SDS PODCAST

EPISODE 925:

AI, AUTOMATION AND THE FUTURE OF WORK, WITH OXFORD'S PROF. CARL BENEDIKT FREY

Jon Krohn:	00:00:00	Welcome to another episode of the SuperDataScience podcast. I'm your host, Jon Krohn. In today's episode, we're honored to have Professor Carl Benedikt Frey, the world's foremost authority on how AI is transforming our economy, particularly employment. Indeed, anytime you read a statistic on how much job X will be automated by ai, this stat almost certainly comes from Carl. Carl is an associate professor of AI and work at the University of Oxford and a bestselling author, his latest book, how Progress Ends Technology Innovation and The Fate of Nations was released just this week. I dare say today's episode is essential listening for everyone because it provides the best research perspective on how AI will transform work. You'll hear anywhere this episode of SuperDataScience is made possible by Anthropic, Dell and Intel.
	00:00:50	Carl, welcome to the SuperDataScience Podcast. It's an honor to have you here. Where are you calling in from today?
Carl B. Frey:	00:00:59	Such a pleasure to be with you, calling in from Oxford today.
Jon Krohn:	00:01:02	Fantastic. Yes, a familiar place to me. I spent five wonderful years there and I try to visit when I can because I still miss it. I've also gotten very lucky with my weather recently when I've been visiting because it's paradise when it's sunny out there.
Carl B. Frey:	00:01:15	We had a few weeks of those recently. Most people that don't live here try to get in, and most people that live here try to get out. That's how it works.
Jon Krohn:	00:01:23	Most people that live there are trying to get out when it's sunny or all of the time.

Carl B. Frey: 00:01:27 When it's sunny mostly.

Jon Krohn: 00:01:29 I see. Yes. Yeah, no air conditioning I suppose. So Professor Fray, Carl, you are best known perhaps for, or your big explosion onto the global stage was, I think it's fair to say this fray and Osborne paper from 2013 where you had lots of startling, well-researched statistics on things like 47% of US jobs are susceptible to computerization, and so those kinds of stats, it led to that paper being cited tens of thousands of times. And it's the case that today, still a decade later, when you come across statistics in news media or in academic articles about how much Job X will be automated by ai, they're almost always referring back to that paper. So yeah, I dunno if you have some comments kind of generally on what that journey's been like as a result of that paper coming out and just you must constantly be seeing your name, your work featured in the news all over the world.

Carl B. Frey: 00:02:38 Well, we certainly did not expect the number of citations that we ended up getting, and we certainly didn't expect a media storm that followed, but I think it suggests that we were on too timely topic at the time. Obviously since Gen ai, the field and the interest in AI has reached a different level, and as you mentioned, this is 10 years ago, so this is IBM Watson playing Jeopardy. It's different era altogether. But yeah, we did notice at the time that the way that social scientists, economists tend to think about automation, it's sort of routine rule-based activities that can easily be specified in computer code and be readily automated. And at the time were seeing computers do many things that are non-routine medical diagnostics, playing Jeopardy driving cars. And so we tried to update the framework for how we think about what the division of labor between humans and computers are likely to be going forward.

Jon Krohn: 00:03:40 Yeah, yeah, it was fantastic work. I think what people really liked about it was how it made it seem like the finger in the air had a lot more, it was rooted in a lot more data and thought than previous reports at that time, and I think that's a big part of why it took off. Now, in the meantime, in the past decade, you've written a couple of books. Your latest book is out right now, it just came out and it's called How Progress Ends Technology Innovation and The Fate of Nations. It argues that economic and technological progress is not a given and that a millennium of global history shows otherwise. Can you fill us in at a high level first, I've got tons of questions for you that'll get into some details, but at a high level, can you elaborate on this book and the mechanics of progress? What states actors and policies play a role in making innovation continuously happen so far?

Carl B. Frey: 00:04:41 Sure. So I try to do a couple of things in the book, and one is sort of push it back a bit against the narrative that progress is inevitable and it's something we should be taking for granted because over the course of the 20th century, we've been through some extraordinary technological changes and it's easy to think that this is destined to continue, but if progress was inevitable, the first industrial revolution would've happened a bit earlier in human history. If progress was inevitable, then most places around the world will rich and prosperous today, and that is not what we're seeing. And second of all, if we look back historically, most places in history have not been the technology leader for very long. Think of the Song Dynasty in China that was at the forefront of innovation. Think of Victoria and Britain, think about the Republic before then. And we come accustomed to thinking of United States as its technology leader. And to be clear, I'm not predicting the end of progress necessarily in the book, but I'm trying to make the point that there is nothing inevitable about and there is no end of history where you arrive at the perfect institutional recipe that

will continue to deliver progress forever. Progress is constant work in progress and we need to constantly adjust our institutions as technology changes. And so I believe that's sort of the key message of the book.

Jon Krohn: 00:06:25 And so given that it's not a given that technological progress will continue, what are some of the key lessons we can draw from the past to know when to adjust policies and to avoid stagnation and even collapse?

