The first WorldCanvass program of 2019, Artificial Intelligence, featured an exceptional group of UI faculty and industry leaders in the fields of engineering, technology, education, medicine, and business.

Joan Kjaer: Hello, and welcome to WorldCanvass from International Programs at the University of Iowa. I'm Joan Kjaer, and we're coming to you from MERGE in downtown Iowa City.

Joan Kjaer: Our topic tonight is artificial intelligence and, in this segment, we're going to explore advances in medicine that are made possible by AI.

Joan Kjaer: Just next to me is Dr. Michael Abramoff, Watzke Professor of Ophthalmology and Visual Sciences and of Electrical and Computer Engineering and Biomedical Engineering in the UI Department of Ophthalmology and Visual Sciences. Dr. Abramoff is also the Founder and CEO of IDx, and we'll we'll have a chance to talk about that in just a bit. Thank you for being here.

M. Abramoff: Thank you.

Joan Kjaer: Mm-hmm (affirmative). Next to him is Dr. Eric Hoffman, professor in the UI Departments of Radiology, Internal Medicine, and Biomedical Engineering, also the director of the Advanced Pulmonary Physiognomic Imaging Laboratory. Thanks for being here, Dr. Hoffman. Mm-hmm (affirmative).

Joan Kjaer: And to the far end, you remember Nick Street? He was in our first segment. He's with the College of Business, but I've come to understand that he's also the head of Health Informatics here at the University of Iowa, so it's a pleasure to have you join us, thanks.

Nick Street: I'm never leaving.

Joan Kjaer: So Michael, could you help us understand what diabetic retinopathy is and why the search for better diagnostic devices has been such an important part of your life?

M. Abramoff: Yeah, sure. As far as my background is concerned, this’ll be relevant later, so let me go a little bit into that.

Joan Kjaer: Mm-hmm (affirmative).

M. Abramoff: I'm a retinal specialist, meaning I treat patients with diseases of the retina. I actually just came from clinic just now. I had clinic today. But I also have a background and a PhD in computer science. And we used to call it image analysis, and now using machine learning, we call it artificial intelligence. But there's a longer background to that. So I wanted to combine these two to do better in medicine and better treat and diagnose patients. And so that's where that interest comes from because retina is my field, and diabetic retinopathy happens to be the most important cause of blindness. It's a complication of diabetes that if you have diabetes, you know, most people with diabetes fear nothing more than going blind. And so it's really important for people with diabetes. It causes blindness in about 25,000 people a year in the US alone, many more lose vision as a cause of that. And so prevention is really important.

M. Abramoff: The problem is that if you catch it early, we really know how to treat it well. We can treat about 95%, we can treat it well if we detect it early, and then vision loss is unlikely. However, if you catch it late and there's already symptoms, typically it's too late and there's permanent damage. So the trick is to catch these patients early, and the problem is that that is not happening in a large enough scale. There are about 30 million people with diabetes in the US, and 500 million around the world. And most of them do not get an eye exam every year, which is necessary to determine whether the disease is in the retina or not. If there is, then you will treat them.

M. Abramoff: So, I said, "Well, let's use artificial intelligence with an easy to use camera to make the situation better." And I've been doing research on that for maybe 30 years working on neuroscience and how, we already talked about it, how neural networks work. And later incorporating into machine learning systems to detect disease in the retina.

M. Abramoff: About in 2000, I thought, well, it actually works. I showed it in scientific conferences and nothing happened. And then I realized, well, maybe I need to do many more scientific publications which is over 200 now about this same and similar subjects. And I thought, well if we do all these publications, it will happen and people start using it. Nothing happened. And so then I heard if you do intellectual property and you go for patent and you register your patents, then big companies will come in and take over and actually make it happen. I did that, and now I have 13 patents and nothing happened.

M. Abramoff: So, long story short, I needed to do it all myself, and therefore, I founded IDx now nine years ago here in Iowa City. I came to the US now 16 years ago. That was the best decision of my life, except for marrying my wife. If my wife's in the audience. Just to make sure. And so that meant two things, I think. Raising money, and we can go into that if you want, and second of all, I really care about safety. I think the potential benefits of AI in healthcare are enormous. Cost savings, improved quality, better access for patients and more easy access, but if we do it wrong, you get what is still happening in self-driving cars where last year, there was an accident and someone died. And many companies pulled back temporarily, but it can set it back for years.

