



CG GARAGE PODCAST #263 | WAEI ABDALMAGEED MACHINE LEARNING SCIENTIST, ISI

Deepfake videos are a new battleground in the war against online misinformation. Join Wael AbdAlmageed to discover how he's developing weapons to combat them.

"Deepfake" videos have become hugely popular online - for better or worse. This AI-powered technology results in hilarious celebrity head swaps but, as Jordan Peele demonstrated with his manipulation of Barack Obama's speech, they could play a more disturbing role in online misinformation. Mathematician Wael AbdAlmageed's mission is to develop tools that can quickly detect deepfakes with a good degree of accuracy.

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CHAOSGROUP

Chris Nichols All right. Wael, right?

Wael AbdAlmageed Wael.

Chris Nichols Wael.

Wael AbdAlmageed Yes.

Chris Nichols Wael.

Wael AbdAlmageed It's like two syllables with a guttural stop in the middle.

Chris Nichols Wael.

Wael AbdAlmageed Perfect, yeah.

Chris Nichols Yes, well I don't know if you know this, but I was born in Cairo.

Wael AbdAlmageed Oh no, I didn't know that. Oh, my God.

Chris Nichols Yes, yes, so I'm-

Wael AbdAlmageed What's the back story?

Chris Nichols What's the back story? Okay, my father was the business manager for the American University in Cairo.

Wael AbdAlmageed Oh, interesting, okay.

Chris Nichols Yeah, I lived in Garden City.

Wael AbdAlmageed Oh, nice. For how long?

Chris Nichols Oh, till I was six.

Wael AbdAlmageed Oh, wow.

Chris Nichols So from birth till I was six years old. I went to the Franciscan Nuns School in Garden City.

Wael AbdAlmageed Wow, this is such a small world.

Chris Nichols I know. I loved it. It was fun. It was in the '70s, so during Sadat years. It was very different. So anyway, you're Egyptian I'm assuming, or you're from Egypt, right?

Wael AbdAlmageed Egyptian-American now.

CHAOSGROUP

- Chris Nichols Egyptian-American, right. So that's where you grew up and that's where you went to school, right?
- Wael AbdAlmageed Not in Cairo. After I graduated college I moved to Cairo to work in Cairo, but I actually originally from a smaller city between Cairo and Alexandria, it's called Mansoura.
- Chris Nichols Mansoura, okay.
- Wael AbdAlmageed So after I finished college I moved to Cairo to work in Cairo.
- Chris Nichols Oh, okay. Then what got you to move to the United States? More education?
- Wael AbdAlmageed Well, I didn't actually move to the United States from Egypt right away. I moved to Canada first. I used to be a software engineer in Toronto.
- Chris Nichols Oh, okay.
- Wael AbdAlmageed Then a good friend of mine convinced me to go back to academia, "Industry is not for you," and he convinced me to move to the United States to go to grad school.
- Chris Nichols Grad school, okay.
- Wael AbdAlmageed Yeah.
- Chris Nichols So you went to New Mexico, right?
- Wael AbdAlmageed I first went to UNR, University of Nevada at Reno.
- Chris Nichols Oh, okay.
- Wael AbdAlmageed The department was too small. I didn't really like the research problem I was giving, so I decided to apply again about a year and a half later or something, and then I moved to University of New Mexico in Albuquerque.
- Chris Nichols In Albuquerque, all right. My dad lives in Albuquerque. It's really nice, yeah.
- Wael AbdAlmageed It's a nice city, yeah.
- Chris Nichols It's a nice city. I like it. It's a really kind of an interesting, very creative place.
- Wael AbdAlmageed Yes. Yes. Very small. You only have the university. You have Sandia National Labs, the Air Force base, and that's pretty much it.

- Chris Nichols Yeah, yeah. But it's really a lot of really smart people live in New Mexico in that area.
- Wael AbdAlmageed Yes, that's true.
- Chris Nichols So you were always focused in computer graphics at some level, or as a developer?
- Wael AbdAlmageed I'm not actually a computer-graphics person. I'm a computer-vision person.
- Chris Nichols Computer-vision person.
- Wael AbdAlmageed Yes, which is pretty much the inverse of computer graphics.
- Chris Nichols Right.
- Wael AbdAlmageed Computer-graphics people create things. We do exactly the opposite. We actually take videos and images and try to understand them, so that's what I have been doing since I graduated college, try to make sense out of images and pixels.
- Chris Nichols Right. Okay. And so what are some of the applications that you could be using for computer vision? Obviously things like autonomous driving is a big thing now. Obviously with Tesla it's all computer-vision-based, right?
- Wael AbdAlmageed Mm-hmm (affirmative), yes.
- Chris Nichols And detecting things.
- Wael AbdAlmageed Detecting things. Basically trying to understand visual information. Try to understand images and videos.
- Chris Nichols Right.
- Wael AbdAlmageed Over the last six years or something since I joined USC, we have been focused on basically two big areas. One of them is biometrics, including faces, face recognition, making biometric systems more secure including fingerprint scanners, iris scanners, and face-recognition systems, so this is one big area.
- Wael AbdAlmageed Then the other area which you and I discussed several weeks ago is multimedia forensics.
- Chris Nichols Right.

- Wael AbdAlmageed Can you look at an image or video and say whether this piece of media is manipulated or altered or not.
- Chris Nichols Right. And that is a fascinating field: Understanding how data manipulation can happen on images, and obviously something very important. We should sort of clarify what we were on a panel for. So we were both on a panel for SAG-AFTRA that was happening during CES in Vegas — ironically a place with a lot of fake stuff going on.
- Wael AbdAlmageed Yes.
- Chris Nichols But also, the big thing there was obviously detecting if digital humans, a video that would be out there would be faked, right?
- Wael AbdAlmageed Correct.
- Chris Nichols And so deepfakes was a big part of that discussion that we were looking at. Obviously, I think it'd be really great from your point of view, if you could help people listening to understand how... There's a lot of people that are using deepfakes in a very broad way, but what would be a good way to describe what is a deepfake? Like, what could you actually describe as a deepfake in a more analytical way?
- Wael AbdAlmageed Well, in a nutshell, a deepfake is basically a video for a person, and that video is not real. It's actually created by a deep neural network. This is where it's not real — that's where the word “fake” comes from — and it's created by a deep neural network; this is where the word “deep” comes from.
- Chris Nichols Right.
- Wael AbdAlmageed That's why we have deepfakes.
- Chris Nichols Right.
- Wael AbdAlmageed There are a lot of methods for creating these deepfakes. Some of them are graphics-based methods, some of them are just hardcore neural network. Bottom line is that what you see is not real. This person didn't actually say this. You basically created him.
- Chris Nichols Right.
- Wael AbdAlmageed As I probably told you on the panel, deepfakes are not all created equally, meaning they're not all bad and they're not all good. Deepfakes have existed in Hollywood for, I don't know, 50 years now, or maybe even more,

I'm not an expert in Hollywood history. But people in Hollywood have created deepfakes or fakes for a really long time.