Carl B. Frey: 00:06:40 So technological progress entails two quite distinct phases. So if you're a tech entrepreneur at the early days of setting up your business, you're trying to figure out what it is that you want to do, what your business model is, what your prototype is, that requires exploration. It's a bit similar for an academic writing a book, right? You're out there, you're discussing with people, you're trying to find the right angle, putting all the pieces together, and that's a very non-standardized interactive face. But at some point, if you write a book, you just need to sit down and write the actual book. And that's very lonely execution work. And from a corporate standpoint, it's also very different phase because when you scale, you don't want too much experimentation. You actually want to deliver what it is you do at the low cost. You want to capture market share, you want to scale up processes and grow globally.

00:07:49 And so that phase is very different from the experimentation phase. And if we take that to sort of a nation state level, some places do exploration better than others and some do scaling better than others. So if you take the most centralized economy in the world that I've ever seen, the Soviet Union, if you were an aircraft engineer in the Soviet Union and you wanted to get funding for your project, you could go to the Red Army at Oscar funding. If the Red Army declined, maybe had one or two or three at most other options, if they declined,

your idea would die with you. And obviously the only chance you have of getting something funded to begin with was if your ideas aligned with the national priorities. If you take the United States, there is no given that you will succeed in the US either if you have a good idea, but it's more likely.

00:08:52 So when Bessemer Ventures declined to invest in Google back in 1999 with the benefit of hindsight, it doesn't seem like a good idea, but it ignores the fact that Google was by no means the safe bet At the time Alta Vista Explorer was out there and other venture capitalists like Sequoia took the risk to invest and yielded an extraordinary return, but somebody actually needs to invest in that project in order for us to know whether we will be successful or not. Somebody needs to take that risk. And in a decentralized economic system, there are more people that can take different bets. There are more technological trajectories that can be explored. And as a consequence of that breakthrough, innovation is more likely to happen in decentralized systems. Now when it comes to scaling, it's a very different process and we tend to forget that the Soviet Union was actually growing quite rapidly for several decades, didn't necessarily benefit the bulk of the population because much of that focused on heavy industry and the economy bo a huge military burden.

00:10:14 But it did very well in sectors like steel, for example. And so what the Soviet Union can do very effectively was to mobilize resources and scale, and that took the country in technological terms reasonably far. And so if you want to understand both why the Soviet Union grew rapidly and understand why it collapsed in the nineties when the computer revolution took off, but I think you need to understand both of those faces. So if you look at economic and economic history scholarship, they tend to explain the wealth of nations through the lens of three factors being culture, geography, institutions. If you take

geography, the geography of the Soviet Union was basically the same in the 1950s when it grew rapidly as in the 1991 when the Soviet Union collapsed. If you take institutions, well actually if anything, the Soviet Union had battery institutions at the time of collapse because Gorbachev was pushing both glass knots and Paris Troika and was opening up the Soviet economy.

00:11:38 And finally, well, cultural terms, probably not much of a change. You could perhaps argue that the radio waves from Western Europe traveled through the curtain and people in Soviet Russia were exposed to Western radio television ideas. And that probably had some impact on the local culture as well. But if anything, that should have made Soviet Union more western and progressive. And so we want to understand both the rapid growth and the collapse. We need to understand the algorithm in the book, the interaction between culture and institutions and changes in technology. And the Soviet Union was not well equipped to capitalize on the computer revolution when it arrived.

Jon Krohn: 00:12:33 That's so interesting. It had never occurred to me that the class of the Soviet Union was related to computing. I always kind of assumed it was political factors or just kind of inefficiencies of the system in general. So it's interesting to hear that computing specifically accelerated the demise of that kind of centralized system. It's also interesting to me that you mentioned Bessemer and them not investing in Google at the time of recording. I was just in the Bessemer office in New York this week, and I think their website is very funny. They have this anti-portfolio that includes all the companies. They didn't invest in that. If they had, they'd be doing much better. So they have Google in there, Airbnb, apple, eBay, Facebook, Intel, PayPal, zoom and so on. And I think it's quite a funny thing. It's nice to see a VC firm not take themselves too seriously.

Carl B. Frey: 00:13:29 Very much so indeed I should, if I kept such a list, it would be a very long list. I don't that way.

Jon Krohn: 00:13:38 So yeah. So going on with this idea of differences in different kinds of systems. In your book you cite a sociological studies showing that a network with a plethora of weak ties generates a greater circulation of information and ideas than a network with a few strong ones. And so that reminds me of what you were already saying about how the Soviet Union, you'd only have a couple of chances, these couple of big opportunities to get your engineering idea across. Whereas in the US there's lots of these weaker ties. I might be taking liberties with these two different pieces and kind of blaming them together. But you describe weak tie networks as our collective brain. And so could you unpack a couple of examples from your book, like the rise of Silicon Valley and the unlikely development of mRNA vaccines and how these two examples illustrate the role of weak ties in driving technological innovation?

