

THE BROOKINGS INSTITUTION
ARTIFICIAL INTELLIGENCE AND UPSKILLING

Washington, D.C.

Thursday, October 6, 2022

PARTICIPANTS:

Welcoming Remarks:

STEPHANIE AARONSON
Vice President and Director, Economic Studies, The Brookings Institution

Introduction:

SANJAY PATNAIK
Bernard L. Schwartz Chair in Economic Policy Development, Fellow, Economic Studies
Director, Center on Regulation and Markets, The Brookings Institution

Keynote and Q&A:

ALBERTO ROSSI (Moderator)
Professor and Director, AI, Analytics, and Future of Work Initiative, Georgetown University

ANDREW NG (Keynote)
Founder and CEO, DeepLearning.AI; Co-founder and Chairman, Coursera;
General Partner, AI Fund

Panel Discussion:

LONI MAHANTA (Moderator)
Nonresident Fellow, Center on Regulation and Markets, The Brookings Institution

DAVID ESTRADA
Chief Legal and Policy Officer, Nuro

MORGAN FRANK
Assistant Professor, University of Pittsburgh

GAD LEVANON
Chief Economist, Burning Glass Institute

* * * * *

P R O C E E D I N G S

MR. PATNAIK: Good afternoon, everyone. And welcome virtually to Brookings. My name is Sanjay Patnaik and I'm the director of the Center on Regulation and Markets here at Brookings. I'm very pleased that you have chose to join us today for this really important event.

We are here to discuss artificial intelligence and upscaling or the development of additional skills for employees and talented people to move up in the career scale. And we are honored to have several high-level experts with us today who are particularly well educated to provide the insights on the public.

For our keynote address, we welcome Andrew Ng, founder of DeepLearning.AI, co-founder and chairman of Coursera and general partner of AI Fund. Our moderators will be Alberto Rossi, professor and director of the AI, Analytics, and Future of Work Initiative at Georgetown University and Loni Mahanta the nonresident fellow in the Center on Regulation and Markets at Brookings.

As our panelists, we are very happy to welcome Gad Levanon, chief economist at Burning Glass Institute; Morgan Frank, assistant professor at University of Pittsburgh and David Estrada, chief legal and policy officer of Nuro, Inc.

At this point, I would also like to note that Nuro provides financial support to the Center on Regulation and Markets which helps make the work we do possible. I would like to review the Brookings commitment to independence and underscore that the views expressed today are solely those of the speaker.

Rapid advances in artificial intelligence and other new technologies such as advanced automation, robotics and autonomous vehicles will have a significant impact on our economic, political and social systems and particularly on labor markets. This raises important questions on whether and how new technology impacts the need for employees to gain additional skills or retrain to succeed in an economy of the future.

An increasing number of companies are pursuing such upscaling or rescaling initiatives and highlighting the importance of advancing our knowledge in this policy and research. I very much look forward to the remarks by our speakers and the ensuing discussion today and I'm now going to turn it over to our keynote speaker, Andrew. Thank you.

MR. NG: Thank you, Sanjay. It's good to be here with all of you. I see the huge impact that Brookings has and I'm looking forward to speaking with all of you here today.

So there's been a lot of hype through AI, about AI. What I hope to do is spend a bit of time today sharing with you what I think is actually happening with AI technology. Whereas, not get working, where I think it will work in the future and then hopefully together, you know, in Q&A or the panel to follow and talk through some of the implications of this AI technology on the workforce and the upscaling.

When I think about AI technology, I often think through two lens. One is tools and second is training or education. And let me start to say a little bit more about tools. I've been saying for several years, AI is a new electricity much like the electricity about a hundred years ago that transformed the economy. AI seems to be on the path to do the same. But all the assembly of AI, I think that in most industries, it is not widespread, and it is not widely used today yet.

So I gave a talk recently that was just posted online a few days ago. You can find it online, where I spoke about my often buying a slice of Hawaiian pizza from a pizza joint. You know, kind of a 10-minutes' drive, a few minutes' drive from my house. And it turns out that that single owner, proprietor of a small pizza store, he does have data. He has a decent amount of sales data. And if he had access to AI, I'm pretty sure he could optimize his supply chain at less, you know, pizza line around.

But frankly, other than large internet, consumer internet companies especially and other than leading tech companies, AI is not from where I'm sitting widely used. And so, why is that? And what is the roadmap to get AI to be more widespread and across society? Which will happen, but why aren't we there yet?

I want to share with you what I think of as the two chief areas to AI adoption. First, the small datasets. So when I was working for a large consumer internet company, I once built a freezer air conditioner system using 350 images, pictures of faces. When I was speaking at a manufacturing conference, you know, a little bit back, I asked this manufacturing audience how many images do you typically have of defects you want to detect?

One of the teams works on helping manufacturers take pictures of things they're making, say, with a smart phone or whatever and using that picture to decide if the smart phone is scratched. But

when I asked this question about manufacturing audience here in the United States, this is the answer, 50 of your images.

And it turns out the technology, you know, that I and my friends had contributed in building for working of (inaudible) and datapoints, it doesn't work for other industries. It turns out this is solvable but there are a lot of industries where dataset sizes are just much smaller.

In healthcare, I've seen a lot problems where you only have a hundred images of a rare medical condition and you've just got to make it work with a hundred images, not a hundred million images.

The second barrier to widespread AI adoption, again this is a problem we will solve as a community, is the customization of the long tail problem. So if you take all current and potential AI projects and sort them in decreasing order of value, you get the results that looks like this with a long tail. Maybe the single most valuable system in the world is some online add system. Maybe the second most valuable is some giant web search system. Maybe the third most valuable is some ecommerce online shopping product recommendation system.

So the AI world has figured out how to hire dozens or sometimes hundreds of engineers to build a giant monolithic AI system to serve a hundred million or a billion users and the economics of that works out. But once you go to other industries, you rarely have a hundred million users in one database.

And so, in manufacturing, for example, I will see a company making pharmaceutical pills and they need an AI system to inspect pills. Or different AI manufacturers may need to inspect sheets of steel. A different manufacturer may need to inspect semiconductor wafers. And it turns out that because every factory makes something different, every factory needs the custom trained, custom AI system to do the thing that they need, which is different from everyone else.

And so, from where I'm sitting, I see, let's call it, the hundred million or the billion-dollar AI projects built well. But I see also a lot of \$1 million to \$5 million AI projects that are sitting around because no one has yet figured out the economies of how to make them work.

I think the way that the AI world is moving to answer this problem, and this is implications to the workforce and upscaling as well, is to build vertical platforms. And what I mean is vertical platforms

that enable the end customer to build the custom AI system that they need. Because rather than, say, me going to, you know, every manufacturing plant and me trying to have my team build a custom AI system.

If there become new generations of tools that the IT personnel in their manufacturing plants build their own custom AI systems, then that would get a lot more of these AI systems built to serve all these use cases in the long tail. And this is, you know, clear implications as well for the skill set needed for all of the, say, IT personnel in all the manufacturing plants as well as much more broadly as you will see in a second.

And it points out the key technology to make this possible. You know, maybe within 12 building years, it's hard. In advanced (inaudible) or whatever, which is essentially not true. But it turns out that the key technology for enabling a much larger fashion of our workforce have the skills to build and participate in not just using AI systems and building customized AI systems is technology to let them engineer the data rather than the code. I'll come back to this in a second. This technology (inaudible) count data is essentially to AI development.