Chris Nichols Right.

Deepfakes: Now accessible to all

Wael AbdAlmageed The problem now is that deepfakes are becoming really easy to create with just a piece of software you download from an open-source portal like GitHub or something, and literally in your basement, if you have a nice computer, a couple thousand bucks' worth of computer, you can create a deepfake.

Chris Nichols Right. So what is the big thing, because right now the software that a lot of people are using to create these deepfakes are becoming very popular around the internet, are the ideas of shifting someone's face to look like someone else. The idea is that someone is acting out pretending to be another person and then they use a deepfake as a mask of that person to look like the actual person that they are doing, right, so that's the scary part, because if you can act like someone then you can make that person actually look like that person.

Wael AbdAlmageed Correct.

Chris Nichols And obviously that's been an issue because a lot of people are saying you can fake someone's performance or whatever they're doing, so this actually has implications both in terms of people's rights of what they're saying correctly as well as creating fake news is another big issue, right?

Wael AbdAlmageed Yes.

Chris Nichols So because you're in computer vision, and I'm assuming that a lot of the things you're doing is actually your role is to detect whether that's being done or not, right?

Wael AbdAlmageed Correct. Correct. Yes. What we have been doing for the last year-and-a-half now is trying to figure out that given a video can we say that this is actually fake or not.

Chris Nichols Right.

- Wael AbdAlmageed The focus, at least in my group, is to try to mitigate all the problems that come with deepfakes in terms of fake news and misinformation. The problem is not just creating one single deepfake video. If you have a single deepfake video it's not a big deal.
- Chris Nichols Okay.
- Wael AbdAlmageed The problem is that when you put a deepfake video on a social network like Twitter and Facebook and it goes viral, that is really problematic. So we have been focused on that for the last year-and-a-half on basically detecting these deepfakes.
- Chris Nichols Okay. So the tools that you guys are creating are to help prevent that from ever happening in the first place, right?
- Wael AbdAlmageed I can't really say we will prevent that from ever happening because like any machine learning or artificial intelligence tool, we will make mistakes. We will miss some deepfakes, and we will say that some authentic videos, we will say that these are actually fakes.
- Chris Nichols False positives.
- Wael AbdAlmageed Exactly. False positives or false negatives, exactly. So what we are trying to do is just make the problem a little bit easier. We were creating a tool that you can use to analyze a video and you make up your own mind whether the evidence that we provide to you makes sense or not.
- Chris Nichols Okay. But that is actually an issue that's a very interesting one because I was thinking about during our panel when you were talking about it is we have tools, for example, constantly that help us with issues like this. Like for example, you could almost talk about spam emails, right? You have a series of emails that comes through, and if I go through my spam folder right now, it is filled with bad emails that I don't want, misinformation emails or selling me things I don't want or whatever, "I am the prince of Algeria and I need all this money," you know the classic spam problem, but my spam filter detects that and puts it into a spam folder to identify that as fake.
- Chris Nichols I can still go to that folder and see whether there are emails that I may have received, which happens, emails that I may have received that were not spam but were identified as spam.
- Wael AbdAlmageed Correct.
- Chris Nichols So in a sense you're creating a spam folder for deepfakes.

- Wael AbdAlmageed Correct. Yes, this is actually a great analogy. That's pretty much what we're trying to do, but if you remember many, many years ago, 20 years ago something, spam filters were really sort of naïve and they didn't really work well, so at least 20 years ago, 15 years ago, we didn't really trust spam filters.
- Chris Nichols Right.
- Wael AbdAlmageed You couldn't really have trusted a spam filter to take an email that arrives to you, take it right away and just hide it from you; you didn't want that. So maybe 15 years ago what we really wanted is something that gives us a label or some indication that a given email is spam.
- Wael AbdAlmageed Now, with the technology that has matured for spam filtering over the last 20 years, machine learning et cetera, you can actually trust the spam filters.
- Chris Nichols Right.
- Wael AbdAlmageed Where we are now in terms of deepfake detection is where spam filtering was 15 years ago. That's why we don't want to make decisions on behalf of people. We don't want to say, "No, I'm not going to show you this on Facebook or Twitter because we think that this is fake." We just want to say, "Be careful. Think about what you're seeing."
- Chris Nichols Possible spam.
- Wael AbdAlmageed Possible spam or possible deepfake before you actually reshare it, because it might be problematic.
- Chris Nichols Okay. And so are these tools that you guys are creating, are these tools that are specifically being given to people in the social media area? Are there people — like the Facebooks and the Twitters — are they using these tools to help them, because this is obviously becoming a problem in some ways, right?
- Wael AbdAlmageed So my group, we work for academia. We work for a university, so our research is public. The first generation of the detector that we created six or seven months ago has been publicly released; the paper is public — anybody can actually implement the software if he wants.
- Chris Nichols Right.
- Wael AbdAlmageed Nobody approached us on Facebook or Twitter to actually use our software. We would be more than happy to share the code with social

network platforms if they actually want to do something "serious" about fighting deepfakes, but that hasn't happened yet.

- Wael AbdAlmageed In the meantime, we don't want to share our code publicly on GitHub or something because people who actually create deepfakes can take our software and improve their deepfakes to fool our software. So it's a cat-and-mouse game. It's something that will be there in the community for a really long time.
- Chris Nichols Okay, well that's actually a good point because I think that people obviously do that, like for example in spam detection, there were weird emails that looked like they were a long email and they would write all kinds of garbage in there just to fool the spam filter, so it'd come out of it, right?
- Wael AbdAlmageed Yes.
- Chris Nichols So they knew how the system worked and it's like you said, a cat-and-mouse game.
- Wael AbdAlmageed Correct.
- Chris Nichols That's interesting. Okay, so now that we have this idea of understanding deepfakes, what are some of the things that you can do that you can talk about that help detect whether something is fake or not? How do you train the system?
- Wael AbdAlmageed We train the system with large amounts of deepfake and authentic videos.
- Chris Nichols Okay.
- Wael AbdAlmageed This is basically not just for deepfake detection, it's sort of the fundamental idea behind deep neural networks.
- Chris Nichols Right, so you're using almost the same kinds of tools to create them, to detect them.
- Wael AbdAlmageed Exactly, yeah. And this is not just for deepfakes, this is pretty much a common theme for everybody who does deep neural networks or artificial intelligence these days.
- Chris Nichols Right.
- Wael AbdAlmageed We all use exactly the same tools.
- Chris Nichols Right.

