PUTTING AI TO WORK

Technology and Policy for Enabling the Workforce of the Future

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Executive Summary

Technologies powered by artificial intelligence (AI) promise to transform the future of work, with wide-ranging effects on employment, wages, and income distribution. In the face of dystopian forecasts of robots and automation replacing workers, we have an opportunity to consider how the power of AI can be harnessed to enhance and augment human labor rather than replace it.

This white paper explores opportunities to apply AI in ways that make the workforce more inclusive, especially for aging populations and individuals with disabilities. We present examples of ways AI can support (re)skilling and training tailored to the cognitive and physical attributes, needs, and skills of diverse individuals; facilitate more inclusive job discovery, selection, and access; and enhance and augment an individual's skills through AI-enabled assistive hardware and software.

AI holds great promise to support meaningful and gainful employment for aging populations and individuals with disabilities, enabling a more inclusive and productive workforce. But to achieve these objectives, a collective approach by both the private and public sectors is needed. We suggest the following strategies to ensure effective development and deployment of AI in the workforce:

- Resources should be allocated for educational and (re)training programs for older adults and individuals with disabilities to be developed and promulgated in both the public and private sectors.
- New models of unemployment protection, including social safety net programs such as unemployment insurance and healthcare access, should be considered to expand opportunities for diverse workers.
- Universal design principles should be applied to mitigate bias, exclusion, and/or discrimination in AI-enabled tools and programs applied in the workforce.
- Organizations using AI-enabled tools and programs should attend to the unique requirements of older adults and individuals with disabilities when establishing and communicating standards of data security and privacy, including standards for ownership, collection, access, control, and notices for use of data.
- The scope and definition of reasonable accommodation under the Americans with Disabilities Act (ADA) should encourage use of innovative AI-enabled technological solutions to benefit a diverse workforce.
- Collaborative research and multi-stakeholder engagement must be pursued to ensure development of evidence-based evaluation mechanisms, metrics, and policies for AI-enabled tools and programs that benefit vulnerable groups across different sectors.

Introduction

AI-enabled technologies hold great potential to make the workforce more inclusive, helping to bring new populations into the workforce or assisting workers to maintain meaningful employment as they age. In this white paper, we explore the pace and extent of the effects of AI on the workforce with a particular focus on its adoption for innovations serving the aging and individuals with disabilities. We investigate its application in training and workforce development; job discovery, selection, and access; and enhancing and augmenting labor.

Individuals with intellectual or physical disabilities are disproportionately under-represented in the U.S. workforce, holding significantly lower employment rates (see Figure 1). In the United States, about one-third of individuals between the ages of 16 and 64 with a disability were employed in 2016, while nearly three-fourths of those without a documented disability were employed.[1] In addition to economic considerations, employment levels are also strongly correlated with social inclusion within societies.[2] Work offers critical benefits in addition to financial remuneration; people with meaningful employment have the opportunity to establish an identity, develop relationships, achieve purposeful goals, and be empowered to act as productive members of society.[3]

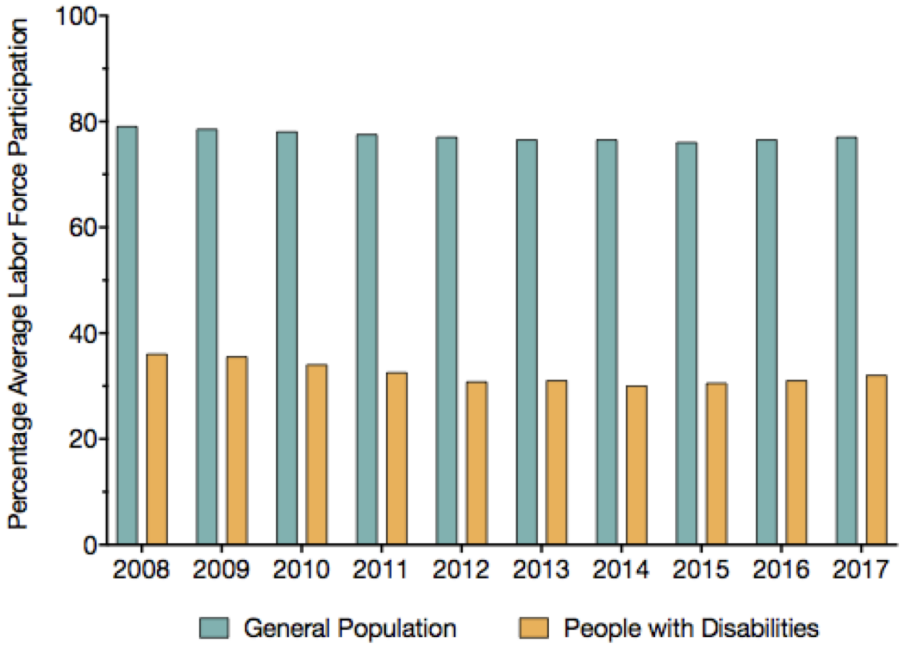

Figure 1. Comparison of Average Labor Force Participation Rates Between People with Disabilities and the General Population in the United States. Source: SourceAmerica, 2018

