[DAISY THE GREAT](https://daisythegreatband.bandcamp.com/): 00:00:00 [BUILT MY HOME ON HOLLOW GROUND](https://www.youtube.com/watch?v=z-1sC1lkmKw)

CRAIG: 00:00:07 ​Hi, this is [Craig Smith](https://www.nytimes.com/by/craig-s-smith?searchResultPosition=0) with [Eye on AI](https://aneyeonai.libsyn.com/), a podcast about artificial intelligence. A few months ago, at the recent [International Conference on Machine Learning](https://icml.cc/), a [workshop](https://slideslive.com/38917851/keynote-talk-ai-for-climate-change-the-context) and [research paper](https://arxiv.org/abs/1906.05433) launched a movement to use machine-learning in addressing climate change. The response was huge and has given birth to the bones of an organization: [climatechange.ai](https://www.climatechange.ai/). It’s early days, but the organization hopes to become a sort of clearing house, where scientists, engineers and others can gather to share ideas, find collaborators and match talent with projects that can either help mitigate global warming or help humans adapt to a warming world.

I wanted to understand more about the effort and so this week I talk to [David Rolnick](http://www.davidrolnick.com/), a postdoc at UPenn, and [Priya Donti](https://priyadonti.com/), a PhD student at Carnegie Mellon. David and Priya were instrumental in starting climatechange.ai and are engaged daily in maintaining its momentum. We talked about how the group came together and how climatechange.ai is developing and what you can do to get involved. I hope you find the conversation as inspiring as I did.

DAISY THE GREAT: 00:01:17 [CROSS IT TO FIND YOUR SYNTHETIC LIGHT](https://www.musixmatch.com/lyrics/Daisy-the-Great/Built-My-Home-on-Hollow-Ground)

CRAIG: I thought maybe we'd start by having you each introduce yourselves just so listeners know who we're talking to.

DAVID: 00:01:31 Hi, I'm David Rolnick. I'm a postdoctoral fellow at University of Pennsylvania. I work on the mathematical foundations of deep learning and neural networks - so, understanding why the systems that we build work so well and how we can build better ones. Climate change has been on my radar for many years, but until recently I hadn't worked to identify how I could work directly to have an impact.

CRAIG: 00:01:55 And Priya?

PRIYA: Yeah. So, I'm Priya Donti. I'm a PhD student in computer science and public policy at Carnegie Mellon University, and I work primarily on developing novel machine learning methods to help reduce emissions from the electricity sector.

I got interested in working on climate change in high school actually. I had this amazing science teacher, Mr. Fornari, who took the first two weeks of his intro biology class and turned it into a student led sustainability curriculum where students taught about topics, sustainability topics including climate change.

00:02:30 And there I learned not only about what climate change is in a technical sense, but also about the fact that it is fundamentally a really human issue and has impact on the lives of people all around the world. So, I got really interested in that topic in high school and then come college. I didn't necessarily know how I wanted to tackle climate change. I started out thinking I wanted to make solar panels more efficient and didn't necessarily love the day to day of the courses I was taking. Fell in love with my computer science courses and then ended up in this dilemma where I was not sure at all at the time how computer science and climate change one hand in hand.

PRIYA: And so, kind of after some soul searching after looking around, there was a paper called [Putting the 'Smarts' in the Smart Grid](https://cacm.acm.org/magazines/2012/4/147362-putting-the-smarts-into-the-smart-grid/fulltext). Uh, that was released by a number of researchers in the UK, describing this area of making electricity grids more intelligent and how that was a grand challenge for artificial intelligence. And so, I really got interested in that particular topic and that point of intervention at that point.

CRAIG: 00:03:32 You’re both – I mean, is it fair to say that you're the core of this team that's forming around the applications of machine learning to climate change? Or am I putting too much of a spotlight on you?

DAVID: 00:03:44 It's a big team. And in particular, there are several people who have played really key roles who couldn't be here today. I'd like to call out [Lynn Kaack](https://epg.ethz.ch/people/senior-researchers/dr--lynn-kaack.html) in particular. But, really everybody on the team has worked on different facets of the problem because this is an interdisciplinary area and bringing in different kinds of expertise is essential to having any kind of meaningful contribution moving forward.

PRIYA: 00:04:09 Yeah. And then I guess it also makes sense to situate what our organization is maybe in the larger ecosystem of organizations thinking about similar things. So, our organizations is CCAI, Climate Change AI. and we are the group that wrote the paper on “Tackling Climate Change with Machine Learning.” and we care about applications of machine learning to accelerate solutions across climate change mitigation and adaptation. but we are one movement here and there've been other movements who have been working on parts of this problem as well. so [Climate Informatics](http://climateinformatics.org/) is one of these, the [Computational Sustainability Network](http://www.compsust.net/) and a number of others that have been thinking about how we can essentially get the machine learning community and the computer science community engaged in climate change, environment, and other issues of societal good.

