



# AI Ignition

## Ignite your AI curiosity with Dr. Andrew Ng

### Will AI penetrate every industry?

From Deloitte's AI Institute, this is AI Ignition. A monthly chat about the human side of artificial intelligence, with your host, Beena Ammanath. We'll take a deep dive into the past, present, and future of AI, machine learning, neural networks, and other cutting-edge technologies. Here is your host, Beena.

**Beena Ammanath (Beena):** Hello, my name is Beena Ammanath, and I am the executive director for Deloitte AI Institute. And today on AI Ignition, we have Dr. Andrew Ng. Andrew is a world-renowned leader in the space of AI. He is the founder and CEO of Landing AI, he is the founder of Deeplearning.AI, and he is the general partner for AI fund. Welcome, Andrew.

**Andrew Ng (Andrew):** Thank you, Beena. Good to see you here. I think despite the circumstances in society and the global tragedy of the pandemic, I think many of us are privileged to have work of a nature that we could do it from home.

**Beena:** Yes, absolutely, totally agree with you. Now, I am curious to hear, because you do so much, you do a lot, you lead a number of companies. Can you share a day in the life of Dr. Andrew Ng?

**Andrew:** I spend a lot of time working. I am privileged to genuinely love my work. The other day I woke up at 5 a.m. on a Monday morning just excited to start work. I'm probably not setting a good example, probably other people shouldn't do that. But outside of work, I really enjoy spending time with my 18-month-old daughter, Nova. As an educator since the start of Coursera and so on, I am trying to teach her the alphabet right now, and even though I know a few things about education, part of me constantly worries that I'm probably doing it wrong and there has got to be a better way to teach her the alphabet. But I hope that when she grows up that she'll consider my efforts to have been adequate. And then I hope that she will still be literate despite all the mistakes I am probably making right now teaching her.

**Beena:** What is her name?

**Andrew:** She is called Nova. There is a fun story behind her name. So Neural Networks is a technology that is really taking off and so when she was born, I wanted her initials to be N. N., kind of like Neural Networks, so I call her Nova. And then in the tech world, my computer sciences friends, there is a thing

in computer science called not a number. If you take 1 and divide it by 0, what is that? That is not a number in computing. And I thought every person is unique, every person is special, and no person should be a number, so I wound up deciding to call her Nova Athena Ng, so the initials would be N.A.N., or not a number. My computer sciences friends really love that.

**Beena:** I love it. I am a computer scientist by training, so totally relatable and the thought that you put behind it, love the name.

**Andrew:** I know you have teenagers. I do wonder when Nova grows up, whether she'll say, "What was my dad thinking when he named me this?" We'll see.

**Beena:** Yeah, I actually have two teenagers, so enjoy your time with the 18-month-old while you can, because once they become teenagers, it's a totally different life, and they don't want to learn anything from you. Parents are the uncoolest part of their life. Changing gears a little bit, artificial intelligence is a very broad topic, and you are involved in several industries. What are some of the areas that are most exciting to you? What do you see as major areas of opportunity for AI across industries and in specific industries.

**Andrew:** I am really excited about the rise of AI outside the software industry. We have all seen all the value created by AI in several leading tech companies starting with Google Brain, which helped Google become really good at AI, ran the Baidu and helped that become a leading AI company in China for the first time. But if you look at what AI has done, what we've done is transform the software industry, and leading software companies have used AI to have a big impact on themselves and on their customers. But the transformation to come is to use AI to also have, I think, an equally big impact on all of the other industries, which is actually much bigger than the tech world. So, excited about AI applied to manufacturing, where deploying things in factories where we take pictures of manufactured things, anything from a car pod to refrigerator pods to semiconductors, I take a picture of it and rather than needing human eyes to check painfully if there is a scratch or defect, we can use AI to do this. Building AI-powered agricultural machinery. We're actually running harvesters that use AI to look at the crop in front of these big wheat harvesters and based on whether the wheat is bent over, we can help tune the parameters of these harvesters so that, same farmer, same field, you get more wheat out in your hopper, the back of the harvester. So good for the environment, will help these farmers that otherwise don't have a lot of income have direct impact on the economics. I am really proud and excited about the work that AI can have on all of these other industries beyond the software industry.

