Professor D'Agostino: I'm so thrilled right now to introduce to you our keynote speaker for today, Professor Kang Lee. He holds a Tier One Canada Research Chair in developmental neuroscience, at the University of Toronto. For over two decades, Professor Lee has studied how children learn to tell lies. I was just talking to him earlier that I'll be taking notes, and he reassures me that it's actually a good thing that my four year old is a liar. I'm looking forward to learning more, and talking to him, too. He's been sitting through our morning session and he, too, has learned a lot from our own presentations. He's definitely a luminary. His work has lead to law reform, concerning how to admit children as witnesses in the criminal court in Canada.

He and his team have developed a novel imaging system called Transdermal Optical Imaging that uses conventional video cameras to decode human physiology and emotions. Professor Lee is a TED speaker, and co-founder and Chief Science Officer of Nuralogix. In his talk, Professor Lee will draw insights from a century of psychological research on human emotion, to discuss various methods AI developers can use to create intelligent systems with affective AI. All to detect, decode, interpret, and simulate human effects. He will also showcase several existing applications related to law, and discuss the opportunities afforded by affective AI, as well as its potential challenges. With that, a very warm welcome to you, Professor Lee.

Professor Lee: Thanks a lot for inviting me here. Many years ago, when I was at UC, University of California Davis, a very famous anthropologist told me about her observations of cross-culture differences in people giving talks. She said, "Kang, I discovered that when American begins his talk, he always tells a joke." And then she said, "But, when a Chinese gives a talk, he always apologizes." I'm a Chinese-Canadian, so I apologize, I don't have a joke for you.

As just been mentioned that for the last 20 years, I've been studying how children learn to tell lies. You may ask, "What's lying have anything to do with law?" I would show to you, later on, that indeed, there is a very close connection between law and then lying. On top of that, you may ask, is there relationship between lying and the AI? Then I would then try to convince you that there is. In any case, but today, unfortunately, I don't have time to talk about children and lying, if you are interested, if you happen to have a child who is less under 16 years of age, who is lying, you should check out this TED Talk. And as you watch with him or her, and the both of you are going to learn quite a bit about children and their lying.

Anyhow, so, that's not the topic of the day. Today I'm going to talk about affective AI. Let's take a look at the problem we have so far. AI is everywhere. It's really everywhere in a sense that it's at work, it's on the street, it's in your hand, in your pocket, at home. Here are just a few examples I want to give to you. One is Amazon Alexa, which is very good at decoding speech, and then responding and answer your questions. The Google system does the similar things. And of course, Siri. Then I want to point out, there's something you actually have never heard of. It is very popular in China, called Xiaobing.

Xiaobing is this girl sitting on your phone. She actually listens to you, has

conversations with you. Seems to understand your emotions according to the design of Microsoft. Because of that, there are millions of lonely Chinese young men who are conversing every day with Xiaobing. They actually stop going out and making girlfriends, but instead stay in, talking to Xiaobing. I actually downloaded Xiaobing to my own cellphone. I have Xiaobing on my cellphone. I started a conversation with her, but very quickly, I discovered, and she's not very good. Not very good in the sense that she's very smart when you ask some basic, effectual questions, but as soon as you talk about something about emotion, and her conversation falls apart. But I... There are many examples of how Xiaobing falls apart, but they're all in Chinese. I'm going to use a different example by Siri.

So this is... I'm sorry. So this is an example about Siri. It will illustrate the problem we have today. Siri asks, “What can I help you with?” And the person says, “I'm going to jump off a bridge.” Siri answers, “I found seven bridges not far from you.” The problem is the current AI system, at best, are intellectually smart. But they are emotionally stupid. They cannot pass the train test, and their emotional intelligence is less than that of a two year old. The two year old can do far better than Xiaobing, than Siri, than Alexa, or Google Assistant.

