefore, how well a person work with AI will become an important determinant of one's employability. It is likely that only certain skills would need to be taught and a lot more knowledge could be accessible by people. Then, people would have more time to create and human creativity could expand. There will not be many jobs that can progress without incorporating AI technology.

Providing the unemployed affordable health care is also important to preventing social unrest. Current living and health care costs are not affordable for most of the unemployed. Besides providing education and retraining, society should also take advantage of AI technology to drive down living and health care costs. This will help let the benefits of AI be shared with everyone. Without control of health costs, a social safety net that includes retraining for the unemployed would not be sustainable. The US spent 17.1% of its GDP on health care in 2013, yet health costs are still rising quickly today (Squires & Andersons, 2015). Fortunately, AI has huge potential to drive down the health cost and make health care, especially preventive care, available to most people. For example, there are studies showing that AI can be trained to detect skin cancer more accurately than many expert human dermatologists (Scutti, 2017). Additionally, IBM is partnering with Celgene to better track negative drug side effects (Leaf, 2016). They are applying IBM's cognitive computing AI technology to recommend cancer treatment in rural areas in the U.S., India, and China, where there is a dearth of oncologists. In fact, IBM's Doctor Watson systems are designed to become a medical expertise system, and it can complete high-expertise tasks such as initial diagnoses of illness. The computer system can store vast amounts of information about illnesses and analyze a patient's symptoms to provide an initial diagnosis or what test to do to further collect information. Such a system could even be sold on phones or in stores in the future, with abilities to take blood pressure,

heart rate, blood samples, or urine samples to drive down health care costs and make health care affordable. For health care, early detection and action are crucial to lowering expenses. Decreasing living expenses through AI will then allow unemployed workers to invest more money in retraining programs.

Another danger to employment is the barriers to entering the AI technology industry. A concentrated AI market will stunt job growth and fuel unemployment instead because innovation will be limited. It is a fact that small businesses create the most jobs in America and in many other countries in the world. According to U.S. Small Business Administration, small businesses create 64% of private sector jobs (*Frequently Asked Questions about Small Business*, 2012). Currently, the AI industry has some high barriers, including the requirement of a massive amount of data, a vast amount of storage space, and immense computing power to enter the business, and only a small number of companies can afford the research facilities and resources required for AI development. Society should not let these barriers get so high that only a small number of companies that have the most data can develop advanced AI systems. If left unchecked, these companies would be able to dominate the AI market with their influence. They could also control and dominate the government and military and gain considerable political power. This limitation of access to data stunts industry growth and inhibits innovation, as concentrated markets often do. Data is the most important resource in the AI age. There are currently a lot of opportunities in society to apply AI. A few big companies will not be able to cover all of them efficiently. The government needs to provide more support to give any person the ability to use AI to create new technology by making some of the data the government owns free to the public, and providing storage and computing power to develop AI. Then, government data on subjects such as population, traffic, weather, satellite images, and the human genome could be used to create many jobs using AI. This action will also encourage more people to work and invest in AI. AI could help us perform scientific discovery more efficiently, find a cure for cancer, devise a solution to global warming, conceive a way to conserve

nonrenewable resources, or discover other solutions to global issues. Thus, the government should consider restricting technology giants such as Google, Amazon, and Apple from buying up the majority of AI startups. Additionally, rapid development is occurring in AI without public discussion or supervision of ethics because there are only a few large businesses involved. For example, "Google's ethics board is shrouded in secrecy, with both Deepmind and Google refusing to disclose any details about the members of the board or what is discussed" (Wales, 2016). So it is important to limit the influence of business by maintaining competition in the AI market. AI, a technology with such powerful potential, should not be entrusted to the hands of a few private corporations and thus the public must keep watch on it and prevent monopoly.

In summary, AI will accelerate job automation in the world and cause structural unemployment. There are opportunities and challenges with such a change. Technology revolutions have already caused unemployment before, with serious economic and social consequences. Governments, industries, and organizations can discuss how to encourage expansion of jobs created by AI to replace jobs destroyed by AI. Strategies to diminish unemployment include reforming education, boosting federal programs that provide training and support to workers, combining AI and humans to perform jobs, driving down health and living costs, and keeping the AI industry competitive. Automation may become so ubiquitous that displaced workers will have nowhere to go with their current skills, producing social upheaval. Society cannot afford to assume that AI will create jobs as fast as it will eliminate jobs or distribute new wealth to all people like other technology has before. To quote from Brynjolfsson: "It's one of the dirty secrets of economics: technology progress does grow the economy and create wealth, but there is no economic law that says everyone will benefit" (Rotman, 2013). Therefore, we must act now in order to prepare our current and future workforce for widespread use of AI and spread the bountiful benefits of automation out so everyone can have a future of increased leisure, wealth, and freedom.

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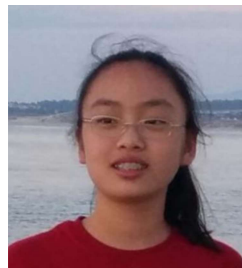
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