The U.S. workforce population is aging. While older workers (55 years or older) comprised approximately 20% of the workforce in 2015, that share is expected to increase to over 30% by 2060 (see Figure 2).[4] Meaningful engagement of older workers is critical to ensuring transformative social and economic benefits.[5, 6] Not only will their participation enable them to contribute their experiences and insights, their mentorship will help younger generations learn and develop.[7] The share of employment held by disabled and aging populations present an opportunity to expand the workforce, both in terms of overall participation and meaningful employment. Increasing workforce participation by aging individuals and those with disabilities can enable a more inclusive workforce that supports economic growth.[8]

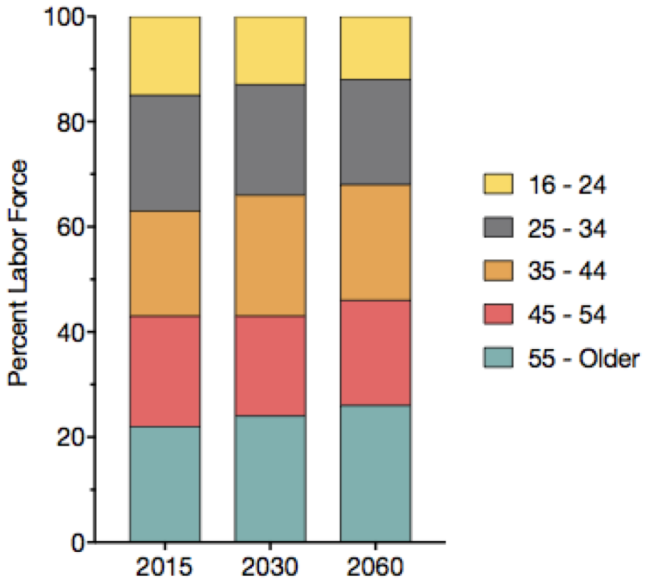

Figure 2. Projected Labor Force Participation by Age. Source: US Bureau of Labor Statistics

Defining Disability and Aging

“Living independently and with dignity means [having the] opportunity to participate fully in every activity of daily life.”[9] This foundational principle underpins the Americans with Disabilities Act, legislation that seeks to enable full, inclusive futures for people with disabilities. Governments have long been working to achieve this goal through creating social security disability programs, exploring gaps and opportunities in policies, and establishing necessary tools to bridge them.[10]

Defining “disability” is a necessary first step to design effective strategies and programs. The Social Security Act defines disability as “the inability to do any substantial gainful activity by reason of any medically determinable physical or mental impairment which can be expected to result in death or which has lasted or can be expected to last for a continuous period of no less than 12 months.”[11]

The World Health Organization (WHO) notes that "disability is an umbrella term, covering impairments, activity limitations, and participation restrictions. An impairment is a problem in

body function or structure; an activity limitation is a difficulty encountered by an individual in executing a task or action; while a participation restriction is a problem experienced by an individual in involvement in life situations."[12] Juxtaposing this definition with the nature of aging populations, "relatively few older adults have activity limitations and participation restrictions."[13] Aging does not automatically equal disability.[14] This paper identifies such a distinction, and focuses on aging adults who experience some level of limitations and restrictions in participating in the workforce, similar to individuals with disabilities.

Technology is constantly changing the nature and scope of work for individuals with disabilities. In the 1950s, more than 30% of American jobs were in manufacturing, requiring certain physical capabilities that made these jobs largely inaccessible to individuals with disabilities.[15] Over the next 50 years, those numbers fell to 17%, while white-collar, service, and retail jobs increased substantially, changing the nature of work and industrial demands.[16] Further, the digital wave starting in the 1990s continued to transform the workplace, enabling more robust opportunities for people with disabilities to participate. This led to laws, including the Americans with Disabilities Act of 1990 (ADA), that "created accessible transportation and workspace standards, along with requirements for employers to provide reasonable accommodations for people with disabilities."[17] These trends demonstrate how technology, with the support of public policies, has contributed to enhancing career and employment opportunities for people with disabilities.