M. Abramoff: And so if we focus on safety, transparency, that's the only way to do this. So I thought early on, if you want to do this you need to be safe and show that you're safe. So I went to the FDA because that's the regulatory body that is the most strict in the world, and I came in, and I said, "Well, I want to do this autonomous AI," meaning, an artificial intelligence that makes a clinical decision by itself, no doctor involved. And they weren't too happy with that idea. And so we slowly started working together on how to do it safely and also ... Which was interesting. I've been saying this for a while now. It needs to be safe, it needs to be efficient to do the cost savings. And it needs to be equitable, meaning, useful and accurate for all people from all races and ethnicities.

M. Abramoff: And actually, the FDA agreed with that, and we created end points for the study and all sorts of things about the design, and that resulted in FDA authorization last year, April. And that was a big moment because the first time ever that FDA approved something that makes a clinical decision without a doctor or any human involved. So long story short-

Joan Kjaer: Beautiful. Yeah.

M. Abramoff: ... we're there, we did it with the entire team of IDx, which is now 50 people all in Iowa, right?

Joan Kjaer: Mm-hmm (affirmative).

M. Abramoff: Like, the entire organization is now rapidly growing in Iowa. And so we have a pipeline in other things we want to do in the retina, in the ear, in organs, so there's a whole thing to do with this autonomous AI, but again, we have been hammering so hard and keep hammering on the safety aspect, efficiency, and equity. I'll stop here because of-

Joan Kjaer: Oh, no, no. Fascinating… but one of the wonderful advantages here, as I understand, it is that you don't have to have an actual licensed physician interpret the results.

M. Abramoff: No. Exactly. And so how in practice is that in a CVS or Walgreens or primary care clinic, typically where people with diabetes are, they don't walk around in the hospital waiting for me. You know, they will probably need to travel four hours and wait maybe three months to get to me. So where they are is where they get the diabetes care, which is typically primary care clinics. And so you need to have the staff there be able to do it. So we made sure that it's a high school graduation, the only thing required to do this exam. And then it takes about 2 x 1 feet to do this. So it's a very small space, it's easy to use. And it's immediate, so when you come in for your diabetes workup, your vitals and talking to the doctor that you shouldn't smoke and you need to lose weight, you need to eat more veggies. And everyone knows this story, but that's what diabetics patients typically need to hear.

M. Abramoff: So, right then and there, they have this retinal exam done in two minutes, few minutes. And the diagnostic quality is better than me as a retinal specialist, so you have the access, you lower the cost because definitely it's way cheaper than me. I mean, you don’t want to know what I charge for if you just come to see me for a few minutes. Like I said, it's more efficient, and the quality's better. So suddenly, you change the entire paradigm of primary care where it used to be they need to refer anything out that you can't do to a specialist like me. But now the more we use AI, the more they can do right then and there. Sort of superpowering these primary care docs.

Joan Kjaer: Fantastic. I know that the company has now--you've searched for funding, you've gotten quite a lot of funding to pursue, I guess, the creation of these. Now that you've developed this, the FDA has approved it, you know that it works well. What happens next in terms of the business?

M. Abramoff: Yeah. So, I or as a group, we've raised 22 million dollars from angel investors. And then with that we created the clinical trial and the product and the entire company. With that, we got FDA authorization. And then we raised another 33 million to essentially go to market and create additional products.

M. Abramoff: And so what we focus on now is just getting it to as many patients as soon as we can. We're doing well on that. I mean, about every week, every other week, we have a new go live, which means some primary care system in some hospital system is starting to use it. Last week, we were in New Orleans. That was very exciting because it's a very impoverished and underserved population. And so that was very exciting for them to suddenly have this AI make the diagnosis. Patients are very excited, staff is very excited. It was just very exciting time in a company.

Joan Kjaer: Must be incredibly rewarding personally knowing that you've been able to get it this far.

M. Abramoff: Yeah. It's very cool. If you see retinal patients, if you see these primary care providers where they didn't know what to do with all these people with diabetes who needed an eye exam and suddenly it's solved for them, that's very wonderful. I also yesterday learned that of the foremost hundred AI companies in the world, one of them is us, so that ... You know, you get stuff like that, it's very nice. You know?

Joan Kjaer: Yeah. Very nice. Well, congratulations. My goodness. We may be able to hear more about it later, so thank you. Thank you.

M. Abramoff: Sure.

Joan Kjaer: Dr Hoffman, hi, Eric.

Eric Hoffman: Hi.

Joan Kjaer: So you are in radiology and internal medicine, biomedical engineering, and I know that you also head up the imaging laboratory for lung care. Tell us how artificial intelligence has made a change in the way you examine patients and what you can tell patients.