In order to solve this problem, we need, really, to move the AI forward, by actually make AI, not only intellectually smart, but also, emotionally smart. What we need is, ICO affective artificial intelligence, or AI squared. This is an intelligence ability to detect, interpret human effects accurately, to respond to human effects appropriately, and to simulate human effects seamlessly. How do you do that? Well, that's where psychologists and neuroscientists come in. Because over the law more than a century, psychologists and neuroscientists have studied emotion extensively. We actually have learned a lot about human emotion. There are many different methods you can use, and approaches you can take to study human emotion.

One is language. The other one's expression, your facial expression, your body language, et cetera. The third one's psychophysiology, such as heart rate, breathing, blood pressure. The third one neuroactivites in your brain, your hormonal systems. Let me just give you a few examples. For the longest time, we actually know, language is effective. This is common sense, you know language is effective. We can decode emotion from languages, that's no big deal. However, and people have studied this issue for many years, they have discovered, number one, even the syntactic tokens, the syntax, or grammar, of your sentence, of your language, actually conveys very good emotional information.

Let me give an example. This is before AI. The FBI officers in the United States discovered that if a husband calls about his wife being missing, and they're able to go over and have a conversation with this husband, very quickly, they would discover, this husband actually murdered his wife. How did they find out? There are many such cases now. Turn out, the husband, that when he talks about his missing wife, he switched from present tense, to past tense. Just using that information is enough for you to know, the wife is dead, the husband is highly suspicious. Having taught you how to not say to FBI officers, after murdering your wife, let's move on

to something else.

Another thing you can also look at, still syntax, has nothing to do with the content, is you actually can look at the grammatical structures of your sentence that you're constructing. From there, you can pick up emotions as well. Here's an example. I'm showing you actually the trees. This is actually using a Connexor, which is a free software on the internet. You can actually use it. It's called a Phrase Tagger. It actually tags the code sentences into parts, and then tag them according to its syntactical categories. Then also it can analyze. I actually told the programmer to analyze the sentence structure according to Chomsky's Theory. By doing so, they actually can lay out a sentence according to how complex the sentence is. The more complex, the more sub trees there is, and the deeper the sentence being analyzed.

I think it's on your right hand side... Let me see, okay. On your left hand side, is the simpler sentence. Then on your right hand, is the more complex sentence. These are the sentences we actually got from... We downloaded child abuses cases in the United States. This all free, accessible data. We took the data, and then we analyzed the transcripts. Then analyzing, in this particular case, the lawyer's questioning. Then from there, we look at the sentence structural complexity differences between the defense lawyer and the district attorney's questioning. Simply by doing that, we were able to predict whether or not the jury is going to convict the accused with about 92% accuracy. Then we took Michael Jackson's trial, and by just using the same method, we were able to predict that Michael Jackson was going to be acquitted with 98% of the accuracy. With confidence. You can see that by simply looking at the syntactical tokens and structures of a sentence is sufficient for you to learn a lot about some of the underlying issues or ideas or emotions that a person's speaking.

The next example is looking at their word choices. What words they are using. This is a free software, developed by a psychologist, called the Linguistic Inquiry and Word Count. This program basically are able to decode and label each words according to its emotional valence. Then, by doing so, do you actually can calculate, very quickly, one passage of someone speaking, and find out the person's emotional tone, as well as other things. For example, what I did was, I just dump Trump's inaugural speech into this program. It comes back with its analysis. The results are very surprising.

I don't know if you remember after the inauguration, everybody thought Trump's speech was dark, was appealing to low social economic status of people, therefore his words were short, were negative words a lot, and that he was self referencing a lot, according to the media. However, when you look at the data, it's actually the opposite. He used long words, and he used more positive words than negative words in comparison with the norm that the program is based upon. The results are actually quite different from the perception of the people just after the inauguration.

We actually use this software to look at whether or not we can tell whether or not

a child is making up a story about being hurt, versus a child is really experienced a traumatic experience. With a more than chance level accuracy. We just did a quick and dirty study with very limited data. Had we had more data, we could build a model based on word choices by the kids to know whether or not their testimonies are true or made up.