Regulation is one mechanism to ensure inclusivity and meaningful participation of vulnerable groups in the workforce. In the United States, the ADA and the Age Discrimination in Employment Act of 1967 (ADEA) protect applicants and employees, making it illegal for employers to discriminate against qualified job applicants and employees based on their age and physical or mental disabilities.[1819] These regulations mandate that employers adhere to reasonable accessibility accommodations, making the workforce more accessible to aging populations and people with disabilities.[20,21]

Artificial intelligence, including machine learning, offers new opportunities to support greater inclusion by mitigating bias in screening and hiring processes and supporting greater inclusion of diverse skills and needs in the workplace. Using these emerging tools, future workplaces and tasks can support meaningful and gainful employment for aging and disabled populations.

Defining AI and the Future of Work

AI can be understood as a system capable of rationally solving complex problems or taking appropriate actions to achieve a set of objectives within diverse circumstances.

Definition and Elements of Artificial Intelligence

AI can be defined as a statistical process that utilizes a body of data to derive a rule or procedure to identify trends in the data and predict future data.

Key elements of AI include:

- Systems that think like humans (e.g., cognitive architectures and neural networks)
- Systems that act like humans (e.g., pass the Turing test via natural language processing, knowledge representation, automated reasoning, and learning)
- Systems that think rationally (e.g., logic solvers, inference, and optimization)
- Systems that act rationally (e.g., intelligent software agents and embodied robots that achieve goals via perception, planning, reasoning, learning, communicating, decision-making, and acting)[22]

We explore application of AI in the workforce in two ways:

1. **Automation** occurs when a machine does work that might previously have been done by a person.[23] The term relates to both physical work and mental or cognitive work that might be replaced by AI.

2. **Augmentation** occurs when a machine complements rather than replaces human work. The goal of such systems is to create a human-machine team, where the skills of both are combined for optimal results. Augmentation can be both physical (e.g., AI-enabled exoskeleton to assist in physical work tasks) and virtual (e.g., AI-enabled software that performs or mediates a sub-task).[24] A process where the function of AI is to transpose, translate, and contextualize elements of the environment.[25] This may involve transcoding text into speech, providing personalized interfaces for each individual within a complex group interaction, emphasizing different data and data sources, re-imagining instruction sets, or acting as a physical or social proxy for the individual where the user's intent is translated through AI. While such technology-enabled capabilities can benefit all, its application can be a great leveler for those who have

been functionally excluded from the workplace. It is important to note that such mediation is not limited to the textual (language-encoded data) or tangible (the physical environment), but also can include applications where *meaning* is extracted from complex systems (e.g., social interactions or navigating a multimodal transportation system) and interpreted into a format that meets the capabilities and preferences of the user, listens for intentionality from the user, and turns that intentionality into action.

While the displacement of entire occupations is of great concern, AI is also transforming the nature of occupations and roles in a range of industries.[26] Across different sectors, automated management, operation, and hiring technologies are being developed and implemented, to achieve greater worker productivity and flexibility, but also exposing workers to risks through "new forms of monitoring, manipulation, and control."[27] This not only changes availability of jobs but also affects labor processes, power relations, and job responsibilities.[28] Therefore, it is critical to explore applications of AI and its potential effects on different sectors and stages of the workforce.

Consequences of incorporating AI tools will not be limited to the technology and manufacturing sectors, where tasks are more likely to be automated with advanced machine learning and robotics. A range of other sectors that currently depend on human interaction, such as healthcare and customer service, are also being affected by AI. Adoption of machine learning technologies and their influence on the workforce will depend on various technological, institutional, and market factors such as:

1. Pace of AI development and adoption
2. Economic growth and its effect on income and consumption
3. Growth in demand for work
4. Infrastructure investments
5. Policy changes that seek to reap the benefits of AI, while addressing issues affecting worker transitions brought about by these technologies[29]

Deployment of AI to automate and augment human labor has been extensively studied in different contexts. Researchers have undertaken a range of approaches, focusing along the lines of geography, sector, and skills, predicting a variety of effects. Results from an array of studies released by companies, think tanks, and research institutions vary with predictions from optimistic to devastating.[30]