**Beena:** Yeah, so true. Some of these industries have been in the same shape and form for years, and it could do with help from what AI can provide. You have really transformed education, I feel your introduction of MOOC has made education accessible to so many people, AI accessible, and then with agriculture, that is another area that is ready for change along with the larger challenges we have around climate change and sustainability and so on. Are there any industries that you think AI will not transform?

**Andrew:** Some of my friends and I have challenged each other to name an industry that we don't think AI will transform. We actually had a hard time. I actually have a hard time coming up with one. My best example was the hairdressing industry where I thought, "You're a hairdresser, pretty hard to build a robot to automate hair cutting." Once I gave a talk on stage, this was before COVID, and I said this on stage. One of my friends who is a robotics researcher was in the audience and afterwards she stood up

and she actually pointed at my head and she said, “You know, Andrew, most people’s hairstyles, I can’t build a robot to cut their hair. Your hairstyle, Andrew, a robot could totally do that.” I think one of the challenges that tech and AI brings to a lot of industries is that it’s causing a lot more industries to become winner take most or winner take all types of industries. And so take chicken farming. I am not working on it. Once upon a time, you could have a pretty nice life as a small-scale chicken farmer raising chicken somewhere in the country. But with the rise of the internet, it allows centralized players to use IoT to collect data from farms all around the country, and use the internet to centralize the data. AI allows the centralized players to then process that data at headquarters and push back out IP and technology and recommendations for all of the small-scale chicken farmers. And this is true for every industry, because tech has infected every industry. So, one of the challenges as CEOs, and I see this when I meet with executives, is if your industry is one of the ones that is becoming a winner take most or winner take all type of industry, one of the worst things that could happen is if you are just missing the beat, even by a year, so that someone else ends up consolidating the industry, this does call into serious questions about wealth and fairness in society. We do need to get through that too. We are creating tremendous wealth; we’ve got to make sure that wealth is fairly shared. And I also see a lot of executives feeling that pressure to adopt AI quickly because tech has affected every industry and with COVID that started everything digitalization and AI accelerating these consolidations, there is a lot of pressure for different industries to make sure they get it right and to do so quickly.

**Beena:** Do you also see other industries being formed which we cannot even think about right now? Do you see a new industry taking shape just driven by AI?

**Andrew:** AI is a general-purpose technology, similar to electricity. It was a general-purpose technology that came up about a hundred years ago. And so this is about transforming every industry, just like electricity transformed every industry, and it’s also enabling the creation of new businesses that maybe didn’t exist before. I think it still feels early. There are now industries built to service AI, there are now giant data labeling farms or giant data labeling companies. I think RPA, robotics process automation, will transform, become much more nimble and much more flexible. I think it may be—and there is a lot of excitement about self-driving cars, which hopefully will get here, but I find that the most exciting AI businesses we tend not to think of them even as necessary AI businesses anymore, because it is not an AI-powered wheat harvester that we’re working on, it is just a wheat harvester to the farmer and they don’t need to think about the AI, it just gives them more wheat, and ultimately that is what they care about. So, I think AI is silently making its ways into a lot of industries, not always with a lot of hype.

**Beena:** So, Andrew, you are a pioneer in education, and the world we are living in right now, there is—my kids just started school yesterday and it’s all remote and online, and you kind of initiated it a few years ago. Where do you see, what do you think education will look like a year from now and going forward? Education has been done the same way, one teacher to multiple students, for a century, from the time when education started, when schools were set up. How do you think education will look like a year from now? We are hearing about micro schools being set up, remote learning has become a necessity right now, but how do you think education will look like a year from now?

**Andrew:** The world has already been moving slowly but surely towards an increase in online digital education, and COVID has dramatically accelerated that. I think at the higher eds and post-grad level, people have recognized long ago that we all need to be lifelong learners. It doesn’t make sense for you to go to school for four years and then coast for the next forty years. Tech changes so fast. And digital

online education, things like Coursera, has been gaining momentum, steady for a long time. The piece that I worry more about right now is the K through 12, certainly in the United States and maybe it's around the world, it's just a mess. We could be doing much better. We need to lean into online education, let teachers do what they are wonderful at, which is forming connections with students, mentoring students, but instead of having so many teachers deliver the same lecture at the K-12 level or at the higher-ed level, I think Salman Khan does a great job teaching the Pythagoras theorem, so let's use online digital content like that or somewhere else. And then also let the teachers do their wonderful work they do. Maybe COVID, despite being a society-wide tragedy, is a way for us to rethink education, so that we can build it to make it better for everyone.