Then, the third one, next example is expression is effective. Here, I'm going to talk mainly about facial expressions. I know, expressions includes body language and postures, but here I'm going to focus on facial expressions. I believe Google and Microsoft are also working on gestures as well. This is a program, when I was at the UC San Diego, I was very lucky to run into a postdoc who had just finished postdoc called Marni Bartlett. She actually developed a computer vision software that was able to use Paul Ekman, which is the guru of emotional research in psychology, and by decoding automatically facial muscle movements. From there she was able to decode your facial expressions moment by moment, frame by frame, and the own in real time very accurately.

Then we took her software, and the run studies together with her. Our goal was to see whether or not a patient comes in who wants to get opiate prescription, whether or not the patient would like with the faking pain to get the medicine, or the really experiencing pain. Our data showed that we could detect someone faking pain with 93% accuracy if I have about a 62nd video data. As you can tell, facial expressions sometimes can allow you to detect true and false emotional expressions.

Then having worked with her for 10 years, by the way. She set up company after left years in the UC San Diego, then she sold her company about three years ago to Apple. If you are having Apple X, I encourage you, there's Emoji program and that's her program. However, after I left UC San Diego and came to join the Faculty of University of Toronto, I discover something unsatisfying about using facial expressions because we discovered one of my student did a study and then she found humans only show facial expressions only 7% of the time, 93% of time. We actually do not show any facial expressions.

As you are now, look at yourself, and you are your neighbors. They don't show any facial expression. This is our common, most common expression is neutral expression. If we don't have facial expression, you only pose neutral expression, then Marnie's program will now work. That was the biggest problem I had when I came to Canada because I run into the problem to detecting children's lies. This is the myth you would have, someone goes to the theater watching a comedy that will be the official discretion. The reality really is this. If you think someone goes to office, and they're all smiling and this and that, but this is the reality. In real life situations we just do not show facial expressions. How are we going to solve this problem?. Next solution is to use newer imaging because when you experience emotions they are two or three system actually at work, one is the central nervous system, the odd ones, autonomous nervous system, which is controlled by the brain stem.

There's also our hormonal system. They are all at work where you experienced various emotions. Then I have focused on the top two neuro systems, and I have used various methods. The first method is called the EMG, which basically picked up electrical discharges on the muscles with electrodes, insert or closely attached to your facial muscles. The second one's called the EEG. That is using picking up electrical activities from your brain. The third one that's the polygraph, which you may being is the using various physiological indexes or activities you display and then we use that understand your emotions.

Typically, we'll use your skin conductance, which accords GSR, the next one's breathing, and then blood pressure as well as ECG. That's a polygraph. Then the third one is a functional MRI. I have used them all, and you probably have encountered cases in the legal settings. Now in the US some people want to use functional MRI to introduce evidence from functional MRI to the court to show someone's telling the truth or not. If you encountered this case, you should say it's bullshit. It really doesn't do anything. There's a very easy for you to fake the data. The best one so far with neuroimaging and cycle of psychophysiological method actually is polygraph. Believe it or not the most of you think they are not good, but it's the best method you can have to detect lies in particular skin conductance, blood pressure, and ECG, which is a cardiogram.

The problem is these methods are not useful for me as a researcher because I study children, I study children aligning in natural environment and natural context and I cannot attach sensors to them, and some of them are very invasive. The problem of these methods that I've explored tend to be invasive, intrusive and expensive. For a long, long time we struggled with this problem and then we came up a good idea. This idea is called the Transdermal Optical Imaging. We know that on our face there's very complex blood vessels, and they are controlled by mainly by the autonomous nervous system, which is beyond our conscious control. When we experience emotions, the facial blood flow changes subtly.

This subtle changes are clearly associated, we know are clearly associated with various emotions. If we can measure this subtle facial blood flow, then we should be able to detect children's lies or adult's lies and many other situations. How do you do that without attaching sensors to their face? We came up with an idea based by a very well known skin color model. We know our face facial skin, the official Epidermis, which is the thin layer that over your face, and they are translucent. When a light like this light comes to your skin, it does not bounce back. It actually penetrates underneath your epidermis. Once the light reaches there it then encounters, two major proteins, one is Melanin, which is the color signatures, a little bit of brown, and the other one's a hemoglobin, the signature is red.