Application of AI and its effects depend on a given sector's requirements and workforce activities, occupations, and skill levels. Activities conducted in predictable environments have a greater potential for automation, and will see a larger portion of jobs replaced by technologies. As a result, activities such as processing or collecting data, or performing physical activities and operating machinery are more susceptible to displacement by AI. Other jobs that exist in more unpredictable environments, where adaptation is critical, are more challenging to execute with AI-enabled tools. These include interacting with stakeholders, mentoring employees, or

applying expertise to decision-making, planning, and creative tasks. Human-machine collaboration can offload mundane, predictable tasks to automation and enable workers to engage in more diverse, higher-level activities. This concept of human-AI teaming and "multiplicity," where groups of humans and machines collaborate to innovate and solve complex problems, is projected to lead to a more productive and inclusive workforce.[31]

Automation will have wide-ranging effects, across geographies and sectors. While development and application of AI is on the rise globally, factors such as the historical nature of work, demographic composition of the workforce, institutional infrastructure supporting the workforce, political factors, and economic development will determine likelihood of adoption and effects of these technologies on the workforce. For example, China and India account for a large portion of the global workforce and are also heavily engaged in the manufacturing and agricultural sectors where automation holds great potential to increase productivity and cost-effectiveness. Yet infrastructural bottlenecks, lower wage rates, and slower economic growth in developing countries could constrain adoption. Therefore, when evaluating current and future effects of AI on the workforce, geographic and demographic factors must be considered.

Effects of AI on Aging Populations & Individuals with Disabilities

While substantial research has been conducted on predicting the effect of AI on the workforce broadly, limited attention has been devoted to understanding differential effects on the aging and individuals with disabilities. We explore positive opportunities of applying AI to enhance accuracy and productivity and caution against excessive focus on negative outcomes that perpetuate displacement and discrimination in the workforce.

Automation of activities can lead to gains in performance and productivity, by reducing errors and improving quality and speed.[32] By improving accuracy, each task will effectively improve the overall quality and quantity of work produced.[33] AI-enabled tools can be applied to fill gaps in capabilities for individuals with physical and cognitive disabilities, including applications within text analysis, augmented reality, sensory perception, and automated transportation. For aging populations and individuals with disabilities, application of AI can enhance the quality of work by augmenting challenging or time-consuming tasks.

While application of AI may increase accuracy and productivity, AI may also perpetuate displacement, exclusion, and discrimination. For example, activities carried out in predictable environments are more susceptible to automation, thereby displacing labor opportunities for individuals with disabilities, a group that tends to be employed in more predictable tasks and environments than others. In 2016, workers with a documented disability in the U.S. were more likely to be employed in service and manufacturing occupations (21.3%) than those without a documented disability (17.6%).[34] Workers with a disability were also more likely to work in

production, transportation, and material-moving occupations (14.6%) than people without a documented disability (11.6%) and were less likely to work in management, professional, and related occupations (31.7%) than those without a documented disability (39.5%).[35] The direct threat of displacement will affect their jobs more than others and disproportionately diminish their ability to find suitable employment.

Because machine learning makes predictions from data and detects patterns and generalizable findings, an essential step is to clean data and eliminate "noise" (i.e., outliers) that could potentially skew results and conclusions.[36] By definition, people with disabilities are not average and risk being dismissed as outliers by machine learning models. This difference, especially extreme differences, can be treated as outlying data in the process of eliminating noise and finding dominant patterns from which inferences are made.[37] Eliminating data insights from these populations can lead to the reinforcement of models and practices that tailor work environments and tools to individuals without disabilities. Further, current AI methods threaten to produce shallow results because they are programmed with little innate knowledge of circumstances and possess no "common sense" about the world or human psychology.[38] The effect of these limitations in data handling in machine decisions can be felt today in many areas such as in the "failure to recognize impaired speech, process unusual requests, diagnose complicated illnesses, accept unusual applications, or give security access through unexpected biometrics."[39]

Application of proprietary or AI neural network technologies can be opaque black boxes, where outputs cannot be easily explained, raising concerns about reliability and bias.[40] In the context of AI models applied to increase inclusion in the workforce, models that rely on historic data and trends that exclude the unique traits of aging and disabled populations are likely to perpetuate inequality. Both in the case of job discovery technologies and assistive technologies, where machine learning is used to determine trends as well as context, the explainability and transparency of the technologies for individuals with disabilities becomes critical. For example, machine learning, language processing, and facial recognition can be used to describe the external physical environment for a person with visual impairment (e.g., Microsoft's Seeing AI detailed later). The bias and reliability of these descriptions depends heavily on the input data and model design. The opacity of these technologies prevents us from identifying and mitigating these possibilities.