Carl B. Frey: 00:14:41 Sure. So the concept of the collective brain, I've admitted borrowed from Jo Henrik and weak ties come from Gran paper published back in the 1970s. But I think it very much illustrates the point I was trying to make earlier and the point that you also mentioned in the context of mRNA vaccines and so how that plays out in different political systems. So the mRNA vaccines that turned out to be the most effective against the COVID-19 pandemic, they were essentially developed within a couple of months of us identifying the virus. But the science behind it has been in the making several decades earlier. And so Kathleen Carrico, who grew up in socialist Hungary, fortunately for us left, came to the United States where she even in a decentralized system where many good universities, many parts of funding struggled for decades to get funding, was denied tenure at her faculty.

00:15:53 But nonetheless persisted eventually came across a number of good collaborators and developed the foundations for the vaccine that allowed us to escape the pandemic similar fashion. If you go back historically most learning, most interaction happened within the family. Over time. We outsourced a lot of the socialization process to preschools, schools, universities. And so both Larry Page and sorry, Bryn had the fortune of having parents working in science and technology. And that's one of the best predictors of whether you're likely to become an inventor yourself or not. A second, very good predictor of that is in what in which community do you grow up in and what's the density of inventors in that community? And obviously the two met at Stanford, right? It was Stanford that brought the two together and so laid the foundations for Google. And so we have these hubs that increasingly facilitate weak ties, I should say, that's not just an artifact of democratic societies, it's something that we see in Russia and in China as well. Russia had some of the best scientists in the world, some of the best engineers in the world, as does China today. They are all interacting within various elite institutions and universities, and they're fundamental to their progress too. So this is not something which is merely a question of democracy versus autocracy, but it is a question of the level of autonomy that you have within a system to choose your collaboration partners and interact.

Jon Krohn: 00:18:04 Very interesting. It's interesting to hear those examples about Circuit brand and Larry Page having those parents who were scientists, technologists themselves. I wasn't aware of that, but it makes a lot of sense with you talking about Google there. It reminds me about how in chapter one you wrote that once the easy gains from innovation are exhausted, big companies stop innovating and start lobbying. And so I don't mean to say that Google has stopped innovating entirely, but maybe that pace of

innovation has changed. Certainly the lobbying activity has dramatically increased over the years. And so I think this is something, it seems like it's a trend that we see in most companies. I know that some companies out there like Amazon have tried to do everything they can to avoid that culture of innovation from stagnating as the company's gotten larger. So what kinds of things can companies do, can governments do to try to prevent big corporations from getting into this lobby trap and allow innovation to keep happening?

Carl B. Frey: 00:19:16 That's a great question. So maybe just sort of highlight the conceptual framework of the book a bit more detail. So I mentioned earlier there's sort of a difference between exploration and exploitation. And so at some point you move into exploitation, you try to reduce costs through process innovation in what you're already doing, but at some point you run into diminishing returns. So there's only so much use in lemon that you can squeeze out. And at some point the marginal return to investing in protecting yourself against competition is going to be higher than the return you get from incremental improving production processes. And that stage essentially for continued growth, you need something new, but incumbents are less likely to deliver that fourth fear of undermining their own business model. And so we saw that with Kodak for example, is a classic example that wasn't the forefront of digital cameras, but for fear of cannibalizing their existing business model and undermine the revenues, they didn't launch it.

00:20:28 Google is another good example, which were essentially responsible for the transformers, but the P of seven people that developed it ended up leaving the company and perhaps for fear of undermining their ad-based model, they didn't launch the kind of generative AI that OpenAI was first to launch. So that is a key challenge. Now, I don't want to suggest that companies like Google

are not innovating. Of course they are, but they also have a tremendous amount of inventive and creative talent. It's a bit like you would never say that China is not able to innovate. They have some of the best talent in the world, but if you have some of the best talent in the world, you should expect that. And the counterfactual is, are those inventors more productive in China than they would've been in the United States? And are those software engineers and the talent at Google more inventive than the startups or the other firms that they previously were at?

00:21:38 Now, I don't know the answer to the question in Google specifically to be clear, but we do have research that shows that generally speaking, more and more creative talent is clustered in a few incumbents. And generally speaking, those inventors are less productive within those incumbents than they were at the startups they previously worked where they tend to have greater autonomy. So I think you can make a reasonable case, and I hope I make a reasonable case for this in the book, that in terms of innovation, we would be better off having more competition and more entry that we currently have. So United States, I live in Europe and here a key concern is we don't have productivity growth. Our economies are stagnant. But if you compare to what the United States looked like in the post-war era or in around the two thousands in productivity terms, the US is not doing particularly well either in business, dynam in the United States is in the client too.

00:22:57 That is a key challenge. Your question was around government policy, and I make the case in the book that what we see today with geopolitical competition with China on many dimensions we saw back in the 1980s with Japan. So Japan had already overtaken the US in autos with more productive was overtaking in the US in semiconductors as well and was really leading in

consumer electronics across the board. And yet in the nineties, Japan basically stagnates whereas the United States sees an upsurge in productivity growth around 1995. Why is, well, a big part is that Japan completely misses the transition into software and in the United States that is basically driven by new companies, and that is in part, in large part I would say due to competition policy and antitrust. So you have the lawsuit against IBM, which forces the company to unbundle hardware and software opens up the market for players like Microsoft to enter.