- Wael AbdAlmageed Think of it like a box of Legos, and we're trying to put together the Legos in a certain way to enable us or help us detect deepfakes. People who create deepfakes use exactly the same box of Legos, just they put it in a different way, different kinds of combinations to create deepfakes.
- Chris Nichols Interesting.
- Wael AbdAlmageed So what we do is we try to sort of capitalize on our experience for the last six years in terms of face recognition et cetera because we had a large project for face recognition, and under that project, we created a whole bunch of tools, for example, face detection from videos from landmark detection, finding eyes, mouth, nose and the boundary of the face et cetera. We had a whole bunch of — think of it as a toolbox — and we're trying to use this toolbox to help us detect deepfakes.
- Wael AbdAlmageed So what we do is detect the face in each frame of the video, detect the marks, and in order to sort of minimize the effect of head motion we use these landmarks in each one of the video frames to align all the faces on top of each other.
- Chris Nichols Okay.
- Wael AbdAlmageed So literally you look at the face... of course, that's not-
- Chris Nichols You're basically isolating the face and body.
- Wael AbdAlmageed Isolating the face and we're trying to minimize the head motion. So after we align all the faces or the face of the same person in all frames on top of each other, it appears as if the face is not moving, only the eyes and mouth are moving, and now instead of looking at each one of these frames independently to try to figure out if the video is fake or not, we look at the whole video as a three-dimensional cube of data in time. So we try to find inconsistencies or incoherencies in terms of how the face looks. For example, is the texture of the same area of the face consistent between frames or not? Does the mouth and eyes move in sort of a coherent way or not?
- Wael AbdAlmageed Because in two consecutive frames or a few frames in between or something, if the eye is open, it will not be closed very quickly.
- Chris Nichols Okay, right.
- Wael AbdAlmageed So we sort of look for these inconsistencies through time to figure out if a given video is manipulated or not.

- Chris Nichols Oh, okay. So one thing else I thought was interesting is if you look at... So the way that some of these deepfakes work, let's say, the famous Ctrl Shift Face videos, which are very good, those are incredibly rich deepfakes where they basically took Bill Hader and they made him look like Tom Cruise. That's a very good example of a deepfake, and a very successful one. But correct me if I'm wrong, the way that they're doing it is they're not actually pasting Tom Cruise's face onto Bill Hader, they're morphing Bill Hader's face to the features of Tom Cruise. Is that a better, accurate description of it?
- Wael AbdAlmageed For that video, yes, but generally speaking there are basically sort of – if you will – two big families of methods for creating these deepfakes. One of them is, let's use the Obama video, the very famous Jordan Peele Obama video.
- Chris Nichols Yes. That was a mouth manipulation.
- Wael AbdAlmageed Exactly. So basically what happened is that this is an original Obama video, except that they sort of transferred the facial expressions from Jordan Peele's video into Obama's face. So that's still Obama's face, they literally just altered the way he moves his mouth and eyes, or maybe just even mouth.
- Chris Nichols It's puppeteering almost.
- Wael AbdAlmageed Exactly, yes. I think this is called face reenactment.
- Chris Nichols Right.
- Wael AbdAlmageed Where that is actually an Obama video, except that you transfer the expressions, or the face expressions from one video to the other, which is from Jordan Peele's video into Obama's video.
- Chris Nichols Right.
- Wael AbdAlmageed So this is one family of algorithms that create deepfakes. The other family of algorithms where for example the famous Jennifer Lawrence video.
- Chris Nichols Okay, yup.
- Wael AbdAlmageed This is basically somebody took somebody else's face, I can't remember who was the source of the manipulation, and literally replaced Jennifer Lawrence's face in the video.
- Chris Nichols Right.

- Wael AbdAlmageed Right? So these are the two big families of methods for creating deepfakes.
- Chris Nichols Right.
- Wael AbdAlmageed And both are equally hard to detect.
- Chris Nichols Okay, but when you're changing the way that Obama's lips move to match the lip synching of the audio, or you're changing Jennifer Lawrence or you're doing the Tom Cruise one, aren't you stretching and compressing pixels in order to make that happen, right?
- Wael AbdAlmageed Correct. But just for clarification, you are not changing Obama's lip movement to match the audio. You're changing Obama's lip movement to match Jordan Peele's lip movements, which in turn follow basically Jordan Peele's audio.
- Chris Nichols Right, yes.
- Wael AbdAlmageed This is what makes it sort of easier if you will.
- Chris Nichols Okay.
- Wael AbdAlmageed Because you're not tracking the audio, you're actually just transferring facial expressions and lip movements from one video to the other.
- Chris Nichols Okay. But they're stretching and compressing.
- Wael AbdAlmageed Yes, absolutely.
- Chris Nichols Is that something you can detect?
- Wael AbdAlmageed Yeah, that's exactly what we're trying to find. There will be stretching and compression, and there will be inconsistencies in each frame and throughout the video.
- Chris Nichols Right.
- Wael AbdAlmageed Is this something that people who play deepfakes are going to solve? I think so. They will. And they will keep improving their methods and we keep improving our methods. That's why as I mentioned in the panel, it's an arms race.
- Chris Nichols Oh yeah, yeah.

- Wael AbdAlmageed This is for people who will be listening to us, this is very similar to what has been happening in computers in the last 50 years in terms of viruses, anti-viruses, people create viruses and other people create anti-viruses-
- Chris Nichols Sometimes it's the same people.
- Wael AbdAlmageed Exactly. Yeah, you can play both teams.
- Chris Nichols Yeah, you can make the virus and give the antidote at the same time.
- Wael AbdAlmageed Yes, exactly. You can play both teams.
- Chris Nichols Right. Which is actually something that's very interesting. That could technically be something that someone does, like I've created deepfake, and I've created something that can detect it's deepfake in some ways, right?