CRAIG: 00:04:56 That's interesting. And what's the history of those others that you mentioned?

DAVID: 00:04:58 So Climate Informatics has been around for I think about a decade started by a [Claire Monteleoni](https://www.colorado.edu/cs/claire-monteleoni) and other people. and the goal of Climate Informatics - not to, not to describe their mission in my own words - but, the goal of Climate Informatics is to apply statistics, machine learning, and data science to problems relevant to climate science. So, the science of the climate, including climate modeling and how the climate changes.

CRAIG: The other two were?

PRIYA: 00:05:31 Yeah. So, one of the others was the Computational Sustainability Network or [CompSustNet](http://www.compsust.net/). This was founded by [Carla Gomes](https://www.cs.cornell.edu/gomes/) who is a professor at Cornell University. and the goal of CompSustNet is twofold. The first is to drive fundamental innovations in computer science. And the second is to drive positive applications in sustainability as defined by the [UN Sustainable Development Goals](https://sustainabledevelopment.un.org/?menu=1300). so, this includes things like environment, but also public health and also disaster management and that kind of thing. and the idea is that these two aspects of novel computational algorithms and applications of societal good are not separate paths, but instead are things that have a lot of synergy and can be pursued at the same time.

MUSIC: INTERLUDE

DAVID: 00:06:25 We found in our work that in many cases there are not just important applications of machine learning that can be impactful in the setting of climate change, but also that these applications as Priya indicated, have the potential to significantly advance machine learning as a field overall.

There was an informal discussion, which I organized at in [NeurIPS](https://nips.cc/), last year, to judge interest among the community. And I was really amazed by how many people were really desperate to work on how to use their, their skills in a meaningful way to work on climate change. Uh, and yes. So there were various conversations with, with [Yoshua Bengio](https://www.eye-on.ai/ai-articles/2019/3/28/interview-the-bengio-brothers) and other members of his group at [Mila](https://mila.quebec/en/) his institute in Montreal. And we were trying to work out how we could be most impactful in tackling climate change.

DAVID: 00:07:17 And I felt that if we and other people were so interested in working out how we could make an impact, then perhaps the best way to make an impact was to externalize that and put together a list of recommendations for how people could use their skills to, to great impact. And the team formed out of those who had been working on different aspects of the problem. So Priya is coming from the energy systems perspective in particular, also from the machine learning side. Other people were coming from a theoretical machine learning or from mechanical engineering industry a and many different other areas because there are so many different facets of having an impact on climate change.

CRAIG: 00:08:00 Hmm. That’s interesting. I remember you saying that there was a meeting that was wildly oversubscribed.

DAVID: 00:08:08 Yes, I tried to organize a meeting at about a week's notice in Montreal and there was only room for 50 people in the biggest venue that I could find. It was, it was difficult finding somewhere that would host all of us. Uh, also difficult since of course, and many people who are concerned about the climate impact are vegetarian and trying to find a vegetarian place in Montreal … they did still give us bacon bits with our salad.

PRIYA: 00:08:26 And it was also really funny because the [AI for Social Good workshop](https://aiforsocialgood.github.io/icml2019/) was going on at the same time and they had a lunchtime event with [Yo-Yo Ma](https://www.yo-yoma.com/). But I also really wanted to attend. So, I attended the Yo-Yo Ma event and then rushed over to the AI and climate change meeting, which I'm really glad I did cause it was, there was so much energy in that room and a lot of interest in, in making something happen, not just talking about the issue but figuring out the best way to collaborate. And to move forward and to actually use the expertise of this community, of the machine learning community to really make a dent in climate change.

CRAIG: 00:09:00 Yeah. And then where did the idea of the writing the paper come from? Was it out of those talks?

DAVID: 00:09:07 I felt that it would be useful to have a founding document for, for this movement and something that went into as great detail as these difficult topics deserved. Of course, each individual section of our paper is trying to summarize what could be an entire field and many books in and of itself. and so we are not going to have done justice to the difficulty of these various topics that said anything shorter than the [50 pages and 700 references](https://www.researchgate.net/publication/333773164_Tackling_Climate_Change_with_Machine_Learning), which we, which we used, would have really not done it justice, you know?

CRAIG: 00:09:41 Yeah. It's a survey, in other words.

DAVID: 00:09:42 It's both a survey and a set of recommendations for what can be done moving forward. So not just a review of what has been done, but also some recommendations for what we see happening in the future.