But just to cast the net a little bit wider than just inspection. If we were to look at a hypothetical t-shirt maker. You know, what can a small t-shirt maker do using AI? Demand forecasting, right? Look at sales data, look at demand data, social media trees, figure out what is likely demand for different t-shirt designs, product placement. How to merchandise? How to decide where to place the products in a supply chain. Manage the complexity of supply chain.

So you place the right orders, get the right products. And also, quality control. If you are making a t-shirt, how do you know if the t-shirt cloth is in high quality or does this cloth have a tear or discoloration in it?

So what I see is that all businesses from the very large companies, the giant internet companies all the way down to a sole proprietor pizzeria to a midsized t-shirt maker with maybe hundreds of employees. All of these companies have many, many possible use cases for AI. But because of the bulk of AI projects or just a large number of AI projects are in the tail then many of these \$1 million to \$5 million projects that frankly no one is working on. And we need the workforce with the tools as well as the training on either/or both in order to create this value.

So until now, for the most part, building an AI system means writing pages of pages of codes. And up in, you know, encouraged by the rise in coding literacy but the number of software engineers, the number of AI development is far smaller than the number of people that hope will rise to being to do the work to build custom AI systems.

When I think about the rise of AI, I often think about the rise of literacy in human society. Hundreds of years ago, many people in society thought that maybe not everyone needed to be literate. Not everyone needed to read and write.

Perhaps even now just go to the holy temple or other holy building and sit in the audience and listen to the monks or the high priest and priestess read some holy book to us and that was enough. Why do you need to read for yourself if you could just do that? But fortunately, we've figured out that if almost everyone in society is literate, we can read and write, we can build a much richer society.

What I see in AI today is most of us are, you know, most people are leaving it to the high priest and priestesses in the large tech companies to write code for everyone else. And if you can use code written by a large tech company, why do you need to build custom AI for yourself? But the problem with this is this is not rising to solve the huge number of applications in that long tail, which I think may create even more value for society. And also, importantly make sure that value is spread widely and fairly than just solving the applications in the head, the small number of varied applications.

So let me share with you two upcoming trends in AI technology that I think will address all these applications in the long tail. And without needing everyone to be an expert software engineer. One is data centric AI technology. And here's the idea.

So you might note that building an AI system requires both writing code, writing software to implement some AI algorithm or some, you know, machinery model as well as taking that code to having it learn from data. So the conventional approach to AI development which my community has used for the last many decades has been the code centric approach where you get the data from somewhere maybe download the dataset off the internet. And then work really hard on the code to make the AI on the data we have.

Because of this paradigm of development, it turns out that for the large majority, maybe the advanced majority of practical commercial applications in AI today, the code, the neurometric model,

the advanced deep learning technology is basically to solve problem, right? There are exceptions but for most commercial applications you might think about quality inspection or demand forecasting or product placement, all those applications, there's an opensource piece of code on the internet. You know, opensource, neurometric model on the internet that will work well now.

And so, the datacentric AI movement is developing new principles and technologies to let teams use a good implementation of some codes of the (inaudible) software but to get teams to focus their attention on entering the data. And I find this recipe promising because if you go to the IT personnel of a manufacturing plant and you ask them to write code to invent a next generation of a deep learning neuronet technology, that's really challenging. But if you ask them to express the domain knowledge about what they're making through creating and labeling data that is a much easier way for them to succeed.

So let me just show you a quick video of an example of this. This is software made by one of my teams in learning AI that illustrates the datacentric approach to AI. Where an AI t-shirt maker and you want to build a custom AI system to check new cloth for defects that you upload a bunch of images and then you will, you know, draw rectangles like this to tell the AI system where is there a tear and where is there discoloration in a piece of cloth.

And datacentric AI means that domain (inaudible). They'll know what is a defect. Can spend their time expressing the knowledge of what is good cloth, what is bad cloth through engineering the data. And this makes it much more accessible. And after learning data and training the AI system, you can then, you know, build an AI system that can then help you find defects in the pieces of cloth. So datacentric AI is an important technology direction that will be key to demarketizing access to AI.

I want to show you second technology direction that I think is exciting and important, which is prompt engineering. So shown on the left, I have a daughter that loves pandas for some strange reason. And so, sometimes I, you know, lie in and sit on a sofa and draw pandas that amuse her.

So the picture on the left is one that I somewhat embarrassingly drew in about 10 minutes to entertain my daughter. In my defense, she was poking me nonstop through that 10 minutes. I had to defend myself, but I know that's bad.

The image on the right was completely generated in mere seconds. So just for fun, I

thought I would show you a demo of, you know, some examples of prompt engineering. This is not my software so if it doesn't work, it's not my fault.

But this is a website. And so, prompt engineering is kind of very buzzy technology. And one of the PR buzzy releases was by a company called Stable Diffusion where you can type in a prompt. By the way, if any of the panelists or whatever wants to give me prompt or anyone on Zoom chat, you know. So this suggested a prompt by the website and when I click dream, it, you know. So this image had never existed. It was just generated in the last 10 seconds, right? So I'm happy and with colorful --

And so, the UI has transformed from pen and paper, or pen and stylus is what I use to -- if you can write a prompt. Write a little piece of English text then you can generate like this. And this particular UI -- this is a very buzzy technology, you know. Let's make it a robot. And if you like many people have the creativity to -- you know, let's do another one.

Many people have the creativity to generate art but not the technical skill. I'm not good at drawing. I try, but I'm not good at it. But I think many of you watching this have the creativity but not necessarily -- okay, Sanjay, just gave me the prompt. I'm going to -- whoops, sorry. An ancient explorer gazing out over the sea. I'm going to type that right. We'll see.

So, Sanjay just gave me this prompt, right? We'll see what happens. Sometimes, it works. Sometimes, it doesn't. Yeah, not bad. All right. Morgan Frank says Eddie Mercury dancing. Right? So this is pretty amazing. Thank you, Morgan and Sanjay for the fonts.

Pretty amazing. There's a lot you can get with a system like this. For what it's worth, I think UI is in a very infant phase. This is buzzy technology. Tons of teams are exploring commercial applications of how we can realize this. Open Eyes Gallery has released this. Google has its own version imaging that a stable diffusion because of the way they released the software kind of letting people download it and run it has been leading to a lot of creativity.

And just to show you the second example of prompt engineering. This is Open AI's GPT-3 model, which you may have read about in the news. So actually, this is (inaudible). Sometimes it gives good answers, sometimes it doesn't. Okay. Not bad, right?

Picture someone with the only thing better than our shoes is your smile. It could work. I'm not a good motto there. You can imagine. But in fact, let me try something else. So let me actually --

let's see. Let me go to the Brookings Institution website. Is this the right website? Okay. So if I were to take some text and paste it here and ask it to continue writing this. All of this is fictitious, you know, made up by -- don't take anything here as factual, right?

You know, President Biden declared blah, blah, blah. Okay. This is plausible sounding text, right? This is made up so please don't take anything here as accurate. But it's, you know, I've seen this type of technology write, you know, surprisingly plausible -- sorry. Just give me a little longer. Surprisingly plausible copy, right? And so, I feel like this type of UI or prompt engineering, it opens up a sensibility of this type of, you know, I don't know if you would call it creative writing or something else. It opens up this type of creative things to more people.

So just to wrap up quickly. I was chatting Daniel Rock from the University of Pennsylvania. And he, you know, made an interesting comment. The nice thing about tools is upscaling by default, right? With better tools everyone is upscaled by default. And just to relate this back to -- so I think tools and training. Tools is a really important part of letting everyone in society do more powerful things.