The pros and cons of deepfakes

- Wael AbdAlmageed Correct. Well, technically yes. I have a big ethical issue with this. As I mentioned earlier, I am not a person who basically says deepfakes are all bad. That's not true. I gave an example at the panel after Paul Walker died, the studio I think spent like \$50 million to recreate him.
- Chris Nichols Right.
- Wael AbdAlmageed So the deepfake creation technology will significantly cut these costs, so that's a good use of deepfakes, right. In the meantime detecting deepfakes is also important because you need to fight misinformation and fake news et cetera, et cetera.
- Chris Nichols Right.
- Wael AbdAlmageed My problem is that you cannot play both teams. You have to stick with one team. You cannot have your cake and eat it too, if you will.
- Chris Nichols Right, right, right. Yeah. Absolutely. Absolutely. Okay, then it becomes much more of an ethical question, right?
- Wael AbdAlmageed Yes.

- Chris Nichols What is allowable and what's not allowable? If you're trying to spread misinformation then you'd have to classify well what is misinformation and what is entertainment, right?
- Wael AbdAlmageed Correct.
- Chris Nichols Obviously the Corridor Crew guys, they famously made a video of them pretending to have Tom Cruise coming to visit them at their office. What they did in that video, and I talked to Niko about it, it was very interesting, he says, "I want to see if we can do this." So the video is about them showing if it's possible or not. They're not actually trying to fool you. They were trying to show you if they can do it.
- Chris Nichols In the video, just to give a better description of it is basically they met a guy who does a very good Tom Cruise impression. He came by the office pretending to be Tom Cruise as an impressionist, but then they helped his impression by actually making his face look like Tom Cruise in some ways. This was shown to you as, "This is fake, and isn't it funny?"
- Chris Nichols So I think that while it's entertaining to see that in some way, it also helps to let people know that this is possible, so it's part of educating people that it's possible, and therefore that is almost more valuable than knowing it. So for example, I've been getting spam emails for years to the point where if something comes through is a false negative that comes into my inbox, I'll say, "That's pretty spam," and I can tag it as spam, right?
- Wael AbdAlmageed Yes.
- Chris Nichols That's because I've had years of my own deepfake deep learning of this process that I can detect that. So do you think that that's also part of a responsibility that we have is to actually show people deepfakes so that they can identify them and when some deepfake arrives, it's like, "That's probably fake."
- Wael AbdAlmageed I 100% agree with you. I think really the fight against misinformation, not just deepfakes, does not just involve people who work in entertainment or people who create technology like myself and my group, I think it's a much bigger responsibility than just entity or one group. I like the example that you said, "We can create this to educate the public."
- Chris Nichols Right.
- Wael AbdAlmageed This is one team of people who actually can do this. In the meantime, people like myself need to continue developing algorithms and technology to actually detect these deepfakes automatically.

- Chris Nichols Yes.
- Wael AbdAlmageed In the meantime there is a big responsibility on the shoulders of social network platforms, because think about it this way: I can create an educational deepfake video, post it on my Facebook or Twitter page, and clearly say that this is a deepfake, it's entertainment et cetera, et cetera, very similar to the Obama video. But a bad actor will take the video, repost it on his Twitter feed without saying that is actually a deepfake that's meant for education or entertainment, and use it for misinformation.
- Chris Nichols Right.
- Wael AbdAlmageed This is where a responsibility on the shoulders of social network platforms come because they can actually use the existing technology to sort of fingerprint their videos and say, "Yeah, this is the social that video, this is not original or this is not authentic. This is where it came from, and it was meant for educational or entertainment purposes."
- Chris Nichols Right.
- Wael AbdAlmageed And of course, the school system, parenting, misinformation in general is a really big problem, and there is no one-size-fits-all solution to that problem.
- Chris Nichols But for example, the social network — let's say Facebook uses a system like the one that you have to detect things — they could automatically put a tag on that post saying, "This video is faked." Right?
- Wael AbdAlmageed Yes.
- Chris Nichols The video can still play. You can still watch it, whether it's educational or intended to try to misinform, but if it has that tag you're going to immediately question it. So it will actually serve both purposes, right?
- Wael AbdAlmageed 100% I agree. I totally understand that social network platforms do not want to really get involved in that battle. I get it. I'm not going to take hard stances against anybody, but Facebook for example, do not really have to say, "This is fake." Just show me a bar from 0 to 100 or 0 to 1 showing how confident the social network platform is in terms of the authenticity of that video. Show me something and help me make my own mind up.
- Chris Nichols Right.
- Wael AbdAlmageed You don't have to say, "This is fake." You don't have to take a given stance one way or the other, just give me tools to make up my own mind.

- Chris Nichols Right.
- Wael AbdAlmageed Or, you know what? It could be even easier than this. You don't have to say anything. The social network platform doesn't have to give me anything, but give me the capability to right-click the video, submit it to a service, and that service will tell me how much are we confident in terms of the authenticity of that video. Just give me tools to study a video, investigate a video.
- Chris Nichols But I don't think people will be... I think that a lot of people don't – especially in social networks, we know this for a fact, people are not doubting what they're getting as much.
- Wael AbdAlmageed Agreed, yeah.
- Chris Nichols They just assume it's on the internet and it must be real, which is the stupidest thing.
- Wael AbdAlmageed I 100% agree. And that actually is sort of magnified by what I like to call the echo chamber.
- Chris Nichols Okay.
- Wael AbdAlmageed My friends on Twitter or Facebook will have exactly the same political views and social views like me, so I tend to believe anything they post without actually thinking about it, and I will probably reshare it.
- Chris Nichols Yes. Yeah. I know when someone sends a news article for example that doesn't seem authentic to me, if I call it out, like, "I don't know if that's real," or I say, "That's not real. It's been well disproven," people get really angry at you for correcting them.
- Wael AbdAlmageed Yes, for doubting them. "How come you doubt me?"
- Chris Nichols Right. Or, "You're saying that I'm stupid because I didn't do the research to actually look for that information."
- Wael AbdAlmageed Yeah, exactly.
- Chris Nichols It's not good and it's not helping the situation by basically ignoring that post and saying, "Well, I shouldn't say anything because I don't want to hurt that person's feeling," is actually dangerous too because it helps propagate it, right?
- Wael AbdAlmageed Exactly. Yeah. Staying silent is not an option anymore.