We released it in conjunction with the workshop that we were simultaneously organizing at ICML, one of the big machine learning conferences along with NeurIPS. So, we'd had a lunch at NeurIPS, and then we had a formal workshop, an entire day of talks and research presentations, at ICML. We're actually also hosting a workshop, as we did at ICML, but at NeurIPS this year in Vancouver in December.

CRAIG: 00:10:21 And you say it's already sold out?

PRIYA: 00:10:22 Yeah, more it feels more coveted to get into nerves these days than most famous rock concerts.

CRAIG: 00:10:29 I was at ICML, saw the workshop, didn't know anything about it. I went, I couldn't stay for the whole thing but, but I was there for a lot of it and, and all of the videos are on online. but I was amazed it was standing room only.

DAVID: 00:10:37 It was certainly very popular. There was a lot of demand for this really for, for a long time. There's been a lot of pent up desire to help in this issue and other issues among the machine learning community. So, I think we are, I hope we can help to channel some of the skills and that eagerness.

PRIYA: 00:10:55 Yeah. And I think it was seeing the excitement at that workshop and seeing how excited people were about our paper that caused us to say, yes, it was a great first step to write this paper and present recommendations about what the community should be doing next. But that there's, there are other things that we need to be doing and other bottlenecks that we can help remove in order to mobilize this community.

DAVID: 00:11:19 Ideally all of these steps should work together. So physical meetups are useful in helping build teams and get people motivated and meeting each other. Uh, the, the goal of our paper was to write down some of the problems that people could be working on, but then of course there is the need for providing tools for making it easier for people to work on those problems. It's not simply enough to tell the world, oh, this is, it is important for the world to be working on remote sensing. One needs to actually provide some tools for people who haven't been working in remote sensing to get their hands dirty. Looking at solar panel locations or methane emissions.

MUSIC: INTERLUDE

CRAIG: 00: 12:08 There's a website CCAI or [climate-change.ai](climatechange.ai) and then there was the workshop and the paper. Out of that is coalescing an organization, is that right?

DAVID: 00:12:18 Yeah, so the organization is the group that has put together the paper and this website where we are collating many resources for use by the community in facilitating work in this area. Our goal is to be a nexus for communication, collaboration, and resources for work in climate change and AI with the understanding that the important work in this space is being done by individuals across many institutions, universities, companies, startups, public organizations, and we hope to facilitate that work and also to facilitate communication and collaboration between those different stakeholders and different people who are meaningfully contributing to this, to this area and can meaningfully contribute.

CRAIG: 00:13:12 Yeah. And, how do I envision that? I mean, is there, will there be indexes by domain or by problem, you know, energy or?

DAVID: 00:13:22 Short answer, yes. Both to that specific thing and to many other tools for, for working in this space.

PRIYA: 00:13:29 Yeah. So, for example, we're currently working on an online collaboration platform where we hope that people from many different domains, machine learning and also domains relevant to climate change, can come together and brainstorm ideas about what projects they may want to work on or share knowledge about things they have been working on or share tips and tricks about data sets or platforms or considerations that one should be thinking about when working in a particular domain. and so, we are working on a variety of things that bring this sort of online collaboration possibility to the fore as well as the in-person meetups that we were talking about. as well as this index of recommendations, etc. And we're hoping that taking this kind of multifaceted approach gives many points of entry for many different kinds of people and allows there to be a very fluid and active community that's thinking about these problems.

CRAIG: 00:14:22 Yeah. Would there also be an index of existing projects? Uh, because I don't know that there exists a catalog of …

DAVID: 00:14:29 Well to some extent, this is provided by our paper.

CRAIG: 00:14:32 Yeah, yeah. The 700 references in the paper. A lot of that is referring to ongoing projects.

PRIYA: 00:14:39 Absolutely. And in addition, we, in crafting the paper talked to a large number of domain experts in these different areas to try to get a sense of not only the ongoing projects but the broader considerations and sort of mental models that people should have in these various areas. And, and these folks that we talked to also represent some really great thinkers in these fields.

DAVID: 00:15:02 It's very hard coming in from one field and trying to work out what the important problems are in a completely different field. And so, we were endeavoring to distill the recommendations of those who have thought about these problems for a long time rather than come up a priori with something which was our conception of what was impactful rather than what was tried and true. open problems or impactful problems within the individual disciplines.

CRAIG: 00:15:26 Another question is how are you funded currently and will the platform bring together funding resources, grants and that sort of thing that people can apply for?

DAVID: 00:15:38 Stay tuned

PRIYA: 00:15:40 The collaboration platform that we're envisioning is going to be largely user contributed content. we additionally do have a mailing list which is still user contributed content but which is curated. we've sent out one newsletter so far. The second one is upcoming. as of this podcast, hopefully there will be a couple more. There we uh, advertise kind of opportunities that we've become aware of in terms of jobs, in terms of grants, in terms of all this kind of stuff. So yes, hopefully, given information about things we hope to disseminate it and make it available to everybody.