Then the light would bounce back. Then using a regular cell phone and that has either a CMOS sensor, you actually can pick up the signals of both the hemoglobin and the Melanin. Then through machine learning we are able to simple doubt the information about Melanin, which is useless to me. I threw it away. And then I keep the hemoglobin formation. This is what your eyes can see. This by the way, my son Nathan. This is his common facial expression throughout the day. T99.99% time.

That's a facial expression. I know he experience a lot of emotions inside, I just have to uncover this. In particular, he's lying, he started to tell lies when was a 14 months of age. I've been tracking, he's lying throughout.

Right now is 15 years of age. It's a feast of superb liar. I'm race between him and me basically. I finally got that technology there may be able to detect these lies. This is what you can see and this is what our technology can see. This is at that moment, the facial hemoglobin concentration in various part of the face of Nathan. This one moment, but all the smartphones, you have now can take pictures, take video images at least at 30 frames per second. Actually Apple can do 256 frames per second while we can do 960 frames per second. Then what you do is you process every single frame and then you put them together and this is what you see.

This is when Nathan is experiencing certain emotion, and you can actually see the up and downs of hemoglobin concentration in different parts of his face. That is correlated with his emotion. We actually did a study, and we found when people tell lies, the official blood flow on the cheek goes down, but he facial blood flow on the nose goes up. We call that Pinocchio effect. Then we wrote up the paper and then University of Toronto people came to my lab. I had a visit. I said, "I'm going to publish this. I'm going to tell the whole world how transdermal optical imaging work, people can just do whatever they want with it." The university you cannot do this. Number one, you have to apply for patent. I say, okay, I apply for patent number two of said, you have to set up a startup company.

I'm a professor, I don't want to be a CEO, there's said no problem. We'll find you a CEO. I said, but we don't have money. They said no problem. I will find a CEO that has a lot of money and, which indeed, they found me a CEO who just sold his company, a Canadian CEO who sold his company to Siemens for $400 million. He was just in between projects. We met, and he's an engineer, and a geek with signal processing. I'm a geek with signal processing, so we really hit it off. We actually, with the help of University of Toronto, we set up a company called The New Biologics. From here onward, this is basically, I use this as my declaration of potential conflict of interests. In any case... We actually have developed, this company has been in existence for three years, and we developed a cloud based service called deep effects.

What does deep effects do? As long as you have a cell phone, or a laptop like the one, exactly the one I have here from Microsoft a surface pro and or you have a surveillance camera, and you can use our service and what you do is, you use your phone to get the videos of your face for a certain amount of time. Then we would extract your facial blood flow on your device and then after the blood flow is extracted and then we send the data to the cloud. The reason we are doing that is because we are Canadian company, we are very concerned about privacy. The first thing we want to do is to ensure that data you send to our cloud is there is no persona identifiable information. It's all sitting on your own computer or your phone.

The data goes up and then within a few seconds, data comes back to your device and this place, whatever information you want. That's the basic, the flow of the process. Let me give you an example of what he blood flow looks like on your face. So this is me. I took a video of myself and then send data up and down in about 30 seconds. This basically tells me the hemoglobin concentrations in different parts of my face, but the other side is very exciting. This is something new. We actually were able to visualize using this kind of data to visualize facial vasculature. I mean collaboration with the field institute actually because there's a lot of mathematics involved here. Using this kind of technology, you can actually visualize where the official vasculature for various kinds of purposes for personal id or for diagnosis.

That will be in the future. This is just what we discovered about a few months ago. What can we do now? In terms of physiology, we can measure your heart rate with very high accuracy. We are the best in the world. I came very proud of saying that, because were better even there Apple Watch, I should take it back. Apple Watch and us, have the same accuracy but typically if you wear Apple Watch your accuracy is going to be one or two bits off. The reason for that is you don't wear it correctly. When you measure your heart rate you have to push it down. Once you push down your results are identical to our results, so you really want to know your heart rate, you really have to push down the watch, anyhow so we can do breathing.