Eric Hoffman: We work with advanced, mostly CT x-ray techniques, and CT has evolved to where we can image the lung with submillimeter spacial resolution dynamically, so it means that when you do a CT exam, you get possibly as many as 600 to thousands of slices of the body. And then if you have dynamically multiple lung volumes, it reaches a point where a human can't just look at it and make a reasonable diagnosis or reasonable estimates of the underlying physiology or anatomy.

Eric Hoffman: So I got my start in the mid-1970s at the Mayo Clinic where when [inaudible 00:37:28] was trying to build a scanner that made a single slice of the dead brain, we were trying to image the beating heart and breathing lung. And back then, we'd scan for 20 seconds and take two months to reconstruct the images and take another half a year to analyze the images. That brought about some understandings, but it was very slow progress. But over the years, as the scanners become faster, the detectors become more efficient, the computers are able to compute more efficiently that we're able to get the computers to identify where the lung is, where the lobes are, or the sublobar segments are, where the airways are, where the blood vessels are.

Eric Hoffman: With all that information, we can begin to subdivide lung disease that's been classified as a single entity such as COPD, chronic obstructive pulmonary disease, or asthma, we can sub-classify them into disease patterns. And there's possibly been miracle pharmaceuticals to cure a lung disease that would have gone hidden because it's applied to everybody that's labeled COPD, and they're labeled COPD simply on the basis of how fast they can blow in a tube. And maybe the drug worked perfectly in one group of people, but it was tried out in a much larger group of people and the advances were very slow.

Eric Hoffman: So, we've turned software into a company, similar to, you just heard about the eye, we have VIDA Diagnostics. That's a company here in Coralville that is able to automatically pull out all these components of the lung and label the airways and so forth. And then it's been applied in many large multicenter trials trying to sub-phenotype or sub-characterize these lung diseases. And what we're finding is that, indeed, there are very different patterns of everybody that's been lumped together in a single entity. For instance, we're finding there's a couple of variances in the pattern of the airways branching in the lung, and those are much more prominent in people that get COPD. And in fact, much more prominent in people that get COPD that never smoked. So we think that it's almost a fingerprint of the lung that says that the lung developed in such a way that possibly at the very periphery of the lung it may be abnormal, the same as the central airway trees that we can see. And if it's abnormal all the way out there that perhaps the lung is trapping inhaled particulate differently than another lung.

Eric Hoffman: Then there's new CT scanners that can image where a gas that shows up under x-ray, Xenon or Krypton, it can image regional ventilation or you can inject iodine, it can image blood flow. And so we're finding that there's a group of people that have an abnormal response to inflammation. You smoke, you get regional inflammation, and if you have regional inflammation, you flood the air spaces in the lung and you get what's called hypoxia, low oxygen. And the lung's designed that if you have low oxygen to shut down blood flow and send it where there's better oxygen. But if you have low oxygen because your lung's inflamed that you then don't want to shut down the blood flow that a certain portion of the population shuts down the blood flow. And if they smoke or if they breathe environmental pollutants or whatever, they'll be the ones that get inflammation. So, having or getting COPD. So having that sort of an insight, you can develop pharmaceuticals that will resolve this constricted blood vessel.

Eric Hoffman: These are all examples of things that artificial intelligence is able to allow us to resolve now. The image reconstructions from the CT scanners that are very high resolution couldn't have been done before that in the mid-1970s with the machine we built at Mayo, we get, again, 20 seconds worth of scanning, and two months later we'd have the image. And to get these insights, it takes imaging lots of people, so you can't image one person and analyze them a month later, the new computers almost give instantaneous reconstruction of the images, and then the software, in minutes, will segment and separate out the components of the lung. And that any individual with all those component extracted we spit out over a thousand different measurements of the lung. And then you can look at the texture of the lung that Nick has been involved with us on some of this that the computer can look at the multiple different texture of the lung and separate out which bit is emphysema-like, which bit is fibrotic, which bit has abnormal patterns of blood vessels or blood flow and so forth.

Eric Hoffman: And then with these large multicenter studies coming online using these imaging methodologies and using this analysis methodology, we bring to Iowa City tens of thousands of CT scans in a year and analyze these people. And then we follow them over multiple years, we have one study that we've studied people for over 15 years now. And every few years, we get CT scans. And so that opens up this new avenue of big data and deep learning to throw in these images with the diagnosis, and the computer can now separate out people into groupings that we never even dreamed of.

Eric Hoffman: We found in one study six different types of emphysema based on the pattern of the emphysema, and two of them are highly correlated with genetic variance. And then looking at what those genes do, it tells us what might have caused the emphysema in those cases, and it informs the pharmaceutical companies to understand it.