And just a last line. On more conventional upscaling training, which I think is very important as well. What I see is AI is raising the bar for everyone. The world we live in is highly digital. Our activities generate digital data as an exhaust. And so, new AI capabilities means that no matter what industry, what sector you work in, you probably have data and teams are able to use that data, will be more competitive than teams that are not.

The centric AI maybe tools like prompt engineering will enable a lot more people to do that. But this basic new capability is pushing everyone to, you know, giving everyone the option as well to do more. From Coursera's data, this is from Coursera's impact report, 92 percent of Coursera's business learners report a positive career outcome from after completing an online course. And so, I find that upscaling, it does work.

But the flip side is upscaling is still very challenging for many managers, right? So this is Coursera user research data. I don't think Coursera released this publicly. But maybe not surprisingly, you know, when someone has their annual performance conversation with their manager only, I would say, 23 percent, 24 percent really set them on a clear path on how to develop. Maybe over 50 percent

have some path, but this is very challenging activity even though, you know, our data shows that when you invest in it, and you do it that it does benefit the individual significantly. And then usually I think it benefits the organizations as well.

But I think a lot the demand for upscaling is also driven by the new capabilities. So I think that figuring out the right path for society and the right policies and the right way to approach this, you know, I'm excited to engage in that discussion with all of you. Thank you.

MR. PATNAIK: Thank you, Andrew, for the fantastic presentation. I hope you can hear me well. If you don't, please let me know. But yeah, I think that you ended up exactly where I wanted to pick it up from, which is kind of the implementation of upscaling within firms.

So what are the different forms of upscaling that firms engage in? So are they mainly outsourced through outside vendors and form a line with the university? Or are they performed internally by the companies themselves?

MR. NG: Yeah. You know, so I think directionally in the last decade, my sense is more and more of it has been outsourced and for the reason of the internet. So, you know, 30 years ago, companies used to write their own HR software because before the internet, you couldn't get access to really good HR software or really good whatever software, really good email software.

So firms were managing their own email systems inhouse. Because of the internet, we now can get good access. A lot of the best tools anywhere in the world and also the rapid pace of upscaling means that there's a lot of knowledge that firms are pondering, you know, with the university or with a company like Coursera or deeplearning.ai, right? Full disclosure companies I'm familiar with in order to drive that upscaling and I see a lot of efficiency in bringing outside knowledge in.

And of course, there is often some amount of inhouse knowledge that is, you know, specific to the firm. And it turns out that there are beneficial to the company and the individual at that specialization, at that fit between the company and the individual as well. But I think directionally, more and more of it has been (inaudible) knowledge.

I should go to CLOs, and I tell them that the smart CLOs, chief learning officers, the job is more to curate rather than to create content because creation of content is so expensive. Whereas, selecting the right content and also to bring it in is much more inexpensive view.

MR. PATNAIK: And when you collaborate with companies (inaudible). Is it something that is fully automated? Is it something that the Coursera deep learning AI provides?

MR. NG: Oh, boy. So I think that online companies, online high-tech companies like Coursera has a very large content library that I find that most corporations would want to look at the content library and customize it for their needs. So I see, for example, a lot of companies feel like they want to improve data literacy across the entire organization, not just engineering.

But we live in a world where if your recruiters and marketers and product managers have that basic data literacy, you would be better off. Or some companies want to improve their business skills or the soft skills specifically. So many companies will try to find great education, you know, from the best universities or the best core creations that are highly qualified to teach this. But then will also match that to their specific needs. And so that process often results in a better experience for the learner inside the corporation. I hope that makes sense.

MR. PATNAIK: Yeah, absolutely. And I think you touched upon in your presentation. But if AI continues to advance in future years what would that mean for the pace of upscaling going forward?

MR. NG: Yeah. You know, I feel like people sometimes have a dystopian picture of AI driven global technological unemployment. I certainly don't see that. I feel like we often don't always remember that new technology has historically has typically created, you know, as many or often even more jobs than it affected.

Some see that to be true for AI as well. AI is transforming many jobs but so long as the corporations and individuals are willing to invest in their people. Hire and invest in their people there's plenty of work for everyone. The U.S. unemployment rate is now at 3.7 percent or something so hardly any of us. Many corporations are struggling to find qualified individuals to fill the open positions.

But as we all know there is a huge gap, right? Between the skills that a workforce has and the ideal set of skills that we wish the entire workforce had. So the only solution to that, I think is to provide upscaling and training.

You know, one of the inefficiencies that I think is quite tragic for education is that it has some short-term ROI. You know, the Coursera data show, right, is six months, half of these see a benefit

for the individual's career. So there is some short-term ROI. But a lot of the ROI and us still in training is long term. And I mean high quality training.

We know about the college debt problem, and you pay for an expensive degree that doesn't give you meaningful skills. That's a huge problem that we need to solve as a society. But good education has, you know, some short-term ROI and a profound long-term ROI. And because of the economic recipe, I see us as a society over and over underinvesting in education.

And this goes all the way back to an early childhood education where, frankly, we know that the children of welfare and get an education, you know, when they are, right, in like kindergarten. That has a fantastic ROI. But how do you pay for it? So a lot of this feels like it should be public good but on the flipside I'm happy to see many corporations stepping in and many employees pushing the corporations to invest, you know, for the benefit of the employee and the benefit of the corporation.

But I feel like globally dialing up the volume of training creates a lot of public benefits as well as private benefits.

MR. PATNAIK: Yeah, thank you. And just one last question and it's exactly about this ability of employees to learn, right? We know that some employees are going to be better at learning new skills and some are not going to be as able to do it.

So what is the solution for companies? Are they going to have to engage in some layoffs? And hiring fresh new talent? Are they going to be trying to redeploy these employees in different areas?

MR. NG: Yeah. I think that this is a very challenging question that many companies have to address. I see companies face the corporate reality of, you know, needing to be profitable and, frankly, to not go bankrupt. And so, that drives certain economics.

I also see a lot of managers and a lot of sympathy, rightly so for the employees whose jobs are displaced. And that may or may not be in a position in life to spend the time to invest in their own education and training even while maintaining a full-time job. I mean I'm very sympathetic to there are individuals in society, you know, that because of their personal lives or health or other obligations may not be in a position at that very moment to make the long-term investments in their own training that's good for them and good for society.

So I feel like this is part of your question of can society create an appropriate safety net so that people that have the bandwidth and the capacity can keep on learning and growing? But if someone just is not in a position to put in that work to make sure that -- part of me feels like, you know, just because someone does not have the skills needed for the job or where the job has gone. To me it does not mean they deserve to be thrown out onto the streets to die, right?

So I feel like our society is not that good. And I wish we were collectively better at creating enough of a safety net. And then also giving people an opportunity while, you know, protected by a little bit of safety net to upscale so that they can have a path back to being -- contributing significantly to society and to themselves and their families and the communities.

I find us as a society pretty bad at helping individuals navigate that journey. Part of it is because of the long-term versus short-term payoff. I'm happy to see many governments, local governments, state governments stepping in, but I think we have a lot more work to do there.

MR. PATNAIK: Thank you so much, Andrew. And on this note, I think this is all the time we have. Let me thank you so much for the wonderful presentation. And let me hand it over to Loni Mahanta who is going to moderate the panel.

MR. NG: Thank you, Sanjay. Thank you, everyone.

MS. MAHANTA: All right, everybody. I'm looking forward to our conversation here. I'd like to start us off by hearing just some topline perspectives from each of you, Gad, Morgan and David, around, you know, what are your thoughts highlight around AI and upscaling? And then we can take it from there. Gad, could you start us off?