Finally, the sociological and psychological effects of incorporating technologies into the daily lives and work of aging and disabled communities must be a key consideration. AI-enabled chatbots are becoming more effective at modeling human conversation and relationships. The ability of AI to replicate human roles is particularly promising in the case of assistive technologies that automate or augment essential labor functions. While such tools can be efficient and economical, they can also prove to be a problematic substitute for human relationships and negatively affect users.[41] One of the main criticisms is that we are still in the infancy of understanding the complexities of humans' relationship with technology, and technology does not fully capture the intricacies of human relationships or the sociological and

psychological consequences when certain parts of these relationships are replaced.[42] Therefore, while chatbots may support greater efficiency, their full replacement of human relationships can have differing and lasting sociological and psychological effects on groups that face physical and mental impediments on different levels.[43]

Predicted effects of AI vary, ranging from its potential to boost productivity and enhance the workforce to being an "existential threat to the human race."[44] Keeping in mind the key influential factors, we must consider predictions with healthy skepticism.[45] Imagined scenarios and bold estimations deserve sustained empirical attention, including greater attention to detail in specific contexts. We next provide examples of ways AI and AI-enabled assistive technologies are being applied or could be applied in training and workforce development; job discovery, selection, and access; and enhancing and augmenting human labor.

Training & Workforce Development

AI and assistive technologies hold great promise to train and re-skill the workforce, especially for labor markets with increasing aging and disabled populations. Companies are starting to provide in-house training, upskilling their current workforce to meet the changing demands of digitally transformed work.[46] For disabled and aging populations, AI-enabled training and development may better prepare them to adapt to the changing needs of their occupations over time.

STRIVR

STRIVR (http://strivr.com), a start-up based in Silicon Valley, is partnering with retail stores using immersive virtual reality to simulate training scenarios, including operational logistics in how goods should be shelved, as well as skills needed for customer service like empathy and hospitality.[47] VR platforms like STRIVR hold potential to support diverse types of training tailored to the cognitive and physical attributes, needs, and skills of workers. Another example, UTURN (http://www.uturnvr.com/), is an immersive VR platform that allows individuals to experience differences between gender-based perspectives in the workforce. Immersive VR platforms like STRIVR and UTURN could also be used to raise awareness of the experiences of aging and disabled populations in the workforce.

Figure 3. STRIVR virtual reality immersive training. Source: Strivr, 2018

Job Discovery, Selection, & Access

With the expansion of markets, rise in number of job seekers, and the integration of technologies into the recruitment process, employers are increasingly automating hiring decisions.[48] AI can be applied to scan resumes for keywords about education, skills, and other relevant hiring criteria, and expanded to include a range of factors, tools, and methods to screen applicants. For instance, AI-enabled anonymous screening removes age barriers for older workers who demonstrate their institutional knowledge, depth of skill and problem-solving abilities. As a result, AI-based assessments and recruitment can help overcome unconscious bias and increase diversity. This shift has already radically changed the way hiring is conducted and how applicants interact with prospective employers in some industries.

Results have been mixed, however. Incorporating AI and limiting human judgment in parts of the recruitment process can improve efficiency and cost-effectiveness, and reduce bias, but it may also serve to perpetuate discrimination where certain skills and characteristics of previous employees continue to be prioritized. As a result, programs that use AI can "screen out non-traditional applications without thinking" and require additional safeguards to make the process more inclusive.[49] Acknowledging the positive and negative consequences of applying AI to job discovery, selection, and access is critical to ensuring AI-enabled processes lead to a more inclusive workforce and create rather than diminish opportunities for aging and disabled individuals. A few programs and tools have emerged that apply AI to optimize these features.

Identifor Career Assessment Tool

Identifor is a career assessment tool that employs a game-based approach to assess job readiness among youth with autism and other developmental disabilities, and match them with relevant jobs and skills.[50] Its strengths-based approach measures multiple forms of intelligence, executive function, and job interests to match each individual to relevant career options detailed by the US Department of Labor. A personalized dashboard also incorporates the McCloskey Executive Function Survey and the Autism Speaks' Community-Based Skill

Assessment to support job discovery (see Figure 4). Identifor also features a chatbot that helps with a wide range of life-management needs, guiding the user when parents, teachers, or aides are unavailable.