Joan Kjaer: One of the things that has become clear to me as you've described all of this is that there really is an interactive team. There's the work that you might do, there's the computer analyst group that's involved in this, there are the pharmaceutical investigators. And in order to move things to the next level, everybody kind of has to be familiar with what the other one is doing.

Eric Hoffman: That's become popular these days to talk about team science but we would have never been able to do anything we do without a team all the way back to the beginning of what we do. It's electrical engineers, bioengineers, mechanical engineers, pulmonologist, radiologist, surgeons, pathologists, et cetera, that they're all an important member of the team.

Joan Kjaer: Wow. Let's go to one of the members of the team here and talk to Nick for a second. Nick, you head up health informatics here. Could you just describe what health informatics is in context of the university?

Nick Street: The big picture is just computing applied to healthcare. I bring the AI machine learning sort of background. And so our people and our students can serve as the person developing that part of the system, but in your next segment, you'll have a human computer interaction expert, and that's an important part.

Nick Street: The app is no good if nobody uses it. Anything that actually uses people and computing to build a better system to deliver something, which in this case is better healthcare. This is a big interdisciplinary collaborative program between the computing sciences on this side of the river and the health sciences on the other side. So it actually started in the College of Nursing. Now, mostly the College of Medicine and pharmacy and public health. And now dentistry. They've been slow, but we're getting them in.

Joan Kjaer: I know that the goal of this all this, of course, is to help people live a healthier and perhaps longer lives and prevent blindness and so on and so forth. But do we think also that AI will be helpful in terms of managing the cost of healthcare as we go forward? Certainly, it seems as though the IDx developments offer a tremendous cost savings for ...

M. Abramoff: Yeah, IDx wouldn't exist if ... The goal is to create cost savings and higher quality. And so without it, I don't want to do it.

Joan Kjaer: Sure. Sure. And what do you think ... I know these machines are expensive, and people are expensive. So this entails some cost, but one would hope that the advances that would result from this kind of work would be worth it.

Eric Hoffman: Right. We may learn by grouping patients together and identifying pharmaceuticals or other interventions that might treat a certain group of people, we may also, we hope that we'll also find new tools that can match more easily and much less expensively identify that person. We first need these expensive machines and large data and so forth to cluster the people together, come up with the diagnoses, but it doesn't mean that you need a three-million-dollar scanner in the east of India in a village of people that make less than $3 a year. The hope is that this will filter down. I think that that's part of the challenge.

Joan Kjaer: Sure.

Nick Street: I'm going to say data and expertise are not expensive. Okay? Data is cheap. That's why we have so much of it. Collecting, storing, managing, it's not that complicated anymore, and we have high performance computing, we have a fabulous high performance computing group here. And if that's not enough, there's Amazon, and just store stuff there.

Nick Street: When we talk about these academic programs, we have a lot of expertise for building these models. These guys are expensive. Okay? What we need is answers because we can't build models until we have a sufficient number of cases that an expert has labeled. Okay? If I'm predicting a stock, I can just watch for a couple of seconds, and I'll see where it goes. But to diagnose a disease an expert label. And so that's the bit that's expensive. But we have armies of students that are wanting to solve these problems and have the expertise to do it. So, this is one of the exciting parts of connecting the two sides of the river here.

Joan Kjaer: Mm-hmm (affirmative).

M. Abramoff: Yeah. In our experience, data is very expensive. But that means good quality data. We have tons of low-quality data out there and you can buy it. Go to any hospital, buy their patient data, whether the patients agree with that or not, maybe a no, and they have one doctor look at it. And typically, that's not good enough. Averaging a couple of doctors typically is not what is actually the state of disease. You want to look at what is the best outcome for the patient and try to relate what you see in the images with that. And it's terribly expensive.

M. Abramoff: Actually, we are very focused on getting high quality data. We needed very high-quality data for clinical trials and for building the first one. We're getting high quality data for the others, but now you're looking at almost $2,000 per patient. So it's in fact a challenge, but we'll solve that. But yeah, I see the problem is a bit different.

Joan Kjaer: You mentioned earlier also that you were very pleased that the FDA approved your product because the FDA has the highest standards-

M. Abramoff: Yeah, that's helping tremendously. So, A, again, if we don't do it safely and transparently, there will be a push back, and we'll lose all that [inaudible 00:51:49]. My standpoint is always US healthcare's the best in the world, just way too expensive. And so I'm focused on decreasing the cost while, if possible, improving the quality, which is what we did with this product. It's actually better than someone like me, but ... Sorry, now I forget where I was.