CRAIG: 00:16:09 Currently you're just volunteering your time and everyone is, it's a, it's a volunteer organization.

DAVID: 00:16:15 Everyone has positions at other institutions. We are a mixture of academics and industry leaders within the field of machine learning. And we are, yes, volunteering our time to do something that we think is very important.

CRAIG: 00:16:33 Can we talk about how you see the organization developing? I mean presumably there will be funding from somewhere. there are a lot of people that are interested in the issues.

DAVID: 00:16:45 If you're listening to this and you would like to give us a few billion dollars, we won't say no, that would certainly be nice. Moving forward, we'll see how that goes. But certainly, there has been a very enthusiastic response from many different sectors and quarters as it relates to investing in, in this kind of work.

CRAIG: 00:17:06 Yeah. Both in dollars and as well as in making tools and platforms and products available?

DAVID: 00:17:11 Yes.

MUSIC: INTERLUDE

CRAIG: 00:17:20 Can we talk about the paper, kind of what the top line conclusions were and then is there a way to categorize the recommendations?

DAVID: 00:17:32 Many people ask what is the top recommendation for impacting climate change using machine learning and we hesitate to give a top recommendation because there are so many and all of them are so important and no one application is going to solve climate change even if perfectly executed.

PRIYA: 00:17:52 There are a couple of cross cutting themes certainly that come up in the paper. So, one of these is materials discovery, so discovering new materials that will allow us to do things like capture energy from the sun and turn it into liquid fuels that can then be used in transportation or various other things. or creating alternatives to cement where cement is a very carbon-intensive material, to creating more efficient carbon dioxide sorbents which are basically like sponges for carbon dioxide when you try to suck it out of the air. and to discovery new [sorbents](https://en.wikipedia.org/wiki/Sorbent) would help to allow us to do carbon capture more efficiently. So, there are a variety of ways that we outline where machine learning can help with the materials discovery process and also in characterizing existing materials. So that was definitely one theme that came up throughout our paper. I don't know. David, do you have other applications you'd like to mention?

DAVID: 00:18:43 Another recurring theme that represents in some sense low hanging fruit for machine learning practitioners is remote sensing, detecting things and labeling things from satellite or aerial imagery. So, there are many different applications of remote sensing that are relevant to climate change from marking the locations of solar panels and wind turbines, which we don't actually know the locations of in many cases, to detecting methane emissions, using hyperspectral imagery to pinpointing where deforestation is happening so that laws can be enforced. There are many different applications, in a lot of cases, and this is another recurring theme, we see machine learning being used somewhat paradoxically to gather data for decision makers and for other kinds of practitioners, and research where there is data in one modality, so satellite imagery, but we really need to know the heights of buildings in parts of the world where urban planning is not written down. And the way to do that can be to use machine learning to use one kind of data as a proxy for another kind of data that can be useful.

CRAIG: 00:19:59 Yeah. Which that raises a question about the sort of collaborative platform again. So much of this is going to depend on having the correct data sets. Is there some sort of way through Climate Change AI to identify data sets that could be useful?

DAVID: 00:20:16 We have listed on our website a number of data sets that are already publicly available for work in these problems. However, we would emphasize that just having access to the data is not enough. If you are looking to get your hands dirty working on some of these problems, you really need to be collaborating, if you are a machine learning practitioner, with those who understand this particular domain. Having the data is necessary in some cases, but not sufficient.

PRIYA: 00:20:43 Absolutely. And I think this is a little bit of a maybe change in the way that machine learning is traditionally thought about or done where in machine learning, or deep learning in particular, we would have some kind of data set or benchmark, like [ImageNet](http://www.image-net.org/), that the community works on to try to improve their performance on. Whereas, in real world settings, including many climate change settings, the data is less well specified or the problem is potentially not as well specified. and you might have things like the physics of your system that comes into play. Like if you have an electricity system there are just simply certain physical laws that your solution has to obey, otherwise the system collapses. And so, these additional considerations come into play and may or may not be entirely captured within a data set that is simply posted somewhere. So, I think a lot of impactful applications here will really, really require conversations that extend beyond simply what is the data.

DAVID: 00:21:40 And we can think of that as requiring deep innovation machine learning because in many situations gray box models are cutting edge, models that incorporate some amount of domain knowledge as well as machine learning algorithms that try to solve a problem, de novo.

CRAIG: 00:21:57 So the paper is organized by domain or by category of climate change inputs or source. I mean there is land use and transportation and industrial heat and all these different things that add up. Uh, is it organized at all in that way?