Figure 4. Identifor Model. Source: Identifor, 2018

Microsoft Inclusive Hiring for People with Disabilities

As part of the company's Global Diversity and Inclusion program, the Microsoft Inclusive Hiring for People with Disabilities Program, is designed to implement an inclusive approach to support individuals on the autism spectrum and match them with skilled positions at Microsoft.[51] To provide a supportive platform for differently abled professionals to fill existing gaps and integrate into the mainstream workforce, the Inclusive Hiring Program is a multi-day, hands-on academy that focuses on team projects and skills assessment. This gives candidates an opportunity to present their skills and strengths and learn about various aspects of Microsoft. The program has successfully placed individuals with physical and cognitive disabilities in a range of technical (e.g., software engineer), management (e.g., product strategy), and other roles.

Amazon's CamperForce & Kiva Robots

In the 2000s, Amazon faced a shortage of temporary workers during the peak months of hectic commerce in December. In some areas of the country, reliable on-demand labor was difficult to fill, and it became expensive and inefficient to move workers from one place to another. In 2008, a staffing agency proposed a model that recruited aging adults living in recreational vehicles to work at the Amazon facility in Coffeyville, Kansas. Following this success, Amazon started the initiative CamperForce, where workers around the traditional retirement age (60s and 70s) are matched with Amazon's warehouse jobs.[52] Though warehouse jobs were not physically well suited for elderly workers, they brought strengths in terms of their maturity, diligence, and responsibility. As Amazon's network of fulfillment centers expanded, the company hired trusted CamperForce members to fill a range of functions including inventory control, quality management, training and recruitment. The application of machine learning in the assessment and recruitment of elder workers in such programs has wide scope and potential to enhance worker participation and effectiveness.

Assistive technologies like handheld scanners that tracked workers' progress around the warehouse, and industrial robots that transported merchandise helped to alleviate any physical

limitations affecting performance. Kiva is one such device that ferries open-faced shelving columns with merchandise to stations operated by humans (see Figure 5), exemplifying how human-machine teaming can fill mobility or physical skill gaps.

Figure 5. Kiva robots moving open-faced shelving columns. Source: Robotics Business Review

Sacramento's Microtransit Experiment

For many aging and disabled individuals, transportation to and from work remains a substantial impediment. Sacramento's Regional Transit Authority is preparing to launch a microtransit trial, that offers an alternative to app-based ride hailing services.[53] This model is based on shuttle buses or vans that riders request via smartphone. The shuttles pick riders up and drop them off at locations of their choice. Building on algorithms similar to those used by other ride sharing services, this system has the potential to greatly increase accessibility to workplaces and other resources.

By employing a technology-driven and high-efficiency solution to public transit, such mobility problems faced by aging and disabled individuals may be substantially mitigated. Ways2see, a pre-trip planning GIS app, was developed by researchers at the University of Graz in Austria to provide visually impaired pedestrians informed maps, including sidewalks and any obstacles such as fences or walls. Tools like Ways2see can expand opportunities to help individuals with visual impairments or blindness independently navigate busy cities.[54]

Enhancing & Augmenting Human Labor

AI holds great promise to enhance and augment human labor, both physically and virtually. Human-machine teaming can improve productivity through physical augmentation of labor, for example utilization of AI-enabled exoskeletons to strengthen an individual's physical ability to

perform certain tasks, or through virtual augmentation where AI is applied to complete or support sub-tasks.

Exoskeletons

Exoskeletons and exosuits are "external structural mechanism with joints and links corresponding to those of the human body."[55] AI-enabled exoskeletons tap into machine learning and data-processing capacities to predict and support movement. With growing applications in areas including rehabilitation medicine and and assistive locomotion, they offer significant benefits for aging and disabled individuals. Use of exoskeletons is becoming increasingly common to strengthen elderly workers in Japan and more recently in the United States. Japanese companies like Panasonic, Honda, and Cyberdyne are investing heavily in research and development of exoskeletons and exosuits as tools to help ease the burdens of older workers engaged in physically demanding jobs (see Figure 6).[56] For instance, in 2015, Tokyo's Haneda Airport provided its older staff members with exoskeletons to assist them in lifting heavy luggage.[57, 58] As similar devices become more accurate, sensitive, and effective, they may open jobs previously out of reach for individuals with limitations in certain abilities, and make them better equipped to perform job tasks.

Figure 6. Panasonic's Robotic Exoskeleton. Source: Panasonic, 2016

Drishti

Accenture, a global professional services company, is piloting an AI-powered solution to improve the cognitive experience and enhance productivity for the visually impaired.[59] The product, called *Drishti* (meaning "vision" in Sanskrit), provides image recognition, natural language processing, and natural language generation capabilities to describe the environment to a visually impaired person through a smartphone. Drishti identifies and informs the user of the number of people in a room, including their approximate age, gender and even emotions based on facial expressions; identifies and narrates text from books and documents; and identifies obstructions like doors to improve the safety of the user.[60] Collaborating with the

National Association for the Blind in India, this pilot seeks to create a more inclusive workplace for the visually impaired.