**Beena:** Right, so true. I honestly think that need for lifelong learning is true and the need to also be able to provide more personalized education. There is work that is going on and being able—just like in factories using image recognition to identify whether a product is defective before it makes it to the end state—to be able to, like I can see the difference in my kids, both of them learn differently, one is more visual and needs more visual stimulation, the other reads through it and gets it. So, maybe there is a way I can actually provide more personalized education targeting on the student's learning pattern.

**Andrew:** Yeah, I find the work in personalized education in the K-12 level to be very exciting. The thing about the K-12 syllabus is there is only a certain set of things taught in K-12 math, so you can create 10 versions of that same thing and then use AI to help learners navigate it in the best way for them. The challenge for higher-ed and postsecondary education is different. The challenge is a lot of the content just doesn't even exist online, and so I think there, the focus for the industry is to just get the content online so you can distribute it at low cost to everyone around the world. So, I think the challenges are different because the curriculum is much broader once you get into higher education.

**Beena:** I wonder how that will translate to the corporate world, the working life. The need for lifelong learning is real, but most of them, they think of a factory floor worker or a person working on a manufacturing floor, they have been trained, they have been doing a job a certain way, but now when you deploy AI to make the machines on the factory floor smarter, how do you upskill that workforce? Are there AI technologies itself we can use to upskill the workforce to be able to continuously learn as new technologies come in? Anything that you have seen in that space where it translates to the work life as well focused around reskilling or upskilling to use these new technologies.

**Andrew:** Yeah, I think companies like Coursera and DeepLearning.AI are educating a very wide audience on AI skills and other things. But there's one other aspect of why this is important. It turns out that, just take AI, a lot of AI had grown up in large consumer internet companies, and large consumer internet companies have a small number of applications that are incredibly valuable. A single project that may be worth, I'm just making up numbers, like a billion dollars. So web search, advertising, product recommendations, or merchandising, a single AI system is just worth a huge amount of money to a company. But once you look into other industries, what you find is that there are a lot of million-dollar applications, so rather than one one-billion dollar application, there may be a thousand one-million-dollar applications. I have seen some estimates that the value of this long tail is maybe even bigger. I think it's actually even bigger than the value in the head. But the problem for all of these industries is, if you have a thousand or 10,000 one-million-dollar projects in, say, manufacturing, where do you find the people to do this work? So when I was leading AI teams in large tech companies, if my speech recognition system broke or my online ad system broke, or something happened, I could send in 20

engineers to fix it. I just go, “Hey guys, it’s affecting revenue, fix it in the next 24 hours please,” and then it will get done. But then if something breaks in the factory, something changes, one thing that happened, we were inspecting things underwater and the water got dirty, so something broke, but the factory doesn’t have 20 engineers sitting around that we can send in to fix what is only a million-dollar routed in a billion-dollar problem. So I think one of the things that needs to happen when I—and which Landing AI has been working on—is to start to develop verticalized solutions, so that we can work with that subject-matter expert in that factory, that person in the factory that has been inspecting things for 10 years, they have tons of knowledge, and we need to build tools to enable that subject-matter expert to come and adopt and use AI tools. So Landing AI has been doing that. I think that to solve these long-tail problems will be a huge part of the future of AI, because of all the customizations that need to be done, and we just don’t have enough software engineers to do all these customizations for these 10,000 one-million-dollar projects that are already out there.

**Beena:** It’s something that I believe in, that AI literacy should be taught to everybody, at least understanding the basic concepts behind AI, so that I do think the next wave of product ideas for an industry will come from the subject-matter experts from their industries, so that is great work that you are doing in that space.

**Andrew:** Interesting thing happened to me on one of my trips. I met this person that leads the team helping different companies with AI adoption, and she came up to me and she said, “Hey, Andrew, one of the best tricks I learned for working with executive teams is I have been telling them to take your AI for Everyone course by DeepLearning.AI and Coursera. And I said, “Why? Your team knows this AI stuff,” and she said, “No, I asked my C-suite friends that I am trying to work with to take AI for Everyone, because I find that once they have done that and learn the basics of AI, they are much easier to work with and they can participate much more productively in brainstorming AI solutions in their business roles.” And I thought that was interesting that others are telling people to take AI for Everyone, because that empowers them to be more effective at brainstorming solutions to their business problems.