00:24:17 And then I think more importantly, you have the breakup of at and t, which essentially means that when the National Science Foundation makes ANet the predecessor to the modern internet available to the world, it's not bottlenecked within the boardroom of at t. So many other countries, carrier services were essentially just sort of handed over to the state monopoly. And that didn't happen in the US because of that breakup. And that meant that the internet developed through new firms and developed organically through its users. And that stands in star contrast Japan, where conglomerates that had been created in the 19th century reemerged in the form of caret. So in the post-war period continued to dominate. They were very good at coordinating production activities, sharing technology amongst them, scaling up production, but they also erected various significant barriers to entry. And so the fact that America is much more oriented around competition rather than bureaucratic coordination within conglomerates, I think is an important reason why the computer revolution happened in America and not just in the United States. And I think it's a lesson that is important to bear in mind as well as United States is now competition with China.

Jon Krohn: 00:26:05 And as we embark on these interesting experiments in policy in the US that we're seeing as well in your answer,

you talked there about Google not releasing or maybe even not putting as much r and d into cutting edge large language models. And OpenAI beat them to the punch on the kind of highly intuitive conversational interface that we saw with chat GPT around the release of GPT-3 0.5. And so I want to talk about LLMs a little bit, which my audience will probably really enjoy. In your talks and in your writing, you've expressed skepticism about using LLMs to automate human ingenuity. You've described them as engines of statistical consensus prone to driving discovery by majority vote, and so that they're therefore unlikely to produce novel or inconceivable ideas. I'd love you to dig into that a bit more. It's something that I can completely understand. Yeah, so I wonder what you see in the near term or maybe if there are some kinds of, I realize that this isn't necessarily your area of expertise, but I don't know if you have ideas as to how in the longer term perhaps machines could have more invention themselves.

Carl B. Frey: 00:27:30 Let me just make two observations on that. So two of my Oxford colleagues have these thought experiments where they imagine LLM in 1900 being asked the question, will humans ever be able to fly consider just for a moment, that trading dataset, right? They would've a long list of failed experiments with humans attempting flight. They might've looked to birds as the best evidence that flight is in principle possible. But even there, there's no bird that weighs more than 30 pounds that's able to get off the ground. Larger birds like os don't fly. And so I think it's highly unlikely that any LLM trade upon our data available up until 1900 would've given us a blueprint for what the Wright brothers achieved. Now, we can always argue about are LMS creative? Are they not? They do recombination very well. Some of that is arguably new. Some of that is arguably novel.

00:28:47 But if you take an algorithm, you train it on impressionist paintings, well the outputs are going to be fairly close to impressionist. You're not going to get to conceptual art that way. And so there are certain leaps that state of the art AI isn't capable of that I think humans are capable of. And so I think that means that in the sort of frontier innovation and discovery that I'm talking about in the book for now at least humans are self safe. I'm very happy to entertain the possibility that could change in the future. And to be clear, I'm not a computer scientist and it's not clear to me what the path forward is, but let me just make some observations there as well. So first, industrial revolution powered by steam, right? Early steam engines are tremendously energy in efficient, and as a result, they basically used to drain coal mines.

00:29:56 And even that they can't do particularly well, right? What's really required is what separate condenser to make the steam engine energy efficient. And then you have several tweaks by others as well, applying it to steamships and railroads, et cetera. And that's what makes makes it useful. I think AI is still in a way waiting for its separate cred, condenser moment. I think if the world was just a static distribution of events, you can brute for it, but the world is not just a static distribution of events. It's changing all the time. And so I think a key challenge going forward is building AI that can like us, sometimes we misjudge new events as well, but that can essentially that are relatively resilient to new situations and new circumstances. And I think another example of this is related to the game of go. We all know 2016 alpha go beats the world champion back in 2023 as Stuart Russell and his lab puts out this paper showing that, well, we already achieved superhuman performance in that domain, but still human amateurs using standard laptops are capable of beating the best go programs convincingly by exposing them to new concepts.

00:31:34 And so I think that tells us something. There are probably people out there that have ideas how to proceed on that front, but we're not there yet. And so I do think that that is a remaining challenge.

Jon Krohn: 00:31:51 That was a fascinating answer as all of your answers have been so far. It's nice to feel that there's a little bit of evidence that at least for the coming few years, maybe people like me, people like our listeners who are writing code, developing AI systems that we might still have some ingenuity to provide that the machines we create won't be able to replicate. We'll see what happens. And so on this note of the AI labor market transformation, something that I haven't mentioned yet is that your title at the University of Oxford is the Dieter Schwartz Associate Professor of AI and work, and you're also the director for Future of Work research at the Oxford Martin School, which is one of the world's foremost futurist research departments. And so there's a lot to be said about AI and work and through your articles, interviews, talks, books, you've contributed enormously to the public discourse on this subject.