MR. LEVANON: Sure. And thank you very much for having me today. It's been an exciting and interesting so far, and I'm sure it will continue to be.

So I think the topic of upscaling and technology and AI, there maybe three things, three types of considerations or occasions where that is an important conversation. One is when we think about shifting away from automated or obsolete jobs and how can we upscale or reskill workers to other jobs?

The second is all those new jobs that are created by AI and technology, how can we reskill and upscale for those jobs? And the third is how can we reskill a worker towards jobs that are in

shortage?

And I think in nowadays and certainly in the past year, but even before the pandemic, probably the third one is the most important because we are having probably the most year labor shortage U.S. history. It's not just because of the pandemic. It's a longer trends in demographics and education and labor force participation. So we are now and probably for the foreseeable future, we are in a massive shortage.

And I think a lot of the reskilling and upscaling should be in that context of how we can get all workers to the jobs that have the biggest shortages. And there, I'm thinking about anything related to healthcare or mental health related jobs, skill trades. And some, but not all of tech jobs. It turns out that a lot of people, young generation are moving into tech jobs and many of them are not the most effect by labor shortages. So I think moving more workers into jobs that are in large shortages and are important for our economy.

MS. MAHANTA: Thank you. Morgan, would you share some of your thoughts?

MR. FRANK: Sure. So I'm really interested in how technology really impacts labor demands and the labor force in the U.S. by really small, microscopic changes to what types of worker abilities and skills are in demand in the workplace.

And yet, we talk about these macroscopic trends that result from these small privations, from technological change, for example. So things like job polarization and the effectiveness of higher education. These are big macroscopic questions. But if you pick any specific technology like forward diffusion that Andrew was showing us, it's a really specific task that it's doing in the grand scheme of all the things workers might do.

So what this says to me is that we need some better insights into what are the specific skills and abilities that workers leverage? And how do they get bundled together? And I think that by understanding these microscopic elements in our labor systems, different labor markets across the U.S., for example, we can start to better understand what pathways for career mobility workers have access to and where bottlenecks exist.

For example, what types of specific skills should be taught to a mill worker based on what they already know? Part of this perspective enables us to consider some other things that I think are

really important like the context really matters. So you can imagine that being very strong in computer programming creates a different type of career mobility here in Silicon Valley compared to if you're located in a rural community.

Another example, it doesn't have to be tech. You can imagine that fossil fuel workers in Texas face a very different future than fossil fuel workers in Western Pennsylvania because of policy considerations and push towards just transition towards emerging green jobs.

So context matters here. And by improving our data and insights into skills and how skills create the systemic opportunities and bottlenecks, we're going to be able to better respond to differential impact across different parts of the U.S.

The other thing that this perspective leverages that I'm really interested in is we have all this information now about employment and skills and how those elements interact across different parts of the labor market in different cities and so on. But we don't have similar data for key parts of workforce development.

For example, what skills are really only available through higher education? And what are the differences in the skills and abilities that are taught across different options for workforce development? Maybe different colleges that contribute or perhaps diminish the polar income and inequality in differential access to opportunity that we see across the U.S.

MS. MAHANTA: Great. I look forward to digging in on a lot of that. David, any word if you want to start us off?

MR. ESTRADA: Yeah. Thank you. Excited to be here. Thank you. I'd like to just put it in context for Nuro, what Nuro is doing.

So Nuro is an autonomous vehicle company. We're building software. We're building sensors. We're building the vehicles themselves, and we're focused specifically on delivery. And we're focused specifically on delivery, so we partner with companies, say, like Febreze. We just recently announced a partnership with. And so, we will be actually delivering food to people who order it online through various partners and other goods as well.

How does AI play in? Well, AI powers the learning models in our autonomous vehicles for perception, prediction and planning. To build those models, we need highly skilled and well-trained

engineers, and those engineers are in short supply. I point out that currently, it's about 30 percent of our workforce working on these programs to power up vehicles who rely on worker visas from other countries. Our country, the United States, is not producing enough skilled labor in this field and we need to address that.

There's also the question of whether four-year degrees are necessary in this emerging technology? In some entities, I think Coursera and there's another one, Udacity, who are focusing on small learning. Some are called nanodegrees where, for example, you can learn a specific programming language and you can go be very valuable in a company like Nuro.

Now, I'd like to focus on these aren't just tech job. When Nuro deploys, for example, we will be upscaling and creating new jobs in many fields. We will work into communities. We will be upscaling instead of uprooting. And so, for example, if you imagine we would go work with our partners in Houston, Texas. We are establishing a base of operations there.

There will be people in grocery stores picking and packing new jobs that didn't exist before. There will be people who need to maintain our vehicles. And we actually have created a technician program at De Anza Community College where people can go there, take a very specific class and gain the skills necessary to be hired by us so that they can work on these vehicles.

We actually commissioned a study with the steer group that showed that over a period of about 10 years of rolling this all out about three million net new jobs will be created. So we're really excited about AI being the core of unleashing many, many new jobs with automation.

MS. MAHANTA: All right. Awesome. Let's just start with a little bit of like a prefatory question here, which is, you know, what is automation going to do for jobs of today? And, you know, are there going to be whole failed job losses due to automation?

Gad, I love your take. As a labor economist, you know, what are you seeing? You know, we've discussed, you know, labor productivity. What does that mean for replacement of workers with automation or some of the new technology that's coming?

MR. LEVANON: Yeah. Well, we can't really measure the amount of automation in the economy direct. So what economist do instead is they focus on a labor productivity, which is not exactly automation, but it is a good proxy because the more automation you have the more one worker on

average can accomplish in one hour of work, which is the measure of productivity.

And when we look at labor productivity, the numbers are actually disappointing. So in the decade before the pandemic, we had the weakest labor productivity in U.S. history. And there were a lot of hopes that with the pandemic and all the strong focus on digital transformation and investment in technology that we will see a balance in the labor productivity. But so far, we haven't seen that.

There's a big debate on why we are seeing those trends. And I think the main reason is simply low hanging fruit. The low hanging fruit of replacing workers is technology already took place before 2010. And since then, it's becoming harder and harder to replace the next worker with technology. And that's one of the main reasons why we don't.

There are some exceptions. And I think during the pandemic customers and individual became much more tech savvy. So, for example, in cashing a check, a lot of people didn't know how to do it automatically or online before the pandemic. And they went to banks to do it. And now, many more do know how to do it. So I do think we see a lot of jobs in commercial banking like bank tellers being replaced right now.

So I do think there is some potential, but I do think the days of massive automation and the replacing of workers will technology are mostly behind us.

MS. MAHANTA: Okay. Morgan, your work has demonstrated that the numbers don't always paint a full accurate picture of what is happening with jobs that are being, you know, lost or replaced with new workers. You know, how should we think about what the data shows us?

MR. FRANK: Yeah. That's a great question. So I think Gad's comments about, well, we have productivity is kind of one measure for what automation is doing. It gives us really just one perspective. And maybe a perspective that's more important for the firm and less focused on what the workers are experiencing.

So another national question is what is technology doing to employment? And is it removing the need for job titles? Are jobs just disappearing? And I think the answer in both cases is largely, no. There isn't widespread unemployment and it's pretty rare for job titles to disappear.

But this sort of creates a bit of a funny situation. If you think about how much technology has evolved in just the last 20 years. Think about how much the internet has changed. We have

machine learning doing things that felt impossible 10 years ago. Look at the Stable Diffusion example and the GPT-3 example that Andrew was showing us. These are like magic.