Microsoft Seeing AI and AIRA

In 2017, Microsoft introduced a smartphone app that uses computer vision to describe the world for the visually impaired.[61] This application allows users to point their phone's camera at a person or object, then provides information such as spoken text, audio guidance, product identification, scene description and audible text correspondence, among other things.[62] With significantly higher speed of neural networks, this app demonstrates potential to "help someone fully participate in her job."[63] Seeing AI is a project under the AI for Accessibility initiative within Microsoft, an initiative that will explore applications of AI to increase employment, enable independent living, and support human connection.[64]

Aira is an assistive technology product developed by a California-based startup and inspired by a community of blind professionals.[65] Aira uses augmented reality to connect individuals who are blind or low vision to a trained professional agent.[66] This agent provides real-time visual assistance and helps enhance the users' everyday experience. This technology demonstrates potential to be used by visually impaired professionals in the workplace to help them navigate both physical and cognitive environments with greater ease and effectiveness. Though this product uses human assistants, the product seeks to employ AI-enabled virtual assistants that rely on facial recognition, natural language processing, and other intelligent technologies.

Recommendations

While it is clear that AI and assistive technologies will have transformative effects on the workforce, the nature and extent of these effects—across low-, mid- and high-skill occupations—are less clear. These technologies will have disparate effects in income distribution and inequality, depending on private and public sector strategies, such as how government policies will influence and regulate the ways in which organizations choose to manage their workforce, and how institutions and individuals invest in developing skills and respond to changing labor demands. We believe that strategies that seek to enable enhancement of labor market dynamism through educational and workforce training models, and strengthening transition support for workers caught in the crosscurrents of automation, are critical to prepare the workforce for the age of automation. The following are suggestions for the private and public sectors that seek to better ensure development and deployment of AI in the workforce is more inclusive, especially for older populations and those with disabilities:

1. ***Education and (Re)Training Programs***

Resources should be allocated for educational and (re)training programs for older adults and individuals with disabilities to be developed and promulgated in both the public and private sectors.

Beginning from primary education and including professional and higher education, the public education system plays a vital role in preparing the workforce of the future. Historically, federal and state governments in the US have invested in Career and Technical Education (CTE) in U.S. secondary education. These programs encompass "a wide range of activities intended to simultaneously provide students with skills demanded in the labor market while preparing them for post-secondary degrees in technical fields."[67] Similarly, inclusive institutional frameworks like Universal Design for Learning (UDL) present great promise. UDL is a framework based on research in the learning sciences, including cognitive neuroscience, that guides the development of flexible learning environments that can accommodate individual learning differences.[2] Therefore, programs tailored to meet the needs of students with physical and cognitive disabilities, and focused on STEM education, skills in human-machine teaming, and development of creative skills not easily completed by AI, can better ensure diverse workers are equipped to meet changing labor demands.

In order to better ensure inclusion of aging populations and individuals with disabilities in the workforce, adult education and (re)training programs will be necessary. Coordination between public and private sectors will be critical to ensuring appropriate education and (re)training of workers to meet the diverse demands of digitally transformed work. Multi-sector collaboration is a necessary approach to ensure inclusivity and life-long learning. Further, companies should consider enabling development of internal education programs and (re)training including establishment of online accreditation.

2. ***Unemployment Protections***

New models of unemployment protection, including social safety net programs such as unemployment insurance and healthcare access, should be considered to expand opportunities for diverse workers.

Employment plays a central social and economic role in our lives. One key approach to address the shifting nature of employment can be by altering the existing social model itself, where "an individual's livelihood, social status, and personal self-worth" are dependent on their employment.[68] Most importantly, social benefit approaches to employment must be adjusted to match the changing nature of employment.[69] In that context, social safety net programs such as unemployment insurance and healthcare access will be necessary to support workers whose jobs are lost to economic transition. Healthcare is a critical aspect of employment, particularly for individuals with

specific health issues. For most people today, their healthcare is tied to their employer, which constrains their flexibility. Therefore, new models of health care will be needed where insurance is de-linked from a single employer. Such models can potentially emerge from both the public and private sectors or a combination of both. One government-driven example of such a model is the concept of health care exchanges such as those developed under the Affordable Care Act.[70] Similar models tailored for individuals with disabilities can enable them to engage in gainful employment and meet their needs.