00:32:52 So starting with to kind of get this conversation going, a fairly recent development is this wide reporting that these kind of deep fake AI job applicants are successfully applying, interviewing and securing remote jobs, sometimes even as coordinated scams out of North Korea. And so if LLMs can be generating plausible essays and AI agents can participate in meetings, what is authentic, intellectual and social mastery look like? I guess in other words, how should we be redesigning assessments and collaborative the norms for how we collaborate in order to separate deep critical understanding from this kind of sophisticated, increasingly sophisticated mimicry that we get from LLMs?

Carl B. Frey: 00:33:49 It's a great question. To be clear, I might come off as an AI skeptic, but I'm thoroughly impressed by what I've been seeing over the past couple of years. And the latest models are probably better teachers, teachers and tutors than I am across the board. And they're probably better than almost anyone, apart from perhaps the world's leading experts in a given field. And I think a key challenge for developers of these tools is that beyond a certain point, and we probably reach that point, people are not going to notice improvements on those dimensions because they're already providing better answers than we do. And so I think where we have bodies of fairly developed sophisticated knowledge out there, AI performs tremendously well. And I think the real challenge is then adapting that on the fly. It's a little bit from economists. AI knows all variety of models, but then the challenge is to apply the right model to the right problem at the right time.

00:35:08 And so I think humans hold a comparative advantage there. I do worry about what you mentioned, and we do have some evidence that, for example, generative AI has reduced trusts in news, and that's a key concern. At the same time, it seems that it boosts the relevance of brands. And so I think brands that build trust are becoming increasingly important as artificial intelligence improves. And so the same applies to podcasts. If podcast hosts that develop certain degree of trust with their listeners are more likely to continue to be popular regardless of how good, much better AI gets. And it's also key challenge when it comes to technology adoption. So many medicines, for example, I don't know whether I should take them or not. I trust the institution behind my doctor that provides good evidence, but those institutions do not exist all around the world. And that means that some people don't take their medicine or they take the wrong medicine, and I think that trust is just going to get more important.

Jon Krohn: 00:36:39 Yeah, interesting that, yeah, trust sounds like a key component there. And hopefully maybe I should start running sponsor messages about how much my audience should trust me, what a reliable podcast host I am continuing on this note of how AI is disrupting labor markets. In an interview recently, you noted that the distinction between jobs changing, occupational change, job elimination, occupational elimination, that these lines are very blurry, making it hard to gauge the real scope of automation. And then in another presentation should how startups are creating fewer jobs than they once did, suggesting that new technologies may be relying less on human labor. And separate from you, Sam Altman, the open ai CEO predicted that AI may make it possible for one person to build a billion dollar company very soon, he says. And so this seems to be quite a potentially transformative moment in the labor market. Even in ancient civilizations, manual labor was treated as lower value work and societies were stratified accordingly. But it seems like we're heading into a world where potentially plumbers could be earning much more than lawyers. Yeah. So what are your thoughts on how labor is being transformed so rapidly by AI and how income, how social stratification could change in the coming years?

Carl B. Frey: 00:38:22 So a lot of in there to unpack, I think to start with the first question around jobs and tasks and jobs changing might have the same effect on workers as jobs being displaced. So if you take a job like a lares or a lamplight, we didn't automate the way the jobs of laundresses by building a robot that would walk down to well perform the motions of hand washing and then walk up to the house and hang the clothes to dry. We did that through the electric washing machine, which does a sort of very different set of motions and procedures. And so if you would just have looked at what LA rests do, a few robots today even that will be able to navigate the forest, walk

down to well perform the motions of hand washing and then walk up to the house and hang the clothes to dry.

00:39:33 And so the same is true with what Artis and craftsman did. The way we automated the way those work was by simplifying it in factory setting and then applying specialist machinery to better define tasks. And so often if you try to look whether your job is automatable or not, just by the tasks it entails, it doesn't necessarily tell you that much about whether it's that job is going to be automatable or not. I think more importantly from the perspective of the individual, it might not even matter that much if the job just changes or is replaced. So sometimes I'm here in school buses, even if the bus drives itself, you will still need somebody in the bus to look after the children, and that might well be true, but that person is not going to need a driver's license and is going to have an entirely different skillset than the bus driver.

00:40:38 So the bus driver would probably be replaced with somebody else. And from the viewpoint of that person, that doesn't make necessarily much of a difference. So I think the distinction there is quite blurry indeed when it comes to new job creation, as you alluded to, I think it's important to remember that key reason that we're not having mass unemployment today is that we have created new types of work. So most work that's done today did not exist in the US in 1940. So most people work in new types of work. And so going forward is absolutely critical that we invent new lines of technologies that also create new types of work for people to make a living through their labor. And a key concern is that new firms are not expanding and growing as rapidly. They're not as job creating as they once were. And I think that is not just a concern in the sense that it created fewer jobs.