So it seems sort of paradoxical that occupations don't disappear and yet so much changes. So I think most of what's going on is that technology is changing the demand for really specific capabilities and skills. And that what it means to have a certain job title adapts accordingly. So this is like within occupation changes to skill requirements.

This can still create costs even if it doesn't create unemployment. You can imagine a scenario where the individual worker has to work very hard to keep up with whatever the current in demand skills are. So it's constant reskilling and constantly being aware of what the frontier of knowledge is.

And as a professor doing research, I can attest that this is quite involved. But this can create a lot of other costly things beyond just skills. You can imagine, for example, that workers unable to reskill, they lose their job, or they quit their job and they're hired by a new employee who is able to complement technology.

This type of dynamic seems perfect plausible. It would produce job separations, but you can imagine it increases, decreases or has no actual effect on the aggregate employment or unemployment by occupation.

So I think what we really need to get at this question of what will the real-world effects of new technology will be? Kind of requires some more nuance data that tells us more insights into how skills map to the capabilities of technology. And also, more information about how those skills and abilities in those technologies are sort of spread out differently across different labor markets, across different occupations. And if possible, even across different firms that employ workers with similar job titles.

You can imagine that every company that employs secretaries but maybe what secretaries are doing varies pretty significantly from industry to industry or even from firm to firm.

MS. MAHANTA: David, I think you touched on this a little bit. But, you know, I think that there might be a picture that autonomous vehicles are going to take away jobs from human drivers. How does Nuro see that perspective?

MR. ESTRADA: Well, what we see out there already is that there's surging demand at a time of a shrinking or a labor force that isn't growing fast enough.

So, for example, if you go and if you want take an Uber or a Lyft today. You see that the prices are going up. In some cases, very significantly along with inflation in most of the country. In many places these are being unaffordable rides. Part of what's driving that is there is clearly not enough drivers. There's a huge truckdriver shortage as well. There's also a huge shortage of pilots for airplanes.

So we don't have enough people to move around all these vehicles at a time when there's going to be incredibly increasing demand for delivery. And so, we see this situation. And think about it in the context, for instance, of ATMs. ATMs were one of the very first forms of automation that we all came into contact with. Instead of walking into a bank. You were able to use an ATM and go grab your cash and not go into a bank.

A lot of people were worried at the time that this would kill jobs for tellers. What it actually did is it caused banks to dramatically expand the number of small branches that they had throughout the country and especially in underserved areas. And in those underserved areas, there were some teller jobs. Now, overall, the total number of teller jobs has increased since then. It hasn't decreased.

So similarly, in our field, we're going to see that there's a lot more delivery happening. There's a lot more paid rides happening. And there will be a mix of both rides and deliveries happening with human drivers and those happening with automated drivers.

MS. MAHANTA: Okay. You know, we got a lot of great questions from the audience. I'll ask some at the end, but I also -- there's some were a lot of thematic questions. So I'll kind of intersperse them a little bit as we're talking here.

But one of the questions that came up a lot was, you know, what are the areas or industries that this panel thinks might be most likely to be impacted? And I don't know if anyone has any thoughts on that?

MR. FRANK: Yeah, sure. I'm really excited for what's going to happen in medicine in the next few years. It's a data rich part of society that has been very safeguarded.

And so, as we come up with ethical, safe, secure ways to make that data available to the people who can apply AI systems to it and engineer these data driven systems. I think we're going to see

all kinds of real abilities popping out in the area of medicine that's going to create opportunities to study.

For example, these rare diseases where it might be hard for an individual to go out and locate a handful of people with the same condition. But when you have access to a wealth of data available and automated systems that can start to relate cases to one another. If you just imagine that alone creates an opportunity to address fringe medical scenarios. So I'm very excited about what medical technology will look like in the next 10 years.

MS. MAHANTA: Okay. So we have, you know, some thoughts around some portion of jobs are going to be shifting. Maybe not wholesale jobs. Jobs themselves might modify within the same job title. But some portion of them are going require engagement with new technology. So a critical part of this conversation is around skills. Skill development and helping individuals kind of build into what those new jobs require.

So, Morgan, I'm actually going to turn to you again. So some of your work looks at skills development. What have you seen regarding the ability of individuals to learn new skills? And, you know, what are your thoughts around micro credentialing or how to think about the broader context around skill development?

MR. FRANK: Sure. So I think that HR departments and public stakeholders who are worried about upscaling and reskilling their population. I think we have a lot of room to grow on this front.

I see a lot of retraining programs that feel kind of naïve. There are things like let's pick a job where employment appears to be growing. Maybe like there's a lot of demand for computer programmers. So we'll just teach people Python. You can learn that online for free nowadays. And they'll be able to land jobs, maybe entry level jobs in computer programming.

But what our work shows is that this strategy probably won't work because it's not just computer programming you need. It's actually a bundle of skills that together create the skillset required to be an effective computer programmer. So, for example, you can imagine that not just an ability to write Floop, but also some mathematical background will be required to be an effective programmer. And then never mind other social skills. Things like being able to interact with a project team that's building this system of software.

So you really need to get beyond linking single occupations to one or two skills. And

understanding them holistically as a bundle of skill and task requirements so that we can effectively start upscaling people with bundles of skills and tasks that makes them effective in the new opportunity.

MS. MAHANTA: For anyone. Is there other types of skills in particular that are increasingly important these days? Gad, do you have any thoughts there?

MR. LEVANON: Yeah. I think in a lot of business-related jobs. And I'm thinking about marketing, sales, HR. There is a huge increase in the amount of data. But in order to make good use of that data, there is a need for people in those departments to know how to use it. To ask the right questions and know how to answer them.

So I think one thing that we already seeing is that in many -- so we use an online job of things to kind of measure skills and trends, trends and skills. So we see the demand for tech and data and other skills in those kinds of jobs are growing very rapidly in recent years.

MS. MAHANTA: There's another question. And I think this was brought up, you know, a little bit earlier. But how does this group think about college degrees? Are they still useful? Are they necessary? Is that changing over time? Gad, we had talked about this a little bit. What are your thoughts around if college degrees are as critical as they once were?

MR. LEVANON: Well, there's definitely a trend when we see it again those things. That the share of jobs that -- or job ads that require a BA is declining. And also, other kinds of education, not just BA but also other post-high school education decrease in credentials are also declining.

I think some of it is because there is indeed a trend of employers trying to target not just BAs but also other people. I think in some cases, it is also a result of the labor shortage when you are desperate to get someone, you are willing to compromise on the requirements.

So I think we are seeing a shift away a little from the college degrees. We're also seeing wage growth in jobs that don't require a BA and much stronger for jobs that do require a BA in recent years. So also from the workers' perspective in many cases, they are saying is it really worth it? Or can I have a good enough career without getting a BA? So that also contributes to the shift away from BAs.

MS. MAHANTA: Yeah. David, I believe Nuro is doing work with community colleges. Did I get that right? And even if I did can you tell us a little bit about it?

MR. ESTRADA: Yeah. So, for example, very close by there's a community college

called De Anza. And we approached De Anza and we talked to them about what we were doing here. How we're building vehicles and that these vehicles are unique, they're custom. They've never built before. Essentially, nobody knows how to work on them unless you worked here at Nuro.

So we talked to them about building a fleet technician program. So you can go now to De Anza College and sign up for these courses to be a fleet technician or a fleet technician supervisor. So this is brand new. It's never been done before. And here it is. AI actually empowering people to have new jobs that they didn't have.