- Chris Nichols Right.
- Wael AbdAlmageed In this day and age-
- Chris Nichols I was actually insulted once, someone was like, "I don't want you to be the internet police on me," and I was like, "Well someone has to be!"
- Wael AbdAlmageed Yeah, exactly. We actually have to be policing each other because this is the fundamental concept of social networks. There is no big brother. We are all big brothers on top of each other. So when I see a piece of fake news that you're posting on your Twitter feed or something, I have to say something, otherwise, if it goes viral it's a really big problem.
- Chris Nichols Right.
- Wael AbdAlmageed Yup.
- Chris Nichols Yeah, yeah, absolutely. Well, I'm glad you said that because it's very interesting. Now, I do want to talk about... because we mentioned that you know Hao as well at ICT, right?
- Wael AbdAlmageed Yes.
- Chris Nichols And so it's interesting the kind of duality you play with him because he actually creates a lot of it, and so tell me about how you guys work together or work with each other in some ways.
- Wael AbdAlmageed Hao's a good friend of mine, but we come from different backgrounds. Hao came from the graphics background-
- Chris Nichols The creation.
- Wael AbdAlmageed The creation, exactly. And he has a lot of experience working with Hollywood through ICT or computer science at USC or even his Pinscreen company. I came from a vision background where I take videos and images and try to make sense of them, try to understand what's in there.
- Chris Nichols Right.
- Wael AbdAlmageed But again, as I mentioned, not all deepfakes are created equally. Hao's is using his skills and expertise to create technology that helps studios to create digital humans, et cetera, et cetera for good uses. I come from a background where I try to fight fake news and misinformation, but we have this duality. It has been nice.
- Chris Nichols Well, both of you are trying to create awareness of this situation, right?

- Wael AbdAlmageed Correct.
- Chris Nichols It was fascinating, I just saw a post that he just put out, I guess they made a big display at Davos.
- Wael AbdAlmageed At Davos. Hao was at Davos this week.
- Chris Nichols So he's at Davos this week showing off, and he's basically showing like, "Here. Here's a deepfake." So this is bringing awareness to a much bigger platform of people to know about this stuff.
- Wael AbdAlmageed Yeah, and I'm glad Hao is taking this stance because he, as you mentioned, Hao creates this deepfakes for good uses, for Hollywood, for digital humans, for privacy et cetera, et cetera. When awareness comes from people who actually create these deepfakes, that's a good thing.
- Chris Nichols Right.
- Wael AbdAlmageed Because if I keep talking about my own research and my technology that, "Yeah, this is important," I might not be as credible as people who actually create this technology and these deepfakes and say, "Be careful. This has to be used with a grain of salt."
- Chris Nichols Right. Yeah, yeah, it's very interesting to bring that up. I want to go to quick detection, because we talked about this briefly as well. There's lots of different ways that you can try to use for detection purposes or strategies that you can use for detection purposes, which you mentioned more specifically is about you isolating the face and creating that.
- Chris Nichols There was another, I forgot her name unfortunately, that I saw her at... I did a similar panel about deepfakes, and her detection is about the reverse. She's looking at disjunction between the face and the hands or the gestures that are going on. There's a different type of technique that she uses.
- Wael AbdAlmageed Correct. I think you're referring to the work that came from my friend's team and Berkeley, Hany Farid's team.
- Chris Nichols Yes, yes.
- Wael AbdAlmageed So his student, I can't remember her name now, but yes, you're right, she's trying to sort of model facial expressions, audio features — I think also hand gestures or something, if I remember correctly — for each individual person.

- Chris Nichols So let's take Donald Trump or Nancy Pelosi for example. So they train the system to learn how that person would actually work, so when she says a word, does the hand do a specific thing?
- Wael AbdAlmageed Correct. Yes, because I think even in their paper they showed that politicians for example, Obama, he tends to move his head in a certain way when he says specific words.
- Chris Nichols Right.
- Wael AbdAlmageed So if there is inconsistency between how the head moves and what he's actually saying, this is an indication that the video is manipulated or fake.
- Chris Nichols Right, which is a pretty interesting approach.
- Wael AbdAlmageed Yes.
- Chris Nichols But the problem is that it only works for that one person. You're training one person at a time, right?
- Wael AbdAlmageed Exactly. I'm glad you mentioned that. My good friend Hany Farid from Berkeley agrees. He's actually the group leader on that, and he agrees that this is a shortcoming of their approach. It doesn't scale to a large number of people.
- Chris Nichols Right.
- Wael AbdAlmageed It works really well for a small number of politicians or celebrities where you try to protect their — I would say identities, but you're trying to protect them on the internet, but it doesn't scale beyond that.
- Chris Nichols Right.
- Wael AbdAlmageed The advantage of our approach, with all due respect to my friends at Berkeley, is that we scale.
- Chris Nichols It's universal.
- Wael AbdAlmageed Exactly. It's one model that works really well for a very large number of people, because we don't tend to model each person independently. We look for inconsistencies through time.
- Chris Nichols Okay. I think that's interesting because there's a little bit of that trigger sometimes when you see certain fake videos. For me, I've been studying the uncanny valley for a long time, but there's something's not quite right. I don't know what it is, but something's not quite right.

Wael AbdAlmageed Yes, it doesn't feel right.

Chris Nichols Doesn't feel right. And that's sort of always what triggers it with me, but there's a certain point the content is so compelling that you let that disbelief go a little bit. What are some of the things that people can do to say, "Okay..." Let's say you're watching a video of something and you're like, what are some of the things that people can do personally to say, "Hey, you know what? That's probably a fake," beyond your filter. What are things that people can look for in a video to say, "Look at this. Look at the eyes. Look at the mouth." What are some of the things that people can visually identify beyond using a filter that would — a tool that can do it? What can you do in your own head?

How to spot a fake video

Wael AbdAlmageed I can mention a couple things off the top of my head. One of them is sort of using your own knowledge about a specific person. So for example, a really famous video for — I think they replaced Trump's face with Mr. Bean. That's a really famous video.

Chris Nichols Right.

Wael AbdAlmageed You look at it, it actually looks visually pretty good, but you don't feel right about it, exactly because of the uncanny valley that you mentioned. It just doesn't feel right, because your own knowledge about this specific person, he doesn't talk or move his eyes or head that way.

Chris Nichols Okay.

Wael AbdAlmageed This is the problem now that people who create deepfakes still have; it's the uncanny valley. Yes, we can create something that visually looks pretty good, but it doesn't feel right. This is where they still sort of come short. So this is one thing. You use your own background and experience or knowledge about a specific person to figure out if the video actually is natural or not. The whole idea about the uncanny valley is about the naturalness of the video.

Chris Nichols Okay.

Wael AbdAlmageed So this is one thing. The other thing — which is sort of a care ability and pretty much all video players now is slow down the video. You have to

play the video at 30 frames per second. Slow it down a little bit and look for inconsistencies.

Chris Nichols Okay.