Nobody in the world can do it. We can do breathing with very high accuracy, and we can do blood pressure using your iPhone and in the last three years. This is the sole focus of our company, and my work actually to develop a APP in the phone that can measure your blood pressure. We are pushing towards FDA requirements. We are almost there a few months down the road, we'll be there. Right now we are just doing engineering work to make sure it works on the phone. Right now the accuracy is over 90%, but not good enough. You have to go beyond 95% to reach FDA requirement. We also by accident we discovered our technology can detect your age, your gender, your height, your weight and your BMI.

Also, we can measure your facial skin age based on the skin signatures that the signal we got as well as your vascular age, which is based upon your vascular stiffness. Then we are doing a bunch of other things. Last week we actually finished algorithm to detect irregular heartbeat. In the future we want to detect AFib, which is series cardiovascular disease and need to be caught and then treated as soon as possible. Anyhow, with regard to psychological activities, we so far are able to measure mental stress, with very high accuracy. And this is based upon heart rate variability. There's a longstanding research on this issue. We just use the existing knowledge and develop something like that. We can detect the facial expression with very high accuracy as well as inner emotions when you do not show facial expressions.

We also have done lie detection study to show that this technology can detect lies with the very high accuracy here is about 85%. Currently we are moving towards developing a model to detect anxiety disorder and hopefully next year to detect depression. Our APP now can do realtime physiological, psychological and

emotional information decoding, but the thing I'm most proud of is that we discovered we actually can travel back in history to decode the existing videos. We went as far back as Bill Clinton and we were able to extract Bill Clinton's heart rate and stress that based of the video, that was a very crappy and which actually VHS tape. We were able to extract this information and of course O.J's TV interviews and as well as our collective nightmare Donald Trump.

Here's is his. I think his last year's speech to the congress. So as in his talking we can actually figure out how tall he is, how old he is, and his [inaudible], how much he weigh and as well as his heart rate, blood pressure, breathing, et Cetera. These are all lives. This is... You can actually track them live. Just imagine in the future your TV watching experience would change if we put this on your TV. Now, I'm going to talk about applications. These are the things that we are actually doing right now, and I will start because this is a very good audience of that. This morning I learned a lot about privacy, data rights, et Cetera. Here I'm going to give you basically your law a challenge. There issues they'll come up with each applications. I started with something I believe to be not very problematic.

That is gaming, It turns out we actually, our system can be used for gamers. Why, so let me show you something. This is actually our CFO for player computer game. He actually has to survive among kinds of people. They have to kill each other until finally you survive, and you'll win the game. He's at this point, at the very end of game, he's about to be killed, and he survived for a long time. Then you see all these red, these red are indications of him being very scared because he knows someone's around corner was going to kill him. The lamb over, you would say, why is this useful? For me it's so much fun to watch him play, and I find out what's going on in his internally, his stress, his blood pressure, his breathing, all sorts of things.

Turns out to the gamers want to post this out to twitch so that when people are watching them playing, they are also watching their internal emotional activities. Another thing they do is turns out is because they would do play computer games for a long time. They don't want to do editing. They want to use this software to go in to find the most exciting period and then automatically edit and post. That sounds very interesting. Also, others want to use this to change the difficulty level of the game according to your game scale. You too scared it would reduce the difficulty if you're not scared, increased the difficulty level. I assume this has very limited privacy or other issue related to it. Next one is useful. It's health. This is something we have focus on.

I have to tell you. The first people called us were TSA, FBI, seizes and CRA, they want us to use this for of course, for obvious reasons. We actually went to give a talk in a workshop they organized and then after we give the talk, they said, "Well, you shouldn't be in this space. You should go to do something good." That's actually they told us. They had the thing they identify to be good is actually health. This is why we are doing... Most of my work right now is actually in health. Let me give an example. This is my father who lives in China with my mom both of them are 90 years of age. I'm living in Toronto. I talk to them almost on a daily basis, either by Skype or by WeChat.