Joan Kjaer: No, no, no. I think we got there. This a good place to say thank you, Dr. Abramoff and-

M. Abramoff: Sure.

Joan Kjaer: ... Dr. Hoffman and Nick Street. Thanks for joining us for this segment, really a pleasure to hear about your work, and good luck with everything.

Eric Hoffman: Thank you.

Joan Kjaer: Thank you. Please thank our guests.

Joan Kjaer Hello, I'm Joan Kjaer, and welcome to WorldCanvass from International Programs at the University of Iowa. This is part three of our program on artificial intelligence. Our guests in this segment will approach the topic from fields as diverse and yet interconnected as computer science, vehicle engineering, and educational testing.

Joan Kjaer: I'm pleased to introduce Yuchi Huang, a senior research scientist at ACTNext. Yuchi is just next to me. Next to him is Dan McGehee, associate professor in the University of Iowa Department of Industrial and Systems Engineering and the director of the National Advanced Driving Simulator here at the University of Iowa. Thanks, Dan. And at the far end, we have Juan Pablo Hourcade, associate professor in the University of Iowa Department of Computer Science and associate director for Informatics Education and the UI Informatics Initiative. That word again, we've been hearing informatics a lot tonight. So, thanks Juan Pablo for being here.

J.P. Hourcade: Thank you.

Joan Kjaer: I think I'll start with you, Juan Pablo. As I understand it, you work in the area of human-computer interaction. What does that mean?

J.P. Hourcade: It means that we study how to make technologies useful, usable, and enjoyable for people and generally for society.

Joan Kjaer: And so how has AI influenced the work you've been doing and the work you do now?

J.P. Hourcade: Yes, I think AI's influencing most areas of computer science and engineering these days, and there's a variety of reasons for that, but among them are the cost to gather data, the cost of process it, the cost of store has significantly gone down. So that has enabled a wide variety of applications among which we've been hearing earlier today that were not possible before.

J.P. Hourcade: The other thing that's been happening is that there are tools to do I guess relatively simple artificial intelligence tasks that have significantly lowered the barrier to having access to those AI techniques. Whereas someone maybe 15, 20 years ago might have had to have a fair amount expertise in artificial intelligence to do certain things, now students with some introductory courses in computing can access the same tools. This has significantly expanded the possible applications and also the number of people who can get things done.

Joan Kjaer: What kinds of things do you share with your students when you're teaching these courses?

J.P. Hourcade: When teaching courses, we can have simple examples. For example, a classified information. So think the Federalist Papers, and for the ones who you're not sure who the author was, you might write a little code to classify who the author is based on other writings by potential authors. So you can do simple things like that that might have taken a lot of power before expertise and now are much easier to do with the systems that we had.

Joan Kjaer: If we think of some of the tools that many of us use every day, something like an Alexa, and we ask a question, and maybe she doesn't quite understand what my question is the first time through, I'll keep trying it, and whatever, this is a certain kind of I guess machine learning device.

J.P. Hourcade: Yeah, and it is a way something that's coming up in human computer interaction but also as agents, they had to re-interact with computers in ways that are different from traditional mouse, keyboard type or even touchscreen interactions.

J.P. Hourcade: Then you have to get into speech recognition, obviously, but [crosstalk 00:56:01] language processing also, and trying to better understand contextual information to figure out what the user wants. And there's still a long way to go but for very specific tasks I think that voice agents are doing well. If you go with more generic questions that require a little more context, then [crosstalk 00:56:23] have a harder time.

Joan Kjaer: What have been some of the breakthroughs over the last, oh, I don't know, if we go back 20 years, what have been some of the big breakthroughs along the way?

J.P. Hourcade: I would say the last 10 years I would say are the era of big data and of machine learning in particular, and again, they're enabled by all the devices that are out there capturing information. And inexpensive storage. So information that organizations were not able to keep before because it was so expensive to keep. Now we're keeping it. And also very high processing power, so we can have thousands of computers working on a problem at the same time, something that was not possible before, and we can do that relatively inexpensively.

Joan Kjaer: You and others have mentioned all of this data that is out there. How does one go about getting that data? Is it something you purchase for a particular project? Or maybe some of it is just shared easily and freely, but I suspect there's a cost or a protocol you have to go through.

J.P. Hourcade: I think one of the interesting issues that this brings up as a societal issue is who controls the data? And who owns it? And I think data's definitely going to be correlated with power in the next few decades and probably forever. And that's one of the big questions. Who controls it and what do they do with it? To what degree do we as individuals have control over data about us?