And when we think about the proliferation of this service and think about this kind of a job and how you can qualify for it literally with one course. That course can provide you good wages. And these jobs can be fanned out across the country. They're not going to be concentrated in specific places like here in Silicon Valley.

We're operating in Houston. We'll be operating all across the country. And people can stay where they are and earn a good wage.

MS. MAHANTA: Yeah. You know, I think it's really interesting that several of the questions that came in were around how do we prepare the younger generation? You know, tips of high school students. Or how can a small liberal arts college prepare students for the changing need for the workplace? Anyone have any thoughts around that?

MR. ESTRADA: STEM. So we've been saying this for decades now at least. And we just don't have enough graduates of high schools here in the United States who are interested enough or prepared enough to go to colleges. To learn the skills required that are needed for AI.

And so, as I alluded to so many of the jobs, the best qualified people for the jobs have been educated in other countries, particularly in China and in India. And as we know, there's real political tensions going on in the world right now particularly with China.

So when you think about our current dependence on foreign workers for these really important jobs for our economy. It focuses the microscope back on us and our early education system. And how do we get kids at much earlier ages to be interested in these fields and do the work required to go get the skills?

MS. MAHANTA: Yeah. I think another -- sorry, go ahead again.

MR. LEVANON: Yeah, I would definitely agree that STEM and any data analysis related skills are a growing -- a demand is growing very rapidly. We are now in the midst of one of the biggest tech booms and science booms ever. And the demand for STEM workers is over the roof. So I would definitely agree with that.

I think another skill of resiliency with kind of bits of analysis when we compare between leading companies and other companies. And so, what are the different skill requirements between the two? And resilience is one of the things that stood out the most. And perhaps I think with the current mental health crisis that we are having in the U.S. I think eating democracy and workforce is a very important thing.

MS. MAHANTA: You know, another one of the ways in which the indicator of a college degree is used is sort of differentiating a line between high skill and like low skill work.

Morgan, I'm curious about is that the right way to think about demarcation between, you know, skill requirement? Upscaling? You know, higher/lower wage job opportunities? Does that help us, you know, from a data perspective?

MR. FRANK: Yeah. This is a really important question. So a lot of the way that economists especially theoretical work and what I see from management science and policy related to future of work issues. They have this paradigm where you talk about workers abstractly as being high skill and cognitive or low skill and physical. With the idea being that if you're cognitive, you're more adaptable and you'll be maybe more productive by technology. But if the work you're doing is physical and routine than you're more likely to be replaced.

But I think that this is great to a first order of approximation. But we're missing out on a lot of information if all we're doing is talking about workers as being high skilled or low skilled. First of all, what do you mean by high skilled? Am I a high skilled worker? How do you know?

Most people would say if you have a bachelor's degree, you're high skilled. But I think you'd agree that there's a lot of variation in what your employment prospects or wage prospects are depending just on what you major in as just thinking about just the population of people that do complete bachelor's degrees.

So even just from that we're missing out on a lot of information. I think that the reason

we're missing out on this is because of the type of data that has been made available through federal sources. Through places like the Department of Labor and the Bureau of Labor Statistics. We have really excellent cross-sectional data on the economy but not so much insight into workforce development. And in particular into how college education prepares you for different career trajectories.

There's a lot of options that makes it recently possible to address this. So, for example, I'm working with an open syllabus project which is an effort to collect all university syllabi from universities and departments offered all across the U.S. This is an ongoing effort, but they're making available a real large dataset of what the learning objectives are across majors and universities and even through the last couple of years across the U.S.

There are other companies, for example, Burning Glass Technologies, Future Fit AI and Revelio Labs that are making available worker profiles which include things like educational history and worker history, which gives us the ability to not just look at what happens to graduates immediately after they enter the workforce which is data you can get from the U.S. Department of Education. But also, what happens to these people downstream?

So, for example, what are the differences in your education that might make you adaptable or resilient later in your career? Or maybe give you access to different labor markets. Give you an ability to get a job in Silicon Valley compared to the exact computer programmer in a rural community. We're just now getting access to data at the scale that would enable lots of research to actually learn about the dynamics at this important stage.

MS. MAHANTA: We touched on this a little bit, but I'm just curious, you know, there's a lot of questions around how do we make sure that we are creating a workforce in the U.S. to fill these future jobs?

David, from an employer perspective, it sounds like, you know, what you're seeing is we can't. Not yet. Not enough. What can we be doing? What can employers be doing to create the skills that they need for their own workforces?

MR. ESTRADA: Well, I do think it's important to broaden our discussion about what kinds of jobs as we're talking about -- another kind of job that's obviously in the news a lot today is manufacturing.

And so, we, for example, we're building a vehicle. Now, there's been a lot of activity in the legislature in a bill recently signed in the Inflation Reduction Act here in the United States. It puts a lot of money towards trying to get companies like ours to onshore their manufacturing particularly of electric vehicles. We are a producer of an electric vehicle.

So we, for example, we've opened up an end of line manufacturing facility in Las Vegas, Nevada. We're going to be putting tens of millions of dollars into building this and hiring hundreds of people to help end of line manufacture our vehicles. So that is something to consider in terms of what is the whole panoply of jobs that can grow out of AI centered industries like ours? It's not all jobs creating AI, but there are so many jobs that are created surrounding it.

And we do, in fact, have the education to support many of those jobs. And we, at facilities like ours, can do the on-the-job training for those kinds of jobs.

MR. LEVANON: If I can add? I think that as a country, we are in deciding what to teach, we are not thinking all the consideration of what the economy needs is not top consideration.

And it's being reflected, for example, in the immigration policy. But also, in the attitude towards labor shortages. You would think that we would want to prepare more workers to come to jobs that require -- that have a bigger shortage. But there isn't, to the best of my knowledge, that there isn't really an attempt to do that.

And I would say, even there is no recognition by many parts of the government that there is a labor shortage problem. So if we can't acknowledge that there is a problem, how are we going to solve it?

MS. MAHANTA: You know, that raises a sort of -- it's a little bit tangential. But it raises a question for me about the nature of work how it's changing? For instance, remote work.

You know, a lot of conversation right now around is remote work here to stay? What's going to happen? But also, what does that do for attractiveness of jobs? Presumably not all jobs can be done remotely. You know, how do we think about the labor shortage? Gad, I'm curious about your take there.

MR. LEVANON: Yeah. I think, you know, a lot of -- you know, if you're like, let's say, a nurse or a teacher and your 40 years old and you're probably not going to change jobs because of the

shift all about work.

But you're now at a younger stage of your career and you're thinking where to -- what career should I choose? I think now the consideration of whether you can work from home is becoming a really important one. So I'm concerned that many jobs in nurse skill and teaching and other jobs that cannot be done from home are going to become less attractive and that will make the shortage an even bigger problem.

I hope and, you know, if you believe active markets that adjust to changing demand and supply then you would expect that the market will solve this problem by making wages for jobs that cannot be done remotely higher compared to the person and vice versa. That may happen. And that would certainly be some kind of a solution.

MS. MAHANTA: Question. A query of whether it will happen quickly enough.

MR. LEVANON: Yeah.

MS. MAHANTA: I think that's kind of one of the open questions. Morgan, has any of your work kind of focused on remote work and what we're seeing in the labor markets?

MR. FRANK: Yeah. So I think that this subject of remote work has really highlighted the need for the ability to work with software and these digital interfaces. And to be an effective communicator over these different mediums.