PRIYA: 00:22:17 Yes, absolutely. So, there are two parts to the way the paper is organized. The first part of the paper is about climate change mitigation. So how do we actually reduce the extent to which climate change occurs? and then the second part is about climate change adaptation. So how can society adapt or adjust to the effects of climate change that do end up occurring?

DAVID: 00:22:38 And we also describe [meta tools](http://weblog.tetradian.com/2015/01/25/tools-and-metatools/) which we see as being useful across both mitigation and adaptation. So, tools, for example, for helping society, helping individuals or collectives to act in ways that they want to act.

PRIYA: 00:22:57 Within the mitigation portion, we've covered sectors including electricity systems, transportation, buildings, farms and forests and CO2 capture. And, in the adaptation section we've covered things like climate prediction or climate modeling, societal impacts of climate change, adaptation and solar geoengineering. And then the …

DAVID: 00:23:19 And then in the meta tools section we’ve covered tools whereby machine learning can help individuals to achieve their personal climate impact goals. tools for helping society to make collective decisions. For example, tools for helping education systems using machine learning tools, for example, for personalized learning and also tools for climate relevant finance. So, helping markets to assess what investments are positive or negative for climate change and also to help determine the impacts of climate change on different investments. To essentially concretize the financial aspect of the climate crisis.

PRIYA: 00:24:08 To basically help companies and decision makers within companies take climate impacts and these kinds of risks into account in ways that they may not be doing yet but likely should be even from just a profit perspective.

DAVID: 00:24:20 Clearly, that is a theme throughout many of our application areas - that we are not just looking at optimizing your systems to where it uses less energy. We are also looking at providing tools for those who can make decisions to make better decisions and to make decisions with all the information which can be useful. So, machine learning is really one of many pieces of the puzzle here. One needs to work both with the people who are working in these different domains and those who are making decisions based on the data.

CRAIG: 00:24:59 Is there a talk of optimizing a [carbon credit system](https://www.conserve-energy-future.com/carbon-credits.php) finally? I mean, there’ve been all these small projects.

PRIYA: 00:25:05 So there's certainly, I think, a lot of proposals as to how exactly we deal with carbon pricing for example, or internalizing the effect of carbon dioxide and greenhouse gases into our financial system. In our paper, though, we've definitely focused on applications where we thought machine learning could provide some kind of leverage or some kind of insight that that helps in financial conversations. And those are the applications that David highlighted earlier.

CRAIG: 00:25:32 To decide whether machine learning could be applied - there's so many different branches of machine learning. Is this primarily deep learning?

DAVID: 00:25:41 Certainly not. It definitely includes deep learning and deep learning has been used in many of the applications we highlight. But we are concerning ourselves with all kinds of classical and cutting-edge machine learning.

CRAIG: 00:25:54 So how do you come up with, how do you decide which machine learning discipline would apply to this particular problem? Some are obvious: computer vision for scanning satellite imagery.

PRIYA: 00:26:06 Yeah, so I mean I think in most cases to figure out in some sense like the match of the machine learning tool or technique to the specific application. We sort of looked at what is the specific problem that needs solving in this domain? What kinds of questions would we generally ask when solving that problem and what kinds of machine learning tools tend to address these types of problems? So, this is both when we were figuring out sort of broader themes that were cross-cutting within sections or throughout the paper. And then of course we were looking at prior literature about what people had done in this area. That said, people certainly think of creative ways to apply machine learning to other domains or to frame problems in ways that we wouldn't have thought about that then make it clear that, ‘Oh yes, maybe this other machine learning method would have been a great fit.’ And so, this is where we really view our paper as a starting point where we tried to interface with a lot of domain experts and have conversations with machine learning folks and really try to think of some initial starting points that we really do hope that it's a jumping off point and that people really can use it to come up with really creative ways to apply machine learning to, to useful problems.

CRAIG: 00:27:12 Having been so deeply involved in the paper, having done research and written yourselves and having spoken to such a wide variety of people, do you have a sense of how big a role machine learning can play in both mitigation and adaptation? Is it potentially the critical factor in getting things done by the times that we want things to be done?

DAVID: 00:27:37 So there isn't a single critical factor. Certainly, machine learning is not going to be the magic bullet that solves everything. However, it is an accelerator of those technologies which are impactful. So, to the extent that many technological paths forward exist, machine learning can potentially work to supplement them.

PRIYA: 00:28:04 And this is where we hope that one of the things that we hope comes about because of our paper is not just people in the machine learning community working on climate change, but also we hope that other fields that have potentially something to contribute to helping address climate change also sit down and also go through this exercise of figuring out exactly what the best way to do that is and to bring about concerted efforts in other areas. Because it will take a variety of technical domains. It will take a variety of climate change domains. It's one of those issues where it can be dizzying in some sense the number of different points of entry. But this also does serve as an opportunity for a lot of people to get involved in and really contribute to the solutions.