I thought why not using our technology and the yes. Every time I talked to them I can give them a physical, so I can tell their heart rate and blood pressure, mood and mental stress. Why not? Then I discovered last year when I went to see them, they watch a lot of TV and I discovered. There's a video camera that's very cheap but very good in China and you can actually install that right in front and then next to the TV. Now I can turn the video, I can control the video from my home with their permission in Canada and then zoom and own their face. Then I can give them a physical as well when they are watching TV. This becomes a little bit tricky. It's very useful. Why? Listen to this music first.(singing)

What is this music? This actually is the music that coming out of my father's face. This blood flow information comes out, and we immediately automatically convert that into midi file and then send to a just a music player. The music player, then plays out. Why do I do this? Because I'm busy. When they watching TV, I don't want to watch them watching TV. I want to do household chores while listening, if the music comes out like this, I should be happy. This is a normal heartbeat and coming out to my father's face. The next one is different. This is from somewhere else who has serious arrhythmia.(singing) automatically this software is able to pick up this unusual beats and the missing beats in the [inaudible] some kind of a half tone, you can easily pick up something as well. Even when your not trained as a musician.

This to me is a potential new for a tool for healthcare, particularly [inaudible]. The next one is something like this. I know a lot of you do not do annual physical, which I know a lot of you do not do annual physical. If you say yes, you're lying, but you go to do physical and your doctors or your doctors nurses actually performing the blood pressure measure incorrectly, and they do it, rush it. You're going to have white coat hypertension that is, you don't have hypertension, but the measurement that turns out to be high. Why? Because when you measure it in front of a doctor or a nurse, you get stressed out, then the blood pressure reading is going to high. Theoretically you should do three times in a row and then average them over, and most of the clinics in Canada as I experienced it do not do that.

They just don't have the time. They do one measurement, not even performed by nurses or doctors, but performed by a device typically is Omron. Sometimes the results are... When you do that you have to use cough, which is painful. You don't want to do it too many times. What we want to do is in the clinic when people come in, they can sit in front of a station like this one, we call it toy station and then you actually can measure all sorts of things in about 30 seconds and that actually avoids, a lot of these kinds of problems. This is an example of you can do a remote clinic with a patient from the one person's maybe here in Toronto, the doctors here in Toronto, but patient could be up North somewhere with no specialist.

You can actually have conversations with her and then you measure her blood pressure. You can trace, movement by movement brought pressure up and downs, breathing up and downs and heart rate up and downs. There are all sorts of other useful information, clinical information you can get from this patient. Another

application is this. You can use your iPhone or use an infrared camera when someone is sleeping and then you can actually monitor the sleeping quality or whether or not there any problems. This is my postdocs [inaudible] who has some congenital cardiovascular disease. We're just using infrared camera in her room and then recording the process and decoding her heart rate as well as her breathing and then in the future what we hope we can also detect her blood pressure, ups and downs and other sleeping quality as well.

You can see, this technology and can be used at home and sometimes without you being fully aware its existence. That's why I put it here could be quite challenging in terms of privacy and things like that. Imagine this is a teenager, a girl, or boy or another adult. The situation may be different. Their use case needs to be discussed and very well thought out anyhow. For people like us, we go to work every day. We also developed something like this. This is smartphone-based health monitoring. We called a new row. You can download it from APP store if you have an iPhone and if you have high end android cell phones, like, Google's pixel or Huawei or Samsung or LG. You can also download this on your android.

You can measure, your only two things. Your heart rate and stress, blood pressure is not coming out yet. What we have inside now is something very unique, We can measure in 30 seconds a lot of things. These are the things that we can measure. We can measure blood pressure, stress, cardio, cardiac workload, vascular stiffness, breathing, heart rate, body mass index, your demographics and the cardiovascular disease risks, stroke risks and heart attack risks in 10 years. This is a base bone, well established medical literature. Anyhow, let me give an example. To show you how, this is what we call CEO version because our CEO is being tested by this internal APP. It takes 30 seconds. This APP works in most of the lighting conditions so that is 30 seconds. A lot of people that complain that takes too long. Let me show you what it can do. It tells you your stress, heart rate and your blood pressure, your BMI, your cardiovascular risk index, 4% that which is great.