So this is not something that we're not necessarily training for, but maybe something we would want to train for if this work from home trend does, in fact, continue to move forward. You know, there's also a lot of other interesting implications for what a large scale, stable work-from-home transition would do to things like what types of opportunities are available in the cities compared to in rural areas.

You can imagine that the workers who do have these abilities are going to have a lot more mobility and a lot more options compared to their peers who aren't able to work effectively remotely or perhaps using these different digital media to achieve work.

There are also some areas of work which have been well documented that really require in person interaction. I would say there's a lot of interesting work trying to get at exactly why? But innovation and creative activities appear to really benefit from in person interactivity and it's not so clear that remote teams or working from home can produce the same amount of innovations, the same amount

of creative work in those areas.

Now, the COVID pandemic creates a really interesting opportunity to test these ideas because the pandemic is clearly exogenous to what type of work you're doing. And it created this shock which maybe was enough to get people to adapt. But I would say that the academic literature on this, the prevailing thought is that these types of innovative and creative activities are not going to do so well in this new media.

MS. MAHANTA: I mean it's something that I hear being discussed all the time within the tech companies that I sort of, you know, am engaging. It also kind of raises this interesting question back to what you were saying earlier, Morgan, about the grouping of skills that actually make like a learning Python effective.

And how bundling that bundle of skills to really make something effective might be impacted by whether or not there's in person engagement or not. I could imagine those things being connected.

MR. FRANK: Yeah, I agree. So we've done a little bit of work using skills data, nationally represented skills data from the U.S. Department of Labor looking at how skills empirically get bundled together across different occupations.

And then we're able to compare that to how workers change the skills that they're leveraging over the course of their career as they move from job to job. And what we find is that it's not very random. People really make smooth, gradual transitions in their skill sets over the course of their career with the exception of when somebody kind of stops working and explicitly goes back to school. That seems to be an exception.

So with this dynamic suggests is that if you're working in a job right now or maybe you were working in a job in 2019 that didn't require a lot of digital interaction. So you weren't already using Slack. You wouldn't already using Zoom and you weren't already using email. Maybe this sudden shift to now almost everything happens over Slack, Zoom and email. It requires a bundle of skills that you weren't prepared for.

Even if you had just one or two. Probably everybody in the country has an email address, for example. So our research is showing that again this idea that it's just one or two skills to get

you through these transitions, it's not enough. I think we need to do more to understand how skills get bundled together. And then how to deliver these bundles of skills to workers through retraining and upscaling.

MS. MAHANTA: Okay. I think I'm going to turn to some of the questions that have come in. So these are going to be a little free for all. If anyone has a perspective, please, you know, weigh in.

So one of the questions that came in was around job title and resumes. And so given the dynamics of, you know, changing work, future of work. What are the role of conventional job title and can job titles be transcended for effective upscaling?

And what I read into that question is like do the titles convey skills effectively? And are they part of sort of -- might we rethink about titling to convey skillsets? That's how I read that, but, you know, I'm curious about anyone else's take here?

MR. FRANK: Yeah, that's how I interpreted it as well. As somebody who actually looks at different datasets, it's really interesting to see kind of how wild job postings data can be compared to the nice clean data you get from the Department of Labor, for example.

So the abstraction with which federal agencies think about occupations. It's really different from how people see themselves. So I think that in practice if you're looking at job postings and people's resumes and looking at the job titles, you are getting more information about what their skills are because of the greater specificity and the job title.

But even then, looking at if you ask people what skills do you use on the job? There's a bit of a bias there as well. People will tend to list whatever is hot at the moment. Whatever is hyped, right? Everybody is an AI engineer right now. And whatever the next big thing is in 20 years, everybody will say that they're good at that as well.

So I think that, yes, I agree with the idea that it would be nice to have better insights into kind of the atomic elements of what workers can do, which are what are the tasks you can perform? What skills do you have? But we're going to need to reform the types of data we have if we want to do that.

MS. MAHANTA: Yeah.

MR. LEVANON: Just to kind of adding on this a little. I think job titles are mostly external

looking rather. Like when you work with someone, you don't need to know their job title. You know exactly what they're doing. It's more like people outside the company or you're wanting a few words to describe what is it that you're doing.

So I think for that purpose, I don't know if there would be -- I think job titles will still be important. Maybe they turn out to be a little longer or maybe we'll see more of them, but I think for that purpose, the communication purposes I think we'll still need them.

MS. MAHANTA: And what about expertise? How do you preserve expertise while upscaling or reskilling workforces? What are some ways that expertise is preserved or transformed between human expert and AI systems?

MR. FRANK: It's kind of a tough question, right? Because very effective AI systems should encode institutional knowledge or the knowledge and abilities that are currently encoded in what that worker can do.

So presumably if a system is so good that a firm would want to invest in it. It's able to do some of the work the person is doing and do it cheaper than what it cost for the person to do it. So it's kind of a strange question I'd say. To say, how do we encode expertise?

So I would say that maybe a more -- a question I'm interested in that is related is how do you encode the ecosystem when technology is there to disrupt the way your company runs? So you could imagine that you have your teams who perform different tasks within your company. You have, you know, customer service, you have R&D, you have people doing marketing. And you can imagine that they have their knowledge within each of these different departments.

And all of a sudden, a new technology comes and really reduces the need for so many people in marketing. If those people are able to adapt to other needs that the company has that aren't addressed by technology, then that's going to be a greater -- an easier transition both for the workers and for the company as it adapts to its new ability and its new needs with their investment in the new information system.

So this kind of goes against the standard model of having really specialized workers and having this hierarchy within the firm, which is shown to make firms more productive. So there's a balance to struck here that I think we need to consider.

MS. MAHANTA: Very interesting.

MR. LEVANON: You know, I saw a recent study that shows that senior management is becoming older. And one of the age when you reach the C suite or become a CO is getting older. And one of the explanations was that work is becoming a more complex and it takes more time become an expert. So maybe that's a trend.

MS. MAHANTA: Yeah, that's interesting. Another question came in around laws and regulations. So maybe, David, I'm going to toss this one over to you as Chief Legal and Policy Officer.

Are there laws and regulations that are needed to assure commensurate increases to employee wages if efficiency is from technology are going to result in reduced labor? You know, and kind of the ecosystem that technology maybe will increase profit for the firm, but what's going to happen for workers and individuals? So I don't know. Is there a role for policy, laws, regulations in that context?

MR. ESTRADA: Well, what we see here is over the past hundred years or more. We've become an increasingly computerized world. The internet came along and now AI has come along. And we've also become increasingly automated.

So you can go into a car factory now and on some shop floors see a few people running machines and not a lot of people doing welding. And we have a worldwide labor shortage, and the price of labor has gone up significantly.

So when we look at what the free market has done already, the free market already is supporting wages at a really high rate. And at this point, the economies are worried that they're getting too high. So currently, governments are looking at this and saying, the problem is the opposite. For a long time, we thought we didn't have enough wage growth. And all of a sudden, we have too much wage growth. And all of a sudden, throughout economies worldwide, we don't have enough people.

Now, if you look at this in certain advanced countries. If you go to Japan, South Korea, even the United States, Sweden, Italy, they're not reproducing enough to actually replace their workers. So we really have a worker shortage problem worldwide. And we probably are not going to keep up with that problem enough to where things like autonomy or AI are going to be the problem. Rather the problem is we don't have the AI fast enough.