DAVID: 00:28:44 It will take all hands on deck to make any kind of impact at the scale that we need. Machine learning is exceptionally powerful as a tool, but there are many other tools.

CRAIG: 00:28:54 I was talking to [John Platt](https://podcasts.apple.com/us/podcast/episode-20-john-platt/id1438378439?i=1000445785908) and that was his point too, at the end of our conversation is ultimately it comes down to human decision making. You know, the machines aren't going to make the decisions for us.

DAVID: 00:29:03 And climate change is a legitimately hard problem, partly because it does require society to make some sacrifices. Machine learning is not going to make it suddenly easy to fix climate change or mean that we can solve climate change without some costs. Now that cost is significantly less than the cost we will have to pay if we don't do anything. That said there are tradeoffs, which are fundamental.

PRIYA: 00:29:31 Yeah. And maybe just put it in a slightly different way: basically, climate change is an area of riddled with value judgments and fundamentally we will need to make these value judgments.

DAVID: And that requires a conversation as a society, not just machine learning scientists.

CRAIG: 00:29:46 Which is what makes it difficult as you've got multiple societies, different political systems. Again, going back to the specifics of the paper; so, you've got the mitigation piece, the adaptation piece …

CRAIG: 00:30:00 In, in either mitigation or adaptation, is there one area that people tend to focus on, whether it's electricity generation or, or land use or whatever it might be. Could you see that people are coalescing around a couple of big themes?

PRIYA: 00:30:25 So historically there has been a lot of interest in how to apply machine learning to the electricity sector. Not necessarily just for things that are directly related to climate change mitigation, but in general, electricity systems in a lot of places have a lot of data, a lot of decisions that need to be made on multiple timescales. But I think one of the really exciting things for me about working on our paper is that even though there are some of these areas that have gotten more attention in the past, other areas that are as important are, are also places where machine learning can make a dent. So, electricity systems contribute about a quarter of greenhouse gas emissions each year, but so does agriculture and land use. And as a result, presumably we should be focusing on both of these areas. And so, there's really a lot of different ways to make an impact. And the hope would be that people would, would really pay attention to many aspects of the problem.

DAVID: 00:31:18 Likewise, people often don't think of machine learning being used for adaptation, helping societies be resilient to those impacts of climate change that are inevitable. Whereas there are myriad applications where machine learning can be used to provide data that is meaningful for decisions like providing flood maps. And also, to help design those systems that are more robust, say to extreme events, to detect faults where they may occur and where they have occurred in infrastructure. And to model those aspects of society that are potentially going to be affected seriously by the climate crisis.

CRAIG: 00:32:02 Yeah. So, there'll be another workshop. How do you see this evolving? I mean without staking your flag in anything. I mean will this evolve for example, into a separate conference series, do you think or into uh, an organization that's staffed and, and managing communications globally? Uh, or do you think it will remain at the level of a platform? Uh, and most of the work will be taking place in discreet institutes in different cities.

DAVID: 00:32:32 We would be very happy to see larger initiatives forming around these overall themes including our own organization. But fundamentally this is a dialogue that has to happen at multiple levels and the impacts will not be achieved just by having conferences in more places or institutes in more places - though we would like that. And in particular, we would like to make sure that we have physical gatherings in many, many parts of the world since we have so far been limited to North America. And we are planning gatherings on other continents. But there will be huge impacts from the engineers who decide that their system can be made more efficient using machine learning and reach out to people through our platform or through other, through other means to find those who can help them to make a better system or to the mayors who decided that their city can be made more resilient by recourse to some of the data that researchers are providing in universities halfway across the world. And those kinds of organic collaborations and a medium scale actions are what will ultimately have the most impact moving forward in the space of climate change and machine learning.

CRAIG: 00:33:49 What sort of international uptake have you seen? I mean, how international has the response been?

PRIYA: 00:33:53 Yeah. So, I would say that people from different countries have signed up for our mailing list or have expressed interest in our initiative or have submitted to our workshop. Our workshops so far have been in, have been or will be in, in North America. And so, I think that ideally, we would somehow expand our presence in other places in order to make the movement more accessible to people everywhere. Because, as David alluded to earlier, I mean, climate change affects everybody and we need input from everybody on this issue. And there's a lot of value I think, in making sure that there is a truly global presence here.

CRAIG: 00:34:26 Yeah. Is there talk of government outreach, or outreach to governments around the world, for educational purposes? If not …

DAVID: 00:34:36 We're working on it, yes. For reference, our past workshop at ICML, we did have submissions from 19 different countries and five continents.

MUSIC: INTERLUDE

CRAIG: 00:34:50 You guys are much younger than me. Are you optimistic? I asked John Platt this question. He said, “well, I'm determined.”