J.P. Hourcade: I would say there are other areas where it's less controversial. I would say if we take physical sciences and we want to have better models of climate, for example. But that's data that in many ways is public gathered by NASA and other entities. That's less of an issue. I think the controversies are going to come with and are coming with [crosstalk 00:58:22].

Joan Kjaer: Unless you're just don’t happen to believe in climate science. Then it's controversial, right?

J.P. Hourcade: Yeah.

Joan Kjaer: But Yuchi, I see you kind of nodding along as Juan Pablo is talking here. Are there other big breakthrough moments that you can think of on the development of AI that really pushed things forward?

Yuchi Huang: I guess it's deep learning. Also deep learning, the algorithm has been invented like maybe 20 years ago. I mean, the basic idea, the concepts, but back in 10 years we have very strong computers. We have tons of capacity to store data. So from that time, deep learning is booming and starting to invent every subfield of computer science. So a lot of break through applications like facial recognition, object recognition, object detection. They are, like voice recognition, they are everywhere right now.

Joan Kjaer: Yeah. Dan, let's pull you into this as well. Talk to us about your work with automated vehicles and just basically with transportation and all the changes that are made possible by this kind of technology.

Dan McGehee: I think the University of Iowa really has a really long history in advanced technology research in the automotive side of things. I think one of the great headlines about the University of Iowa is, and this is touched on in the earlier panels, is how interdisciplinary we are at the University of Iowa. This is inherent from this side of the river to the other side of the river, whether it's computer science, engineering, medicine, pharmacy, we're all bringing that together and making some really cool discoveries and really pushing the edge of technologies.

Dan McGehee: So for over 25 years now, we've been doing automated vehicle work here, sort of operating quietly here in Iowa. In fact, most people don't know that Joan was part of that original first wave in 1994. Joan's voice was used in our first simulated automated vehicle, too. So she goes way back.

Joan Kjaer: I missed my big chance, though. If you had been just a little bit further along, I might have been the voice of Siri.

Dan McGehee: Oh, that's right. Definitely.

Joan Kjaer: I would have been much more pleasant.

Dan McGehee: [crosstalk 01:00:51]

Joan Kjaer: Much more pleasant than she is but anyway.

Dan McGehee: Yes. So we generally, you know, we talk about what our production cars are today. So we're coming up on the 2020 model year. Those technologies that are in those cars today were studied here about 20 years ago. Most of the technologies in crash avoidance systems came through the University of Iowa as part of the original research and development and regulatory research. So we've touched on that research for a long time. Now we're focusing much more, another 20, 50 years away on much more robotically controlled vehicles. And so the AI, the machine learning, the deep learning that's going on now is much more on the mathematical side of how we can describe behavior of next traffic? So it's not like we're going to get rid of all of our manually driven cars tomorrow or in 20 years or even 50 years. So how we interact with automated vehicles is where we're focused today.

Joan Kjaer: And how do you figure things like that out?

Dan McGehee: So what we do is every one of us, the way we drive, the way we steer, the way we modulate our accelerator pedal, we're different. It's a different signature, it's a fingerprint. So as we track how you drive and how I drive and how Juan Pablo drives, we essentially put together those signatures, and we're very predictable about how we drive. Some of us in here in the room are very aggressive drivers, some are much more passive. And so we can start to understand how you are going to interact with an automatic vehicle self-driving car robot that's out there.

Dan McGehee: And so one of the issues is that self-driving cars get bullied. They get bullied in a very different way than we talked about bullying, but if you're a pedestrian walking in downtown Iowa City and you see an automated car, you're going to walk in front of it because you know it's going to stop. If you encounter self-driving car at a four-way intersection, you're always going to pull out in front. And so these cars, because they're bullied, they're stopping all the time. And then they hold up traffic.

Dan McGehee: So we're developing new machine learning algorithms to be more aggressive because I know how you drive, and you drive, I'm going to guess, you're probably pretty cautious. My robot car's going to pull out in front of you, and we're going to redevelop uncertainty. Sometimes I'm going to pull out in front of you, and sometimes I'm not. So much like, you all love roundabouts, roundabouts are really safe because they're very uncertain. You don't really know what that person is going to do. Most people hate roundabouts. In consumer surveys, they despise them, but they're super safe. And why they're safe is because it's uncertain. So we're creating uncertainty in the algorithms of the next generation of cars but on purpose. But we're measuring everybody else's behavior and their profile.

Joan Kjaer: So the automated car that we're talking about would not only know how it is programmed to behave or think or whatever, but it would detect me and my driving style when I'm sitting in my own car over there?