MS. MAHANTA: Interesting. Is there a role for agencies and nonprofits to help with

reskilling to the extent that we do have AI that is moving quickly enough? Do you guys think that like there's a role for those types of community organizations to help?

MR. LEVANON: I think there is a lot of room for research in that and to the degree that some not for profits can do research in that area. I think that would help. And also, kind of implementing that research in an employer level.

I do think, for example, like when you talk -- we say risking. So that's taking someone who has a current job and making them be able to work in a more complex job. So I think there's a lot of -- a very tough question is what workers -- at what jobs you're going to take workers from? And there, there is a lot of information that could be had, for example, a skilled adjacency.

Like how similar those two jobs are and how similar the skills that they require are? But also looking at actual transitions. Like if you have a job of cyber security analysts working in the past. What kind of a worker has moved into that occupation? So I think knowing more about that would help a lot in making successful transitions.

MR. FRANK: I wanted to add my two cents also, which is I think there's plenty of work that nonprofits can do here. I think that it's kind of a privileged situation when you are able to look at the frontier and have the view, the vantage, to start to identify. Well, I should go to college. I should learn data skills and some basic computer usage skills. That's sort of a privileged position. And so, one obvious thing nonprofits can do is to help disadvantaged communities get access to these opportunities to learn relevant skills.

I think also different elements of the digital economy are creating these potentially short-term employment opportunities. So Andrew Ng in his talk, he talked about that we need people who can create new datasets to train these AI systems for fringe applications. He pointed to prompt engineering as a new type of work that Stable Diffusion has created, and GPT-3 has created as we need people who are going to be proficient in that.

So the benefit of these things is that they can be done by anyone, anywhere in the world. They just basically need a computer and some internet, and they can be an effective worker for this type of work. But I wonder how good these jobs really are? Are they interesting? Are they actually stable? Or will we have AI systems that, for example, through the next generation of unsupervised learning don't

actually need this labeled dataset?

And I can imagine prompt engineering being so generic that anyone on any Zoom call with the Brookings Institution can just be typing in prompts and start making these beautiful pictures. I wonder how good of a job that will be since anyone really can do it?

The other thing is it creates a disparate workforce. It's hard for a workforce which is just people scattered all over the globe to come together and to leverage their collective interests against, say, the interests of the employer. And I think it's probably healthier for there to be a balance of power between employer and employees. And it's just very difficult when people aren't face to face.

So nonprofits have another opportunity to make sure that disparate workers are able to come together and have the means and mechanisms to achieve that. So maybe the most relevant example of this is there are some cities where Uber drivers have come together and started demanding certain rights and goods from Uber because of their workfare. But this is a rarity. It isn't the norm quite yet.

MS. MAHANTA: It also raises another question. I mean this question around datasets is that discrimination and bias that can be inherent in sort of the datasets that are being used.

And that is some of the questions that were coming in were around how do we think about ethical considerations in a lot of the AI in automation that are happening? So one question might be like how do we ensure that discrimination that is prevalent in every day society isn't sort of being replicated in our AI systems?

One of the questions that comes up a lot is around stuff that is being used for facial recognition technology. But if bias is inherent in the dataset is then being comported over into some of the automated technologies? I'm curious about anyone's thought there.

And also, I think a related question that came in was around should we be focusing on designing AI and automation that is augmenting rather than replacing people? And again, sort of thinking about it from perhaps an ethical perspective.

MR. ESTRADA: Well, from a policy perspective, it is a valid question, and the U.S. government is looking at it and so are other governments. And governments are going to have to learn a lot from each other on this and work really hard not to overstep.

The issue is that AI learns in a way that people don't quite know how they're making their decisions. It's very interesting that the AI programmer puts together a program and teaches it how to learn. It learns to make decisions, but the programmer doesn't know exactly how it makes decisions.

So this does raise the question about is it making the decisions that, say, a company wants to rely upon that actually may help the company make certain decisions, release certain products? But might it be doing something that it's making decisions discriminatorily? It's a valid question that I think governments look at.

At the same time, when they do it, generally speaking, a lot of government legislate is they don't learn enough about it, and they may come up with a very blunt instrument which can really get in the way of the technology doing very good things for the world.

So, for example, there are studies showing that AI can be used with its imaging technology to detect skin cancers potentially better than the world's most well-trained skin cancer doctor might be able to. Now you wouldn't want to get in the way of these lifesavings technologies by putting a really blunt legislative instrument in place. So we need to look at it, but it needs to be handled very consciously.

MR. LEVANON: I can answer? I think AI could also add transparency. And one of the reasons why it's hard to reduce, let's say, under-representiveness of women and minorities in high paying jobs because you don't know how companies are doing in this regard for the most part.

But using AI, I think we are not far and probably within a year or two, we will know how much companies are hiring women and minorities in high paying jobs using a social profile data. And that would kind of remove the mask and allow much more transparency that could then lead to actually changing policies and companies trying to do better.

MR. FRANK: Yeah. So I think this is a really topical question. I believe that just this week the White House announced new guidelines for AI and the driven systems. So it seems like there's a lot to come on what the ethical infrastructure around AI will be in the U.S. moving forward.

One of the things that they list. They don't really offer many solutions. They really point to problems in their statement. But one of the things is that people should have the right to opt out. They should have the right to where reasonable not be included in data, but also have a right to deal with a

person instead of with an automated system. That's a really interesting thing.

And that we need safeguards for ethical AI decision making. Now, I think that if you start asking computer scientists about this question, they'll say, well, the examples we've seen are all examples of garbage in, garbage out. We're training systems on empirical data that reflects our society's biases to really we're just seeing a reflection of ourselves.

And that we can fix this if we just augment data in an artificial way that's less empirical. That is somehow removes the biases that we don't want in our systems. So there's a lot of -- strictly speaking that is how supervised machine learning works. But when you see these AI systems coming from these major tech companies.

So the facial recognition example of not failing to detect black faces. I believe that that was tested with facial recognition software from Facebook and from Microsoft which are companies we've all heard of, of course. So it really begs the question, what should the institutions and institutional safeguards be for these types of systems? To prevent this type of garbage in and garbage out from passing all the way up to deployment?

And this is a really hard question. Basically, I think we need more research here. You could imagine some type of really strange system where there's sort of a shared platform where companies are able to upload the compiled code and run it against a suite of different scenarios that somehow certify that, all right, yes. This software detects black faces. It doesn't bias based on gender. It doesn't bias based on health conditions. Or maybe this software isn't applicable to this test. It has nothing to do with medical conditions or anything like that.

You can imagine creating a whole suite of scenarios. But even having such a system is double sided market, if you will. It would be an incredible engineering problem to solve in the first place. So I think there's a lot of barriers both technically and then kind of institutionally to creating the safeguards we need to meet these goals from the White House.

MS. MAHANTA: Okay. All right. Well, I think that we're at time. So I will leave it here. Thank you all for speaking with us today. It was a really, really wonderful panel. And yeah, thank you very much.

* * * * *

CERTIFICATE OF NOTARY PUBLIC

I, Carleton J. Anderson, III do hereby certify that the forgoing electronic file when originally transmitted was reduced to text at my direction; that said transcript is a true record of the proceedings therein referenced; that I am neither counsel for, related to, nor employed by any of the parties to the action in which these proceedings were taken; and, furthermore, that I am neither a relative or employee of any attorney or counsel employed by the parties hereto, nor financially or otherwise interested in the outcome of this action.

Carleton J. Anderson, III

(Signature and Seal on File)

Notary Public in and for the Commonwealth of Virginia

Commission No. 351998

Expires: November 30, 2024