PRIYA: 00:35:00 Yeah. I, I think I'm in that boat. I think that there is a lot that we can and should be doing and, in some sense, our only choice is to act. Both in terms of climate change mitigation, right, as I said, reducing the extent of climate change, but also thinking about, given any climate change that will occur, what can we as a society do to adapt to that? Many people think about climate change as something that happens and then once it happens, that's it. I think I'm with John on this. What we're more focused on, let's see what we can do, than anything else.

DAVID: 00:49:00 I would second what Priya said, we really have a choice how, how far this goes. Climate change is not an on-off switch. And people ask is it too late? Well, ultimately, yes, it is too late to avoid pretty significant consequences, but there are different levels of bad and we can work to make sure that this is as little bad as possible -- and humanity when it decides to act is pretty good at acting.

PRIYA: 00:49:41 And I think when we act, I think we have to be very conscious of the fact that the impact on different parts of the world are going to be relatively disparate. And so, making sure that we really take not just maybe the perspective of the place that we're in into account, but really think about this globally and equitably. And ensure that the actions we take are significant enough to create good outcomes for, for everybody, not just some subset.

CRAIG: 00:36:20 Can we talk about the roadmap for action? Presumably nearly everybody in the machine learning community writ large, I mean everybody from undergraduate students who are entrepreneurs who have $100 million companies or more, are interested in addressing the problem. Is the hope that this will become a movement so that you could say that half of all people in the machine learning community are contributing in some way to this initiative. Do you have any, any sense of how wide or deep the penetration could be on something like this? Looking at past organization sees other organizations that you mentioned?

PRIYA: 00:37:07 I think it's of course hard to predict necessarily what proportion of the machine learning community will take this up. But we really do hope it is a large number of people who are either thinking about how they can use their career or job or position to help climate change or rather help address the problems of climate change. And so, our paper, for example, largely focused on how machine learning tools can help address the problems of climate change. But I think there are other ways as well in which machine learning people in their roles as you know, citizens and their roles as humans can help contribute to climate change solutions outside of these tools. So, we hope that we've helped start a conversation within the community, not just about how machine learning tools can help with climate change, that we hope that is of course a huge thing that happens, but also generally what people can be doing to help with the issue.

DAVID: 00:37:59 Anxiety can be a powerful motivator. We hope that it motivates people to work on the most impactful ways forward.

PRIYA: 00:38:08 Absolutely. And research has gone on in the [Engineering and Public Policy Department](https://www.cmu.edu/epp/), one of the departments I'm affiliated with, that talks about public perceptions of traditional air pollution versus carbon dioxide and greenhouse gas emissions. and with conventional air pollution, it can be in the air, but once you decide to stop emitting it, the air is clean. And there's a proportion of the population who have a similar mental model regarding carbon dioxide, feeling that if we stop emitting carbon dioxide, climate change stops. But of course, that's not how it works. Carbon dioxide hangs around for decades, centuries and contributes to climate change over a longer scale. So, while I do hope, the phenomena that you're mentioning does occur, I think it will take a lot of thought up front and figuring out ways to induce action ahead of time, simply because the effects of carbon dioxide do hang around for much longer.

DAVID: 00:38:59 Climate change is like piloting a boat where you turn the tiller and you think, oh, nothing happened. And you turn the tiller some more, and then about a minute later, you realize that you're driving straight into the rocks because everything happens with a delay. And once you realize where you're going, it can be too late to change course.

DAVID: 00:39:15 So our roadmap for action can be summarized as learn, collaborate, listen and deploy. First of all, learn about the problems involved in climate change. Climate change is not just one problem, it's a multitude of different problems and there are a multitude of different solutions associated with those different problems. Our paper is one set of recommendations for what can be achieved in these many different problems. But there is a lot of background reading that we point to, in some cases, and that could be helpful in helping someone new to the area understand what there is to do and why it's a problem. Second, find collaborators and, and work with people who really understand the problems involved for every problem and way to have an impact on climate change. There are people who have spent their careers working on that problem and understanding why it's hard.

DAVID: 00:40:08 By working with them, you can make sure that what you are doing is truly impactful. Listening to what they have to say. There are many problems that seem to be problems if one's coming from another area. But aren't actually the bottlenecks that are holding back progress. Also, sometimes machine learning is not necessarily for solving a problem. Sometimes [linear regression](https://en.wikipedia.org/wiki/Linear_regression) will do the trick and finally make sure that your work is deployed where people will actually use it. There are too many great research ideas that languish in journals or conferences and aren't actually used in practice. In many cases being used in practice will mean working with a range of different stakeholders, whether they are decision makers who can use the data that you are creating or companies that can leverage the techniques that you are providing. Sometimes you will have to start your own startup and generally there will be a multitude of different people you need to talk to. But definitely don't just stop at a great idea. One needs to see it all the way through. So, learn, collaborate, listen and deploy.