**Beena:** Yes, absolutely. That is a very valuable course, and I think it’s also about just having the conversation at the same level. When you are an AI expert, you tend to use complex words, which may not be relatable to the subject-matter expert who you want the inputs on. So, that is actually a course that I would recommend. But here is a question for you. What suggestions or ideas do you have for CEOs or board members, really the leadership within large enterprises who are very early in their AI journey? Like taking the AI for Everyone course is a great level setter. What other things should they be considering if they are very early in the AI journey? What are the different aspects that they should think about?

**Andrew:** AI has strategic implications for many industries, and I have seen companies everywhere on the spectrum, from don’t have any projects yet to have—a lot of companies have a handful of projects that are in the proof of concept stage but not yet deployed, to the very mature companies, like Google, that still has room for growth but has very mature AI teams and systems and processes. I think it is important for the C-suite to think about what are the next steps on the journey and to keep moving to improve the organization’s AI. I published online a document called the AI Transformation Playbook that talks about how companies can, in a relatively systematic way, become what other companies like Google and Baidu and other companies went through, to create a lot of value for their enterprises. Companies should start with small pilot projects, deliver some quick wins in order to build momentum,

but have that quick win be part of a longer journey to then figure out how to build the teams, provide the training, identify the useful AI cases for the business that will have a big impact, and then either finding partners or finding the internal resources to execute on those projects. I think two challenges I see a lot of companies face—one is a lot of projects are often stuck in a proof of concept stage, where you have your own internal teams. One CEO said to me, “Hey, Andrew, I have 40 projects in my company, but none of them are deployed. Can you or can Landing AI help me figure out what is going on?” So there are a lot of companies like that, and then it is actually wonderful that they have dozens of successful proof of concepts, that is wonderful and should be celebrated. And I think working with teams with experience taking it to products and deployment will be helpful as well. Another challenge that many companies face is how to bridge building point solutions to letting AI have a true transformative impact on the company. And if you look at the leading software internet companies, it is not that they are AI companies because they have a good advertising system they use as AI is not the point solution, it is actually a much broader transformative impact, and so bridging that, I found CEOs have a hard time with as well. And then also just getting started. If you don’t have any sufficient AI talent in-house, how can you find the right business problems to even get started on. When I meet with executive teams, I actually tell them, “I don’t want to hear about your AI problems, I want to hear about your business problems, and then it is my job to brainstorm with you whether there is an AI solution in terms of your key business problems.” I think finding the right partners to do that, and you don’t want to work on a one-million-dollar problem if there is another 10- or 100-million-dollar problem that would be an equal amount of work. So having partners to do that brainstorming so you can select the right next steps, I think that is really important for C-suite to get right.

**Beena:** What about the C-suite and board members for the companies that are more advanced in their AI journey, where they have a few AI solutions in production and they are using AI in most of their business functions? What would be some of the tips for them to go to the next level in their AI journey.

**Andrew:** One thing I have seen recently in financial services, take banking. Single out all the regional banks facing a lot of competitive pressure to adopt AI systems quickly, for example, credit scoring, because the modern AI credit scoring systems, they are just more accurate, and better loan making has a direct impact on the bottom line of these organizations. But the challenge is if a regional bank does not have the technology capability to deeply assess a vendor-created credit scoring system, which they have tremendous pressure to adopt quickly because of [inaudible] pressures, then this risk of putting in place a credit scoring system that unfairly biases against protective groups and this results in unfortunately rolling out systems with biases that we do not want in our credit system. So this is a dilemma for many of these banks. The competitive pressure, but the lack of capability to deeply audit these things, so I think we actually need a better maybe national, maybe even international, set of standards for auditing credit scoring systems, for example, so that the black box learning algorithms, which are more effective, can be made a little bit more transparent, a little less black box, and checked against the types of biases that we do not want to have.

**Beena:** Yes. That is so important, driving more transparency and accountability for the AI systems that we build. Changing gears a little bit, we hear a lot about AI taking away jobs, but AI is also creating jobs and new roles, and you have been in this space for a while. Have there been any roles that AI has created that has been a surprise to you and you were like, “I didn’t think about this.” Were there any new roles that AI created that took you by surprise.