00:42:04 It also means that we are having less productivity growth. So think about it this way, if all we had done since 1800

was automation, we would have sheep, textiles, and we would've productive agriculture, but not much else. We wouldn't have vaccines, antibiotics, airplanes, rockets, computers, et cetera. And so most prosperity comes from actually doing new and previously inconceivable things. So if we overwhelmingly use AI for automation, we're actually not creating that much value. We can get the sort of short-term productivity boost, but if AI is just a productivity tool that we shouldn't expect to get that much productivity growth out of it, and also not that much job creation. And so the hope for growth from a standpoint of economic prosperity and job creation is that we can use AI to create new types of industries. Now, if we create a billion dollar firm with one employee, that's good for that employee, and that might be good for some of the people that use that services, presuming it's creating something that is of use and value and that's behind the valuation.

00:43:31 And it might be good because we can potentially tax that and provide social services, education, healthcare, et cetera. But if we just have a few unicorns that's not going to be shared prosperity. And unless their services are much incorporated into all different sectors of the economy, it's not going to create much productivity growth either. So I think for AI to truly be transformative, it needs to create new sectors. And that's what we saw during the first industrial revolution as well. So first seven decades, most of the technological changes that we see during the first industrial revolution is focused on mechanization of textiles. It's only really with the railroads that growth in Britain takes off. Similar to the second industrial revolution, we see a lot new industries, automobile industry, the largest manufacturing enterprise the world had ever seen. On top of that range of electrical industries, every gadget you have in your home is basically from that era.

00:44:39 And there's an industry behind it. And then there's all the components that go into the car and then the machine tools to produce those components like huge industries as well. And then road commerce and tourists, there's a lot of new sectors being created that drives a huge joburg in productivity growth over the post period. We see that to some degree with the computer revolution, but not to the same extent. And it peters off quite rapidly. I think we will likely to see something similar with AI unless we're able to create those large sectors that we saw in the mid 20th century.

Jon Krohn: 00:45:14 Yeah, I suppose it's very hard to predict what industries will emerge, what kinds of jobs will emerge when it's so many steps down the line, just as it would be difficult in 1900 to imagine you talked about in 1900, if we trained in LLM back then, how it might not have predicted that humans would be able to fly. Likewise, it would be difficult to envision that a century later. We would have so much around the airplane industry, all these kinds of jobs that are supported, people cleaning airports and selling snacks at airports, baggage handlers, all these kinds of jobs would be difficult to foresee with that new innovation. As a quick kind of anecdotal story, I recently flew from San Francisco to Australia, and in San Francisco, one of the things that I love to do is ride in fully.

00:46:11 They often can arrive more rapidly and are more affordable, and frankly even seems safer to me than being in an Uber or a Lyft or a taxi. And after flying from San Francisco to Australia, obviously I couldn't hail a waymo today in Sydney, and so used Uber. And the Uber, I had a particularly chatty Uber driver and he says, oh, what do you do for a living? And I'll explained, oh, I do this AI stuff. And he says, oh yeah, white collar work. He was actually pretty well informed about AI innovation, and he said, it's interesting how white collar work is being

displaced more rapidly. And I said, yes, but there are some interesting categories where it isn't just white collar work. For example, I just flew from San Francisco where I was in a fully autonomous waymo, and to him he was kind of like, well, but do you trust that actually, that's how it came up.

00:47:15 He said, would you trust being in a fully self-driving car? And that ends, to which I responded, actually, I just came from San Francisco. And I said, I actually prefer that experience in a Waymo over an Uber. And so absolutely, I do feel safer. I'm not sure if I would necessarily feel safer in a Tesla, which is only relying on computer vision, but in the kind of lidar based system that Waymo uses and a lot of the self-driving companies use, it feels extremely safe. So yeah, I think this is, it shows a lot of people aren't expecting what's coming, even if it's your job. And so it seems like there's a good chance that AI's job displacement in the coming years and wage changes will be substantial. Are there lessons we can draw from the previous industrial revolutions to enact sensible policies that will balance innovation with worker protection and ease the social shocks?

Carl B. Frey: 00:48:17 So first of all, I think what you just described is very similar to the sentiment and the debates that people had around the automatic elevator. So a lot of people, or at least the unions argued that most people would not feel comfortable going into an elevator with no operator responsible for their safety. And then obviously there was all sorts of accident with elevator operators doing all sorts of mistakes, and some of them ended up being even fatal. And so I think there is tendency often to think that humans trust humans more, but I think there's not that much required for us to be convinced that is not the case when we see the performance of these technologies. And so as more and more people will come in contact with driverless cars as you just described, I think that's going

to change very quickly. And as a bit of a side note, back in our 2013 paper, most of the jobs that we estimated are fully automateable.

00:49:32 They are in transportation and logistics. And I think we're still just very much at the beginning of that transformation when it comes to white collar work. I think it's true that for the most part right now, it's not the entire job that is going to be replaced a certain tasks within. But I think it's also true that AI is making a lot of white collar work, a lot of creating work much, much easier. And if it becomes easier, then it reduces barriers to entry. So it's a bit like GPS technology and Texas services. So GPS technology essentially meant that knowing the name of every single street, Knox Oxford was no longer a particularly valuable skill. And so when Uber came along, anybody could essentially get into his or her car and then top up their incomes on the side with professional service jobs. On top of that, those jobs are tradable.