3. ***Universal Design***

Universal design principles should be applied to mitigate bias, exclusion, and/or discrimination in AI-enabled tools and programs applied in the workforce.

"Universal Design is a framework for the design of places, things, information, communication and policy to be usable by the widest range of people operating in the widest range of situations without special or separate design. Most simply, Universal Design is human-centered design of everything with everyone in mind."[71] Tools like the Global Public Inclusive Infrastructure (GPII) can better ensure that everyone who faces accessibility barriers can access and use the internet and all its information. Inclusion should be considered at all levels of workflow structure and process, taking into account the unique needs of aging and disabled populations.

Machine learning models rely on cleaning data and eliminating edge cases and anomalies that disrupt a general pattern. This process can result in the exclusion of vulnerable groups and perpetuate bias, especially among populations that do not conform to a standard "norm." Identifying such effects of data cleaning and mitigating potential bias is critical. As AI continues to evolve in its scope and complexity, an approach that is more granular and targets specific areas of application may be more practical. That would mean oversight over those areas that directly affect human life, mitigating discriminatory effects on aging and disabled populations. Greater transparency in machine learning tools is a prudent and practical starting point to address exclusion and bias in AI applications in the workforce.

4. ***Privacy and Security***

Organizations using AI-enabled tools and programs should attend to the unique requirements of older adults and individuals with disabilities when establishing and communicating standards of data security and privacy, including standards for ownership, collection, access, control, and notices for use of data.

AI-enabled technologies can have transformative effects on supporting greater access to employment opportunities, but the same technological advances also have potential negative consequences for privacy and security. Particularly for those applications that collect sensitive data from individuals' immediate environments to assist them and help navigate different contexts, questions of data protection and security breaches become critical. Measures such as the European Union's General Data Protection Regulation (GDPR) attempt to address the complex data protection issues broadly through policy. At the same time, concrete measures have been taken by particular communities and industries, which take into account the unique aspects of data collected and the AI tools built using it. Principles of data stewardship should be collaboratively developed between industry, public sector, and aging populations and people with disabilities.

5. ***Rethinking Reasonable Accommodation***

The scope and definition of reasonable accommodation under the ADA should encourage use of innovative AI-enabled technological solutions to benefit a diverse workforce.

Incentivizing AI innovation while monitoring responsible development and application that align with policy objectives is essential to maximize benefits for the workforce. Regulation should be informed through a holistic and practical approach where the needs and priorities of aging populations and individuals with disabilities are central. For instance, a key policy tool that is critical to employment of individuals with disabilities is the requirement of reasonable accommodation under the ADA, which requires employers to provide reasonable accommodations to qualified individuals with disabilities that will enable them to perform the essential functions of jobs held or desired. AI-enabled and assistive technologies hold great potential to comply with the reasonable accommodation requirements under the law.

6. ***Collaborative Research and Engagement***

Collaborative research and multi-stakeholder engagement must be pursued to ensure development of evidence-based evaluation mechanisms, metrics, and policies for AI-enabled tools and programs that benefit vulnerable groups across different sectors.

Multistakeholder collaboration can explore critical research questions in the area of AI implementation within the aging and disabled workforces. Specific questions can include the potential of AI in training, impact of AI in support and caretaking, and the role of AI in bringing together inclusive and diverse teams of workers. The private sector and government agencies at federal, state, and local levels can play an important role here both by funding and providing collaborative platforms for such research. Private

and public sectors must be encouraged to implement pilot programs applying AI in the workforce, and closely monitoring their impact. While models and products that apply AI are underway in many sectors, systems that evaluate progress and impact of AI tools are lacking.

Conclusion

In the face of dystopian forecasts of robots replacing workers, it is important to consider that AI can be applied in ways that make the future of work more inclusive by enhancing and augmenting human labor rather than replacing it. AI can be applied in novel ways to enable (re)skilling and training tailored to the cognitive and physical attributes, needs, and skills of diverse individuals; facilitate more inclusive job discovery, selection, and access through inclusive resume screening, interviewing, and training mechanisms and transportation models that ease the burden of aging and disabled populations to travel to and from work; and enhance and augment an individual's skills through AI-enabled assistive hardware and software. But to achieve these objectives, a collective approach by both the private and public sectors is needed, to identify and support development and deployment of AI in ways that tap into the unique perspectives and skills of aging and disabled individuals.

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