His height, his ages, gender. Let me show you. To prepare for this talk, the last weekend I measured myself. This is me. I have a systolic 125 diastolic 76, which is great. My heart rate, 62, my normal heart rate, which is great. My breathing is normal to 15 breaths per minute. 46 is my post for a pressure, which is actually very important, that is the difference between your systolic and diastolic blood pressure, but not using mathematically, they actually predicted that according to your real post pressure, and my mean arterial pressure is 85, which is also very good. This is also very important in indexes that your doctors should give to you, but we don't because it just too cumbersome for them to do it for you.

Then also I found out about my stresses 2.2. I was pretty chill at the point at home. Then my cardiovascular risk in 10 years is 4%, which is normal. My heart attack and my stroke risk is 2% in 10 years, which is also great. I'm going to reveal you about my personal information. This is the part of our privacy, my age, the program says I was 55.82 years of age. I'm actually 56 years of age, gender male. That's great. It says my height is 1.71 my actual height is 1.70. My weight, it says 69.65, roughly, my weight is about 70 kilos. It's very accurate. My BMI is also very accurate. Having

said that, that's health. Now let's move on to education.

I'm from Boise. This is one of the first thing I thought about how our technology can be used in our own schools. This is our own school teacher, grade five teacher, Ben, and his teaching math. One of the possibilities we haven't really implemented due to privacy concerns is actually we can put video cameras in the classroom so that we can tell, which child is having low anxiety when learning math from Ben, also, which child how has high anxiety about learning this math subject measure or who is actually not paying attention. This is one possibility. Then you imagine you can actually put this in many learning environments to help teachers teach better and help students to learn better. Of course, they are many privacy issues. Here's another scenario, which is happening every day in the world. This is English teacher teaching Canadian kid, actually English. Then so you can actually monitor both of their vitals and emotions simultaneous. This information as you are learning, sorry.

As you're learning, and you want to find out whether or not the child's learning the child is happy, whether or not the teacher is teaching and teacher and child actually the match in terms of the psychological activities and physiological activities to ensure you can actually find the best teachers to go with the best students and also ensure the quality of your teaching. The online teaching is now ubiquitous in China. Actually a lot of foreign teachers are teaching Chinese kids English. The various companies want to know, "Is my teacher teaching well? Is my student learning well?". Not just in terms of scores but in terms of the learning experience. Do they feel happy? Do they feel anxious? Then you marketing. Now getting more dicey so it's totally possible today when you walk into a store like this, there'll be cameras somewhere, and they can pick up what products you are actually prefer, you like, or you do not like.

Imagine you can take this farther in the dating scenario. Now go to more dicey situation, more issues. Safety, security and law. You know that there are many critical infrastructures in which that you have to rely on these people to ensure nothing goes wrong. These environments are typically very boring. How do you know your workers who are in charge, in trusted with controlling these critical infrastructures, be it a nuclear power station or your airplane and who is actually paying attention and do their work. Using this technology, you actually can do it. You can tell the physical activity, the vital signs of your worker as well as whether or not the person's paying attention, or the person is falling asleep. There of fatigue to begin with. This is the one scenario.

Another scenario is this in the airport, I don't know, you know, so two years ago, TSA and FBI together, they did a test. They had people pack knives, guns and bombs in there, carry on suitcase. Do you know what is the detection rate by the TSA officers? 5% so 95% of the time they actually fail to detect these carry on test kits. That's scary. Most of the time they just fail. You may think, well, maybe we should do something different. This is why the TSA called us the first time we talked about technology. This is a Chinese company where they are trying out our technology. There are workers coming into their office. You can immediately detect who they are who they are. Also, their heart rate, their stress and many other

things.