00:50:39 And so it means that if you think about, let's say the work of an accountant, an accountant in New York City earns six digit salary. An accountant in Manila earns a lower four digit salary. And so if AI reduces the productivity differential between those workers, I think it's very likely that we're going to see a lot of white collar work moving across borders to places where labor is cheaper. And then obviously for white collar professionals in Europe and the United States will affect on them, is the same as if their job were automated, even though what AI is currently doing is just reducing barriers to entry in these professions. Now, what should governments do? I think what you don't want is governments, you want government to protect people but not jobs. And so if you look at Europe where you have strong employment protection, what that means is that when a technology like generative AI arrives, firms like SMP, they find it very hard to adjust because they can't just hire and fire.

00:52:04 Whereas firms like met and Google, they can pivot much more quickly. And that I think is a drag on the European economy. At the same time, you want to have a social safety net that takes care of people, and that means that the broader population see the benefits also from the technological changes that we're seeing. So in my previous book, the Technology Trap, I make the case that the Luddites, they were essentially right to riot against the mechanist factory because they were not the ones to benefit from it. Wages in Britain were stagnant of falling for two decades, so two generations lost out. And it took a long time to see the benefits of new technologies for most people to see those benefits in their pockets. And what you also see is that in places in Britain where the poor laws at the time were more generous, you saw less social unrest as a consequence. So Britain was the only country in the world at the time to tax itself 2% of GDP to provide for the poor. And that actually had an impact on whether workers would riot against making assumption or not. And when autonomous cargo trucks arrived in la, there was a huge strike when the same technology was used in the harbors of Norway and in the Netherlands, no reports of such incidents. So I'm very much in favor of Danny's style, flex security, flexible labor markets, but then actual security also when you lose your job.

Jon Krohn: 00:53:49 Yeah, there were so many facts in there and so much useful information. I don't even know where to begin. I think I'm just going to transition to my final technical question, which builds on what you were just talking about and comes full circle with this episode because at the beginning of the episode, I mentioned how the public awareness of you of Carl Benedict Fre exploded with your 2013 fray and Osborne paper, the future of employment, how susceptible are jobs to computerization. And so I mentioned how that estimated that 47% of jobs are at risk of automation in light of generative ai. Last year you revisited your predictions in another article called

Generative AI and the Future of Work of Reappraisal, but actually you stated for the BBC after that that there's no way of knowing how many jobs will be replaced by generative ai. But you do highlight key areas where humans have an edge, so things like face-to-face interpersonal skills.

00:54:59 And you've talked about how things like remote teams are consistently less likely to make breakthrough discoveries relative to in-person teams. And so I guess where I'm getting to with all of this context and this question that I'm asking is that for my listeners, are there some actionable takeaways that they can take as individuals? Most of this episode we've talked about what governments can be doing, what enterprises can be doing. What can individual listeners to my show be doing to try to make the most of this generative AI era and to maybe protect their wages, protect their jobs? What are the kinds of skills that they should be developing or focusing on to try to limit gen AI eroding their earning potential?

Carl B. Frey: 00:55:50 So back in 2013, we pointed to three sort of key bottlenecks to automation. So one being complex social interactions, one being creative work, one being the capacity to navigate complex unstructured environments. So I think in the first one obviously been tremendous progress with chatbots, and they are, it's a different universe now in that space than it was in 2013. But I think generative AI is actually going to increase the value of in-person communication. And so we have quite a bit of evidence that AI is sort of having a homogenizing effect. Many of these either the outputs, various models, produce are quite similar. And so a question is how do you distinguish yourself in such a world? How do you distinguish yourself in a world where AI writes your letters and everybody else's? And I think that differentiation is going to be in in-person

communications. I think that those skills are going to become more valuable.

00:56:54 And then creativity, we touched a bit upon that earlier. So there's a lot of stuff that AI does that I would regard as creative. There's also some other stuff that maybe not that creative, but seems creative. So writing prose in the Shiloh style of William Shakespeare, well, I can't do that. AI can, but how creative is that? Shakespeare did that. And so that's the reason that AI can do it. But then there is a lot of cutting edge creativity and maybe watch that resilience creativity to the same bottleneck because as we discussed earlier, responding to shocks, events in the real world, something that humans still have a comparative advantage yet. So the combination of resilience, social skills is still very important. And then navigating complex environments, et cetera. Although we're in the domain of robotics, there's been noticed by the progress there too, not as rapid as in ai, but AI is aiding that to some degree. But as you said yourself earlier, plumbers, electricians, gardeners, all of those jobs may well be higher status them being a lawyer or a consultant in the foreseeable future. And so acquiring some practical manual skills might be a good idea. And unfortunately it doesn't put me in a very good place, and my wife can attest to that.