Dan McGehee: Yeah, so each vehicle is communicating, whether it's through your key fob, just like your car might know your seat position. We're broadcasting that, if you will. We can also measure that, so we have sensors around traffic signals that can look out. You'll see these white cameras. They actually can measure how fast the cars are approaching in an intersection. We can take those data, and I can predict if that's an aggressive driver, if they're entering a particular intersection, if they're breaking hard. Then I can tell if that's an aggressive driver or not.

Dan McGehee: So then we incorporate whether we're going to pull out in front of that car or not. We still have all these layers and buffers of safety, but we're going to take a shot at a person who has a much more timid approach than a person who has an aggressive approach.

Joan Kjaer: Wow. Do you envision a time ... My mother is getting older now, and she no longer drives but she misses it every day because of the lack of freedom to just go to the grocery store, take a drive if she wants to. Will there be a time someday when people may have their own vehicles but that they won't have to be responsible for managing all the time?

Dan McGehee: Yeah, I think the next generation is sort of the Uber and Lyft model versus owning a car. I'm pretty skeptical that we're going to have self-driving cars to the point of ubiquity. And that means most of you, probably 100% of you, own a smartphone. So smartphone's GPS navigation is ubiquitous. To move that forward so we have almost all the cars, 90% of the cars are self-driving, we're looking at a very, very long range forecast.

Joan Kjaer: So we've been talking about cars, but what about other kinds of transportation? Do you work on vehicles that are really big like semis and that sort of machine and load and so on as well or is it transferable from a smaller vehicle?

Dan McGehee: Yeah, the truck's, you know, driver behavior is very similar, whether you're driving a heavy truck, even though you got to brake way sooner. But we're really looking at how to make driver error something of the past. About 95% of crashes are caused by human error. And that's a really big number. It's a huge public health issue. Last year, we killed about 38,000 people in the US alone, about 300 in Iowa, a million people worldwide. So take a look at how crashes, injuries, and fatalities stack up against other diseases, it's a big public health issue.

Joan Kjaer: Yeah. Thank you. Yuchi, let's go into the field of education, educational research. So you work with ACT and something called ACTNext. Can you tell us what that is?

Yuchi Huang: Yeah. Basically everybody knows ACT is a company for college admission tests. But right now, we're changing. We're changing from a traditional testing company to a learning limitation and assessment company. So by doing this, we invested a lot in the past several years to acquire some companies. For example, we bought OpenNet. It's an online platform for videos, video lectures and other educational content. And we bought Knovation. It's a company focusing on the curated learning resources.

Yuchi Huang: So we also established ACTNext. It's a research department conduct the research for next generation educational products. So we are doing this trying to satisfy the needs of our customers better. And we think AI is going to play a big role in this process. So we are doing a lot of projects involving artificial intelligence, machine learning, deep learning. And I think we are in a good progress.

Joan Kjaer: So you look at student behavior as they're taking the test, or as they're looking at your videos or whatever… you're assessing the user behavior?

Yuchi Huang: Yes, So, one example of our applications is on adaptive learning. Because we can connect students' performance data from those online platforms, so we can use this data to train machine learning models and to track and marry the student's ability and to decide to detect whether they're engaged in learning or provide learning ladders for them to learn gradually in a very efficient way.

Yuchi Huang: Also, we have other projects like trying to measure the skills of students. So talking about measurement, it's not only, for example, the automatic scoring for written essays or answers for the questions in a test. But also some [inaudible 01:09:51] to the complex skills, such as collaboration, communication, leadership. And those skills are very important, very critical for the entire life of students.

Yuchi Huang: So what we do is that in a lot of scenarios we can build up like some multimodal data collection system to collect some verbal, nonverbal video, audio features. So we utilize these features to train computer vision or natural language processing models to contain the information from those signals and then predict the level of the skills and provide feedback to students.

Joan Kjaer: So that makes me curious. I know that one of the criticisms some people have of standardized testing is that it is said that some students are really quite well-adapted to taking standardized tests and other students just don't do as well in those because they have a different kind of learning pattern or whatever. I assume you take that into account as you're trying to build out all these different levels of perception for machine learning?

Yuchi Huang: Yeah. Yes, I think learning is a very complex procedure for human beings. So one key factor, I guess, is learning materials. It's quite different from other domains like, for example, self-driving. We have unlimited data to use because every day people drive. But in the educational domain, we don't have a lot of high-quality content. So because creating content is very expensive and time-consuming, it's quite difficult. It depends on the effort of domain experts. It's quite difficult to align very limited educational content to the evolving needs of students. So how can we handle this?