Wael AbdAlmageed Do the eyes move in consistent ways? There is actually a really interesting sort of shortcoming of these methods. Now, sometimes they have what we like to call semantic inconsistencies, which might not be really clear, and deepfakes. I'll give you another example in a moment, but what I mean by semantic inconsistencies is that sometimes they create one blue eye and one brown eye, so this is a semantic inconsistency. This doesn't really exist in deepfakes, because deepfakes, as I mentioned, you take the whole face and replace the face of another person, or manipulate their facial expressions.

Chris Nichols Right.

Wael AbdAlmageed But in terms of generally speaking about multimedia misinformation there is actually a sort of parallel big problem now where you can actually create faces of people who do not even exist.

Chris Nichols Right.

Wael AbdAlmageed There is a really famous website called ThisPersonDoesNotExist.com where you can continuously generate images of people who don't even exist, and that's actually a big problem, which is — even from a computer-vision perspective, from an artificial intelligence perspective, it's even harder to detect than deepfakes.

Chris Nichols Oh, okay.

Wael AbdAlmageed Yes, because you literally have one frame. It's just one image.

Chris Nichols Right.

Wael AbdAlmageed You need to figure out if that image is true or not true; one image. So that's a much harder problem than deepfake detection.

Chris Nichols Yeah, okay. Fascinating. Okay, so hold on, I had another question about... Okay. So I do want to talk about just generally the idea of using deepfakes for good things or ideas that could be better, right, so right around the time that, right after — I think it was almost hours after we did our panel in Vegas — there was an article that came out, I think it was in *Esquire* about someone who did not like the de-aging that was happening for *The Irishman*. They created a deepfake version of the de-aging instead.

Wael AbdAlmageed Oh, interesting. I haven't seen that one.

- Chris Nichols I'll have to show it to you. So I had a bit of an issue with the de-aging in *The Irishman*, not that I thought it was particularly bad, I think what ILM did was very interesting. I think they have really good techniques to do it. It was based on actual CG face replacement as opposed to 2D manipulation that can happen in some of the other methods.
- Chris Nichols The problem I had was in terms of the narration of the story, is that they took someone that was 70-plus years old, and then they de-aged them to about 50 years old, but then they used that same age pretty much throughout the entire film, which was three-and-a-half hours, so Robert De Niro never looked like he was 30.
- Wael AbdAlmageed Yes.
- Chris Nichols But in the deepfake one, they basically trained it on Taxi Driver when he was 30, and he looked like he was 30, and the video is very compelling. It was like, "Oh, he definitely looks a lot more like Robert De Niro when he's 30." Although, there were several issues that I had that I think were interesting. One was that they selected areas or parts of the film to show where he wasn't necessarily moving too much, because then it would work because there's certain body language of someone that's in their 70s, that's not different than body language of someone in their 30s, so if he's not moving too much, there's not as much inconsistency, but a 70-year-old man does not walk like a 30-old-man, so there's a lot of inconsistencies there.
- Chris Nichols But the other one obviously that was interesting to me because of my study of digital humans is that the ILM version was very good at creating an incredible amount of detail in the face because they try to retain as much textural detail and all that stuff-
- Wael AbdAlmageed Then kills it, yeah.
- Chris Nichols But then the deepfake one I thought was more successful at creating the proper face shape, but not as good as creating the texture.
- Wael AbdAlmageed Correct.
- Chris Nichols What are those limitations? Obviously there's a limitation in creating the micro-detail in deepfakes, and why do those limitations exist and how are they going to get better and how?
- Wael AbdAlmageed In terms of whether they will get better, I can assure you, they will get much better – and really quick.
- Chris Nichols Okay.

- Wael AbdAlmageed I would say even my good friend Hao expects that these will get really much better within a year or so. How, I don't exactly know how that will happen. I am sure somebody from the content-generation community will come up with a more sophisticated deep neural network that creates these sorts of fine-grain details.
- Chris Nichols Right.
- Wael AbdAlmageed I don't know how that will happen.
- Chris Nichols Well, the limitation right now is the amount of memory you have in a GPU.
- Wael AbdAlmageed Exactly. Yeah. So the main limitation right now is that most of the work is done at low resolutions because of the amount of memory, as you mentioned, on the GPU. Everything needs to be moved from the CPU to the GPU to do all the processing in terms of the deep neural network, and then you bring it back to the CPU.
- Chris Nichols Right.
- Wael AbdAlmageed My assumption is that in the next couple of years at most, NVIDIA will come up with another GPU with much bigger memory, so that's from the hardware side. From the algorithm side, someone will come up with a really sophisticated neural network that actually-
- Chris Nichols Much more efficient.
- Wael AbdAlmageed Much more efficient, memory efficient, and it can produce these fine-grain details.
- Chris Nichols Right.
- Wael AbdAlmageed Whether it will happen or not, this is what I also mentioned to the panel.
- Chris Nichols Right.
- Wael AbdAlmageed Get on the train. AI will work, and will work much better than it is now.
- Chris Nichols Right. Basically this a form of AI, right? It's an artificial intelligence system.
- Wael AbdAlmageed Yes.
- Chris Nichols But the thing that's interesting about these ideas of what these deepfake things do is that they are all based on knowledge that it already has, so it only can really work based on things that it already knows.

Wael AbdAlmageed I wouldn't really say things that we already know. It's basically data-driven.

Chris Nichols Right, but that data is an existing thing.

Wael AbdAlmageed Exactly. It really depends on things we know, as you said, but sort of indirectly through data. So the whole premise of deep neural networks is that we learn from data, we don't handcraft features or handcraft algorithms. We have a whole bunch of data and you learn from data. That's the whole premise.

Chris Nichols Okay. All right, that's very interesting. I find it fascinating, obviously I've been looking at a lot of these ideas, and obviously there's more to it. There's detection of images, those are happening right now. There's also audio manipulation that's starting to happen at this point. Is it a very similar thing in the audio world? I don't know how much you know about the audio problems as well where people can actually learn how someone speaks and then type out sentences and have that person say it as if they were saying it for real.

Wael AbdAlmageed Correct. I am not an audio expert, but I have seen a couple of demos from some colleagues at Google. They have really sophisticated technology that basically you give it text input and say, "Simulate how Chris would have said that particular sentence."

Chris Nichols Right, and there's plenty of audio from my podcast that they can learn from, right?

Digitally deaging *The Irishman*

Wael AbdAlmageed Exactly. From movies, same thing. The same thing they did in *The Irishman* for Robert De Niro can be done for Robert De Niro from his previous movies. You just extract audio. You learn how Robert De Niro speaks and you recreate his audio from text.