Jon Krohn: 00:58:38 Yeah. So earlier I was talking about how plumbers might have incomes that on average exceed those of lawyers in the near term. So it sounds like your advice is for the lawyer to get some skills as a plumber potentially.

Carl B. Frey: 00:58:53 I'm not sure if I want the lawyer to do my plumbing, but maybe that's another podcast.

Jon Krohn: 00:58:58 Yeah, I guess, yeah, anybody who's that litigious I don't want in my household. So that's the end of my questions. I do have one from a listener. So I posted on social media, I posted on LinkedIn a week ahead of us recording that

you would be on the show. We had a lot of engagement. And one particularly good question from someone named, now, she's based in Munich, so I'm assuming she kind of pronounces this with German sound. So Ava Simona Lehotski, and she's managing director of the AI lab at something called the service plan group, which is a big communications company. And she had a great question for you, which was looking at past technological revolutions, what have we consistently misunderstood about the human side of innovation and how can we design trust into today's AI transition so we don't repeat those mistakes?

Carl B. Frey: 01:00:01 That's a very interesting question actually. So I think it's pretty consistently historically we've overestimated how fast things go in the short run and then underestimated a change in the long run as many people have observed, but with regard to trust in particular. So in research in my first book, it struck me that the very first train rider between Manchester and Liverpool in Britain actually killed a member of parliament. And that was a huge tragedy, but it didn't stop the rollout of the railroad network. If you look at early tractors in automobiles, they were extremely unreliable, sometimes exploded, various accidents, still didn't stop adoption. I think we've become obviously much more cautious as a society when it comes to rolling out new technologies. And I think building trust today around these tools is more important than in the past and specifically as we were discussing earlier, that in a world where it's hard to distinguish between right and wrong brands become more important, and then if you roll something out which is not functioning properly well, that can have severe consequences for trust and for your brand.

01:01:39 So I think the environment in which firms operate today is very different from the environments that we saw in the early 20th century, for example. So there is this constant

tension between trying to build trust and reliability, but also not let the perfect be the enemy of the good, because there's also a real risk that we end up there is a lot of things that are completely unforeseeable. There is no way that we can write the rules of regulations around AI with a level of foresight that will capture every potential use case in five years from now. And so experimentation is also absolutely critical to the rollout of the technology, and I think it's fair to say that had Sha PT not been released, we wouldn't even be having these conversations around AI regulation. And so we need to actually release some of these technologies into the world for them to be tested and for regulators to collect information about how to regulate in the first instance.

Jon Krohn: 01:03:16 Excellent. Thank you for that Great answer. And thanks to Ava for the question to bring all of that out. To wrap up here, again, your brand new book is out now. It's just come out in the past couple of days, and it's called How Progress Ends Technology Innovation and The Fate of Nations. Obviously, this is going to be a fantastic book for people to read based on the conversation that we had on the podcast today, huge amounts of insight for people to glean from there. Something, Carl that I always ask my guests before I let them go, however, is whether they have a recommendation of anyone else's book that they should read as well, what do you have for us?

Carl B. Frey: 01:03:54 That's an easy one, Jon ils Liver of Riches, everybody should read it. That's what got me interested in technology to begin with, and there's no more comprehensive overview of what drives innovation, what's inhibited, and yeah, everyone should read it.

Jon Krohn: 01:04:09 Nice. And for people who want to get more of your brilliant insights after this episode, how or where should they follow you?

Carl B. Frey: 01:04:17 I'm trying to post more on LinkedIn these days, so I think that's probably a good platform.

Jon Krohn: 01:04:22 Yeah, yeah, yeah, I agree. So yeah, so we'll be sure to have your LinkedIn URL in the show notes. Professor Frey Carl, thank you so much for taking the time with us today, especially at the time of this book release. You must have so much going on a media flurry and to grace us with your presence on the show. It's been an honor. Thank you so much for taking the time.

Carl B. Frey: 01:04:43 Such a pleasure. Thank you very much for having me.

Jon Krohn: 01:04:49 Well, what an honor to have Professor Carl Benedikt Frey on the show today. In today's episode, he covered how centralized systems like the Soviet Union excel at scaling existing technologies but struggle with breakthrough innovation. The distinction between exploration and exploitation phases in innovation where big companies eventually stop innovating and start lobbying once easy gains are exhausted. Why LLMs function as engines of statistical consensus that excel at recombination but struggle with novel discoveries, the critical role of weak social ties and decentralized networks in driving innovation, predictions for AI's impact on the job market and policy recommendations for balancing innovation with worker protection, emphasizing the need to protect people rather than jobs, while maintaining strong social safety nets during tech transitions. As always, you can get all the show notes including the transcript for this episode, the video recording, any materials mentioned on the show, the URLs for Carl's social media profiles, as well as my superdatascience.com/925.

01:05:53 Thanks to everyone on the SuperDataScience podcast team, our podcast manager, Sonja Brajovic, media editor, Mario Pombo, partnerships manager, Natalie Ziajski, researcher Serg Masís, writer Dr. Zara Karschay, and our

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