MUSIC: INTERLUDE

CRAIG: 00:41:25 You had mentioned that the paper surfaces a lot of commercial opportunities, and that you were hoping there would be some entrepreneurial activity. What kinds of things were you referring to?

PRIYA: 00:41:38 Yeah, so I think one example here is forecasting of electricity generation and demand. This is an area that has been explored quite a bit, for example, using statistical techniques and machine learning. And I think while there are still fundamental research challenges there, things like how to better quantify the uncertainty of your forecasts or make sure that uh, if they can integrate physical models or physical assumptions, this kind of gray box machine learning concept of using domain expertise. Like these are all fundamental ways I think in which the research community can help with forecasting. But that said, there are some really good forecasting models available, some that already exist within the electricity system sector and some time series modeling approaches that exist in other places that haven't yet been brought to the electricity sector. And I think there's definitely, for example, a market to help electricity generators optimize profits or help electricity system operators better balance their electricity systems. That is already something that machine learning can commercially provide.

DAVID: 00:42:41 There are examples in every one of our application domains, solutions, paths forward, that really can be monetized within existing market forces. Some of course cannot be, but in many cases, there is a market for more efficient systems, a market for systems that reduce climate impacts for the benefit of society.

CRAIG: 00:43:10 Are you building bridges to these other initiatives that we talked about? And to accelerators or, or different competitions, to make them more climate focused.

PRIYA: 00:43:18 Yeah, I think that's certainly the goal. But in terms of specifics, again, stay tuned.

CRAIG: 00:43:24 Yeah, yeah. There is a talk about doing a series of competitions under the Climate Change AI rubric?

DAVID: 00:43:32 Yes. But competitions are only one way to mobilize the community and probably in terms of direct impact, they are not the most effective way.

PRIYA: Yeah. I think that a lot of our applications require some kind of long-term engagement. Or long-term impact as opposed to maybe thinking that a problem will be solved over the course of a week or 48 hours.

DAVID: We would stress, all of these applications are accessible and that anyone can get their hands dirty and start working on them. But in order to have an impact, you should expect to be working on them for a while. They are open, but they are difficult.

CRAIG: 00:44:05 Are you getting a lot of people contacting you?

DAVID: 00:44:06 Yes.

PRIYA: They are reaching out from a variety of different domains, from a variety of different sets of expertise and I think it just gives us more and more context about what exactly are the bottlenecks to really doing impactful work at this intersection of climate change and machine learning. And one thing it would be great to say, to those listening: this is a really important area. This is a really exciting area. So, learning about this area is of course the first step, but acting is the most important step. So please do get involved. Please feel free to engage with our initiatives at ClimateChange.AI.

CRAIG: 00:44:42 Yeah, all hands on deck.

PRIYA: All hands on deck.

DAVID: 00:44:48 And explore how you can best use your skills to engage with climate change regardless of whether it's through machine learning. We hope that everybody will use their particular skills to make a difference.

PRIYA: 00:44:59 And it's been really awesome to see that, even though machine learning and electricity systems is how I started to tackle the climate change issue, that through this paper there have just been so many other domains and other ways in which machine learning can help. And so, I'm excited to also try working in some of these other areas as well.

DAVID: 00:45:15 I think everyone's goal is to work out how to have the maximum leverage using the skills that they have at this particular point, what was called for was to enable work across domains by leveraging skills in machine learning, by leveraging expertise in machine learning. The field needed a call to action. There will be other calls to action, which are called for, but every situation requires a different kind of impact. And in another situation, the best thing to do might be to work very hard on solar panels or to work very hard trying to persuade your boss to make your company do something different strategically. So not everyone needs to write a paper. People are called upon to do different things at different times.

PRIYA: 00:46:16 Yeah. I think, when the paper was conceived and written, that was certainly a gap as David mentioned and something that had to be done. But of course, the, the reason that we wrote the paper and the, the reason really that we should be thinking about this issue is fundamentally people have to also do the work, do the things that mitigate carbon dioxide emissions and other things that help us adapt to, to climate change. And so …

DAVID: And we are ourselves are not just providing recommendations. We are also going to be working through some of our own recommendations in the coming months and years. It's a lot easier to say what people should do than it is to actually do it. We need to actually do it. All of us.

CRAIG: That’s it for this week’s podcast. I want to thank David and Priya for their time and I encourage all of you listening to get involved in some capacity. There is no problem more urgent, no need so deep. If you want to learn more about this global effort, visit climatechange.ai. To download a transcript of this episode, visit our website, eye-on.ai.

The singularity may not be near, but AI is about to change your world. Pay attention.