Yuchi Huang: So our target, our strategies, we are going to, for example, for video lectures, we are going to tag and segment the long form video lectures into fine grain small pieces and store them into a very large ripple. And then for specific learning topics of students, the algorithm will select those video units automatically and stitch them to a long form video for specific usage of that student. In this way, we can provide better and unlimited resources for students. Yeah.

Joan Kjaer: Wow. How did you get into this educational research?

Yuchi Huang: Allow me to share some personal background information. Nine years ago, I graduated as a PhD in computer science. At that time, I did some general research in computer vision like object recognition, facial recognition. And then I worked for GE and NEC to conduct this kind of research. And I feel like I need to find a domain I really have a passion for. And later, I decided this is education. So, that's why I joined the ETS in 2015, and in the same year ACT established ACTNext because they really want to do some great research to push the frontiers of education. So I think this is a good chance for me to join. So later, I joined ACTNext.

Joan Kjaer: Wow, that's terrific. Is your work, is ACT's work and ACTNext, focused on the US? Or does their testing and their ambition go far beyond the US?

Yuchi Huang: Basically, we conduct the research not only for the US students, also for the students of the world.

Joan Kjaer: Great. Let's come back to you, Juan Pablo. And just talk a little bit more about the kinds of things you personally work on in your own research.

J.P. Hourcade: Yeah, so my research is a little bit different. It's about measuring human-computer interaction and typically I work on designing technologies for groups of people who are typically not the focus of Silicon Valley. So I work with children, with older adults, with people with specific health conditions.

J.P. Hourcade: One area that's a little bit closer to our topic today is we've been working on voice agents interacting with preschool children. A very young audience, and we learned a few things that are interesting and a bit unexpected. For example, these very young children, three to four years old, they're very interested in knowing how the systems work, and they want to control them. So there's a really ... It was interesting that even at that age, there's a longing for transparency and for control of technology. And I think it gives us a clue as to what are some of the things that we need to do with artificial intelligence and putting it at the service of people but making sure that we have that transparency and that control by the users.

Joan Kjaer: Well, it seems to me, just observing the little people around me, that they come into the use of technology much more easily than people of an older age. Some of the people my age think it's a really wonderful feat to just kind of learn how to use Facebook because it's not familiar to us. It isn't what we grew up with, but these little kids have it all around them.

J.P. Hourcade: Yes. And I think each generation is a different kind of digital native these days. So the older digital natives, I guess are my college students now. And, you know, they grew up with desktops and laptops. A lot of kids who are in elementary school now grew up with touch screen technology. So when they get to a screen, they touch it, if it doesn't do anything, they think it doesn't work. And now we're having a younger generation that's starting to experience these voice agents, and around the corner we have what's called The Internet of Things. So kind of more and more items in your household and perhaps in your school will be interactive and have computers embedded in them. So coming into your house and your house knows that you're there and just doing things, that might become an expectation. Maybe the house is not working if that doesn't happen. So expectations for what technology is available and what it's supposed to do are changing.

J.P. Hourcade: And obviously, we have now the expectation of getting any information anytime, anywhere, or being able to connect with anyone, anytime, anywhere. That's quite a change, and we expect that now.

Joan Kjaer: Yeah. Dan, some of the things that are available in mid-priced cars today once upon a time seemed unbelievable.

Dan McGehee: Yeah. I think that's really the main headline is that for $18,000 Toyota now has automatic emergency braking with a computer vision system. When I first started doing this 30 years ago, one single pencil beam laser box was $10,000. And that was really crummy, driving around in traffic trying to measure how far a car was ahead, how [crosstalk 01:17:55] is, how hard it was braking. But yeah, no, it's exciting thing. When I tell people all the time, if you're thinking of buying a car, buy one today because the technology that's here today, it's going to be here for quite a while. And it's really pretty good day-to-day crash avoidance, keeping you in the lane if you get distracted, not by your phones, but it's going to put your brakes on. it's going to make it a lot more comfortable ride.

Joan Kjaer: Yeah. Thank you all so much. What an interesting conversation. I really appreciate it. So, Juan Pablo Hourcade and Dan McGehee and Yuchi Huang, thank you very much.

Joan Kjaer: And I invite all of you to join us for next WorldCanvass if you can. It's a different topic. We have a literary topic next time, and the program is called What's in a Word. The Translator's Challenge. And we'll have some interesting guests for that one. It's March 28th, and I hope you can join us also here in this room. So, thank you all for coming tonight, and thank you to all the guest. And we'll see you next time. Thank you.

Yuchi Huang: You're welcome.

Joan Kjaer: Thank you so much [inaudible 01:18:57]-