Chris Nichols Yeah. Okay. Okay, so you mentioned there's some good things that can happen from this technology. You mentioned the idea of they needed it to recreate Paul Walker from the specific movie. Now there are people that have ethical issues with that in itself, but what are your feelings about that idea of recreating actors that have passed on or things of that nature? What is your concept in that ideas there?

- Wael AbdAlmageed I don't want to discuss this from an ethical perspective because I think it's a really complicated thing, and it has different perspectives. As I mentioned on the panel, I really think it has to do with contracting and legislation.
- Chris Nichols Right.
- Wael AbdAlmageed If an actor gives permission through his contract to a studio to create new episodes for a given show or something from him, and he gets paid, there is nothing wrong with that. As long as you're protecting the worker's right. I think this is the most important thing.
- Wael AbdAlmageed In terms of recreating actors who have died or something, again, I don't want to take an ethical stance about this. It has to do with the agreement between the studio and his estate or something like that. So I really think we are at the point now where we really need to think a lot about things like freedom of speech, government intervention and things like that; contracting, legislation.
- Wael AbdAlmageed The problem, Chris, is that AI literally took everybody by storm in the last eight years, or something like that — not just us researchers but the entire society. We need to really think fast about how we should handle these ethical issues, if you will.
- Chris Nichols Right. Yeah, because very famously, lie detection for example, lie detection has been famously flawed for a long time, and a lot of people who actually know the one where they measure your pulse and all that stuff, famously is like it doesn't really work, but the idea that it might work is what scares people into saying the truth. You could actually lie and it won't really detect it in a lot of ways.
- Wael AbdAlmageed Yes.
- Chris Nichols But wouldn't you be able to do, using similar concepts of your system, training a video to learn when someone is lying and someone's not lying. Couldn't you basically try to use an algorithm similar to yours as a lie detection concept?
- Wael AbdAlmageed This is actually really interesting. It takes me back to 1997 where I was still a graduate student, and we sort of worked on a really early version of lie detection from videos.
- Chris Nichols Oh, really?

- Wael AbdAlmageed The whole idea, it's very similar to what you see in movies. You detect the eyes. You detect the pupil and irises, and you see basically how these dilate and get bigger or smaller based on certain questions.
- Chris Nichols Right, like in *Blade Runner* at the beginning.
- Wael AbdAlmageed Exactly. Yes. And I think if I remember correctly, in 1997, when we were working on that project when I was a graduate student, I think we used some of the Nixon videos to show that he was actually lying.
- Chris Nichols Wow.
- Wael AbdAlmageed You can tell from his videos.
- Chris Nichols Could you do that today on current presidents?
- Wael AbdAlmageed Well, we could do that. I don't want to go there because I don't want your audience to hate me. Yes, if we have a large amount of data, I don't think it will be technologically hard, the problem to train lie detectors, a deep neural network to give you a score from 0 to 1 to say how much we think this person is actually lying.
- Chris Nichols Is telling the truth, right.
- Wael AbdAlmageed Yes, based on just his facial expressions, eye movements, pupil dilation, even analyzing the frequencies in his audio, things like that, yeah. I think this could be relatively easy. I think it's actually an easier problem than detecting deepfakes.
- Chris Nichols Yeah.
- Wael AbdAlmageed Detecting lying is easier than detecting deepfakes.
- Chris Nichols Interesting.
- Wael AbdAlmageed Yeah.
- Chris Nichols Interesting. It's funny, but I do remember a very funny episode of Seinfeld when they were trying to use a lie detector on Jerry, and George Costanza who's a famous liar, and he goes, "I have knowledge of one of the best liars in the world," and he looks at him and he goes, "Remember, Jerry, it's not a lie if you believe it."
- Wael AbdAlmageed If you believe it. Yes, I love that episode. Yeah.

- Chris Nichols And so it's interesting, it's like okay, how do you do it? Because I think you know, obviously in a sense, this is a good example, if we actually think about the fact that when we as a species, we learn if someone's lying based on all of our knowledge of seeing people lie or not lie.
- Wael AbdAlmageed Yes, exactly.
- Chris Nichols So we have created our own deep neural network of detecting lies just... Yeah.
- Wael AbdAlmageed Exactly. And again, this is what I was mentioning earlier, the whole idea of deep neural networks and artificial intelligence is that we learn from data. Give me a big data set for people who are lying versus not lying, and I can train on your network; I think it will do a pretty good job. Again, nothing in AI is 100%. We will always have false positives and false negatives, but I think if you give me a reasonably sized amount of data, I can train on your network to detect lying, including presidents.
- Chris Nichols Presidents, yeah. Okay, that's a really great idea, which basically brings up the idea of when I try to explain to people sometimes about AI and deep neural networks, and we can use it for many things, not just faces obviously, for many, many things are being used using this technology. What is interesting about it is what people like about it mostly in the computer-graphics world. Even audio compression uses deep networks to do that as well – is that it's not actually a truth that it's giving you. It's giving you a best-educated guess.
- Wael AbdAlmageed Correct.
- Chris Nichols And the advantage is that it can create the best-educated guess faster than giving you the actual truth.
- Wael AbdAlmageed Faster and actually even more accurate than humans, in many cases.
- Chris Nichols Right, right, right.
- Wael AbdAlmageed Correct.
- Chris Nichols So I think that's a really fascinating idea about that. So, listen, we're actually pretty close to an hour, and I want to make sure that you can tell us about any other things that you think people would be interested in finding out about what kind of area of research you're doing and where people can follow some of this stuff.
- Wael AbdAlmageed Here's something that you'll be pretty much the first person to know this: So we created our first generation of deepfakes detectors back in June.

CHAOSGROUP

This is where we published the paper in Long Beach. In a week or two, we are releasing our second generation of deepfake detection algorithm. It actually works much better than before.

Chris Nichols Oh, okay.

Wael AbdAlmageed I have now support from the USC administration and Information Sciences Institute where I work for creating a service very soon, hopefully before-

Chris Nichols A service?

Wael AbdAlmageed A service where somebody actually can submit a video and we will return what we think of as forensic evidence-

Chris Nichols As a scale.

Wael AbdAlmageed At a scale to say whether this video is fake or not.

Chris Nichols Wow.

Wael AbdAlmageed We're trying to deploy the service and release it as soon as possible because we know that this is election year, so that's something that this is the first time I say this to anybody.

Chris Nichols Great.