We actually did a simulate this study about putting bombs inside your suitcase. In our control condition, the person is carrying a book, and we are able to detect the width more than 80% accuracy, whether or not you're carrying a bomb or carrying a book in your suitcase, and the false alarm and miss rates are very low. This is very encouraging. This is simulated situation with university students. It doesn't really count too much, however this looks promising. You can use this technology during police interrogation or this is the one, in the US, in Canada that doesn't happen very much, but in the US during deposition, you typically allow to videotape the person being deposed. You actually can, they are millions of tapes. Millions of eight hours of tapes out there right now.

You actually can get, and you can analyze the video using our technology, and you can find out what's going on because you can have multiple sessions of their position and that you can find out. The last time I asked this years questions, the post is not responding with emotion, but the certain situations, the person seems to responding differently. Now let's bring the person back again and do another deposition. Just think about this kind of potentials. Another one of course in the court, this is actually Canadian court, and I don't know the extent to which the whole session is being videotaped, the videotape the session would be enormously useful for me as a researcher to analyze various courtroom exchanges and to find out some predictable things by the four lawyers on both sides.

I think it will be enormous useful for you to learn about the courtroom activities and the judge and therefore learning about the judge and how you can approach your cases. I'm just making it up. This is the case. We had this person doing a simulated experiment. He carried a bomb and then during the entire period, he's pretty calm. Once we talk about bomb before you even we ask question, he knows the questions coming up. His entire physiological activity change. Our software is able to pick up so to give us a warning to the interrogator about, this is the time, he probably has something to hide. This is wrong, and the finally along another application is this, I'm going to show you all three videos. Are you heard of this? This is called deep fake. Go watch this. This is a job. Real person, I need to stop this. Okay.

[inaudible] we were able to actually. Can you turn down that sound it's not necessary. You can see. This is the of there, so they can put anyone's face on anyone's body, any voice on any person's face. Then produce a realistic looking fake videos. Imagine you can have this in being introduced as evidence. That the question is how do you defeat it? We are working on this, just a side project by one of my students. He created a lot of them. Then we use our technology. We actually can tell using facial blood flow because when you do deep fake, you destroy this critical information about your face and therefore the information comes out as fake. Then we can differentiate between the fake and the real videos very easily.

Of course the technology going to develop, we don't know what's going to happen. People are going to develop a technology against us. We have to develop the

barriers algorithms. So far so good. Anyhow, I want to move to the next level. When I'm talking about in the future, if any AI system only has the I chord code AI, that's not enough. Is there AI system that interact with humans must have emotional AI in it. This is the future of AI should be able to decode emotion from language, from expression, from physiology, and hopefully in the future, even from your brain, by taking all this data together, then you should be able to learn about your emotions and then interact with you appropriately. Then there's actually a future that you can imagine in the next five, 10 years, there's a robot in your office or at home who actually becomes your friend, interact with you, talking to you to solve some problems and being really your friend and are a member of your family.

This is something that I envisage that's going to happen not in the far future. I wouldn't bring back to you the Ai Work I started actually is somewhere around 2004 2005. I collaborated with this guy. Which side is this? The shorter guy is the real person. The other one is actually a robot, they call it's an android. This is Hiroshi Ishiguro from University of Osaka. He was the pioneer of android robot. He want to design robot that has all the artificial intelligence that's similar to human, emotional and intellectual intelligence. He wanted to devote, and he also wanted, the person looks exactly the same as humans that you cannot differentiate. That was his dream. He's working on this for more than 20 years now. His very famous, a mad scientist.

I always wondered, I said, you know, I said, why would you do this? There's no need that you can create a robot like this. They still can do all the work, but he said no, he's a con. The reason I'm doing this work is not creating some intelligence system out there and serving people because I really want is to use this process to understand human nature. I believe this is really struck me as something very fundamental. The reason I'm doing AI work is not because I want to create something out there that benefits people, which is great, but I really want to do is through my work, through others work. We learn more about ourselves. Thank you very much.

Professor D'Agostino: Thank you. That was so humbling and inspiring and all I could think of is just keep up the brilliant work and we look forward to welcoming you here maybe next year and hearing about your latest inventions. Thank you so much. I'm also grateful to UFT for how they were able to really connect with you and really help you commercialize this and neurologic. Thank you, professor Lee.