Wael AbdAlmageed Yeah.

Chris Nichols Well, that's perfect because this podcast will come out several weeks from now, so hopefully you'll be able to get a link at that point to talk about it.

Wael AbdAlmageed Yes.

Chris Nichols Basically you're giving away a tool, but you're not giving away how you make that tool.

Wael AbdAlmageed We're not releasing the source code again, because my team and I decided a while ago that it's not ethical to release the source code, so people who like to generate deepfakes for non-ethical purposes for spreading misinformation can use our technology to improve their creation technology, so we decided we're not going to release the source code, but we're creating a service that will be available to the public.

- Chris Nichols Right, but they can still create something and say, "Let's run it through the service, see how good our stuff is, and then let's make it better and see how-
- Wael AbdAlmageed Of course, right.
- Chris Nichols But they can't actually do it to say, "Let's reverse engineer this to make it faster," right?
- Wael AbdAlmageed Yes, correct. But in terms of reverse engineering, we are still academics, we will publish a paper. If somebody's interested in re-implementing our method, he or she can. We're just trying to make it just a notch harder; but we cannot keep hiding.
- Chris Nichols But honestly speaking, do you think even fake videos, I mean fake or not, even real videos sometimes people don't believe them. People are so ground into their belief about whatever they're believing in because of the echo chamber. I never heard of that term, but that's great: The echo chamber. It's like you reinforce your idea and people keep echoing your idea.
- Wael AbdAlmageed Correct.
- Chris Nichols So even fake or not fake, people aren't going to care sometimes, right?
- Wael AbdAlmageed I agree with you, but I think there will be sort of a tipping point where everybody gets sick of this and starts using a tool to tell them whether they are really being manipulated by someone or not. And again, I don't know how people would be willing to use our service. We're creating a tool and we're putting it out there. I hope people will start using it. I cannot control what people will do.
- Chris Nichols So classic example, someone had put something, some information up there and I said, "I don't think that's correct," and then I found a Snopes article that said, "This isn't correct." That person replied back, "Snopes is biased."
- Wael AbdAlmageed Yes. Yes.
- Chris Nichols It was like, "Nope, that's not real." It was like, "But the whole point is that they're giving you facts."
- Wael AbdAlmageed Fact checking is not biased.
- Chris Nichols Yes, fact checking apparently is biased if it goes against your beliefs. So do you think that people could look at your tool and say, "That's bias."

- Wael AbdAlmageed Absolutely. Are you kidding me? People who love the current president, if we show up manipulated video of the current president, will probably hate us. People who do the same thing with Obama might actually hate us.
- Chris Nichols Right.
- Wael AbdAlmageed You cannot do something in technology and make sure that everybody's happy.
- Chris Nichols Right.
- Wael AbdAlmageed We are creating a tool. One of the things that I'm seriously concerned about is the amount of heat we're expected to get, but we're willing to take the heat. We totally understand this is election year. Our democracy has been tampered with four years ago, and we want to try our best to not make this happen again.
- Chris Nichols Yeah, yeah. Absolutely. I'm glad you're doing it. I think you're right. We do have a responsibility because the internet is technically a functioning anarchy in some ways, that we have a responsibility to police ourselves, and so I think that that's a good thing that you're giving people a tool to allow that to happen.
- Wael AbdAlmageed Correct. I really think that it's an ethical responsibility. I'm a big advocate of freedom of speech. I am totally against government interference or regulating social networks et cetera because it's a slippery slope. Once you get on it, you don't know how it will end, and we don't want that to happen. I really think that it's everybody's responsibility to police each other, create technology, from my perspective as an academic or researcher, create technology, people who are in education should educate kids on how to share content on social networks. Everybody should play a role in this.
- Chris Nichols Okay. Well, that does bring up a point because now you said what you did about freedom of speech, there are, for example, California's trying to make up a law that's making it illegal to make deepfakes — or something of that nature. There are states that are trying to say, "We should make this — outlaw this idea." I mean, I was joking, that's like trying to take pee out of a pool, you can't-
- Wael AbdAlmageed That would be hard.
- Chris Nichols Yeah.

- Wael AbdAlmageed Why not just create a law that if you actually infringe on somebody's right; for example, one of the big problems with deepfakes, which we haven't touched upon in this podcast-
- Chris Nichols Is revenge porn.
- Wael AbdAlmageed Yeah, exactly. Revenge porn. You don't create a law that says, "Don't create deepfakes," because there are some good uses of deepfakes. Just create a law that if I find out that you created the deepfake as a revenge porn for Scarlett Johansson or something, you will be punished.
- Chris Nichols Right.
- Wael AbdAlmageed We will hunt you down and punish you.
- Chris Nichols Right.
- Wael AbdAlmageed That will be enough of a deterrence to people who use deepfakes for something like that.
- Chris Nichols Right, okay.
- Wael AbdAlmageed So again, freedom of speech is a really slippery slope, and I probably told you this after the panel.
- Chris Nichols Yeah.
- Wael AbdAlmageed I'm an Egyptian-American, as you mentioned earlier. I come from the Middle East and I value freedom of speech more than you can imagine.
- Chris Nichols Yeah, I bet you do.
- Wael AbdAlmageed Freedom of speech is a slippery slope, and you have to really protect it.
- Chris Nichols Yeah, absolutely. Absolutely, I believe that. I think it's very, very important. I 100% agree with it. I think that I have just as much to say the things I do as someone who I completely disagree with says things.
- Wael AbdAlmageed Exactly.
- Chris Nichols And technically that's the thing that makes this country great, and the fact that we have been segregating different speeches just through social networks has actually been a little bit disturbing to my point, because we actually lack a conversation anymore.

- Wael AbdAlmageed Yeah, exactly. And I want to add something to your point. You made a great point that you have the right to say whatever you want, the same as anybody's right to say whatever they want. I want to add that it's your responsibility to defend their right to say whatever they want.
- Chris Nichols Yes.
- Wael AbdAlmageed And it's their responsibility, not just right; it's their responsibility to defend your right to say whatever you want.
- Chris Nichols Yes.
- Wael AbdAlmageed This is how democracy works. Otherwise, it's not going to be funny.
- Chris Nichols No, no, it's good. It's good. Well, that's an excellent way to put it. So thank you so much for doing this.
- Wael AbdAlmageed My pleasure.
- Chris Nichols This has been an incredible podcast, lots of information I think people are just going to eat it up. But this is great. Thank you so much.
- Wael AbdAlmageed Thanks for having me. I really appreciate the opportunity.