**Andrew:** One thing that surprised me was how fast AI roles has fragmented and specialized. To make an analogy, once upon a time there were just software engineers, computer scientists, but as a few specialized, that became frontend, backend, mobile, cloud, security, software engineers, and AI has really quickly fragmented to different roles as well. One of my friends, \_\_\_\_\_ (25:13) at Work Hero did a big survey, and so today there are specialized data engineers that get the data working. There are data scientists that analyze data to help drive business results, there are machine learning engineers that build the production AI systems, and so on and so on, and I think it is very healthy that the field has become so complicated so quickly that we already need to start to have a specialization.

**Beena:** Yeah, we live in this interesting era right now with AI where the technology itself, the base AI technology itself, is growing, the applications of the AI technology is growing parallelly, and then there is all the risk consequences, regulations, and policies that is growing, so it's like three parallel streams and each one is moving at a fast pace.

**Andrew:** Yeah. There is actually one other role the C-suite should consider, which is a chief AI officer. So, as far as I know, I think I proposed this role first in an HBR article several years ago, and then actually, frankly to my surprise, some of my friends started getting jobs with the title Chief AI Officer and then they were emailing me saying, "Hey, Andrew, I just got appointed chief AI officer, you wrote this article. Do you have any tips for me?" and I said, "Well." I think with the rise of the internet and tech, there started to be more CIOs, chief information officers, and AI is a new thing that is very complex, and there are some companies appointing CAIOs, so sometimes the responsibility goes under the chief data officer or the CIO or some other role, but AI is very much a C-suite responsibility because of its transformative impact on the whole company.

**Beena:** Absolutely. I think you started a whole trend there with that HBR article on chief AI officer role. I have suddenly seen that role rise up almost in parallel against the chief data officer and balancing it out. What would your next prediction be of what will be the most in-demand job or role or title 10 years, 5 years from now, given the pace at which we are growing? What do you see some of the new roles that will come up both at the C-suite and leadership level, but also at a more granular level? Do you foresee anything like similar to the chief AI officer role coming up in the next few years.

**Andrew:** I am not good at predicting titles, but I can tell you what I think is a bigger job shortage right now. There are lot of roles in AI where we don't even have enough people. Machine learning engineers, AI engineers, still not enough of those. But the one role that is really, really hard to find, is almost impossible to find, is that AI architect that can look at the business problem and propose and see if there is a technology solution to it. I think because of online education, a lot of companies are upskilling their talent base, more people are becoming AI engineers. We still don't have nearly enough of AI engineers and certainly great ones, real shortage of that, but the role that's just nearly impossible to find is the AI architect that can come in, look at the business situation, and then see if there is an AI solution to that, that is like almost impossible to find right now.

**Beena:** It is like asking for a unicorn because you want somebody who understands the business and you want somebody who understands the AI and then being able to bring it together, so that could be another course that comes out.

**Andrew:** Yeah, actually, one of the companies I am working with, millions of customers, tons of data on these customers sitting in the data center. They have had this data for years, but it took us working with

them to figure out that we should roll a customer 360 project so that we can use the data that you already have, there is already a data lake, to better understand who is who among your customer user base, so what do they want to buy, how can we service them better, and we think that by doing a customer 360 project to just do a better, to optimize how the company cross-sells and upsells to these customers, that type of project can have a direct impact on the top line of the company I am working with. And so I see a lot of examples like that where the opportunities are like sitting there. You have the data, but having the right teams to identify the use cases that can drive very direct top line to bottom line value, finding the right person to do that is still really difficult.

**Beena:** That's true. So, you are a visionary in this space, and one question that, because this space is evolving so fast, one question that I love to ask is, how do you stay current?

**Andrew:** One of my teams publishes, but I am also a reader of an AI newsletter called The Batch. I remember when the AI field was small enough that someone like me could literally read every title and abstract of every paper published in the field. I used to go to conferences, take the proceedings home, and I'd read at least every abstract. So you could basically see everything going on in the field. We are well past that now, and no one human can keep track of all of the latest happenings in AI, so The Batch, which we publish every Wednesday, tries to synthesize all of the latest findings, and we have several dozen writers, so a very large team trying to get signals about what's the most important happenings to report in The Batch, so that is a good resource. And I actually find that useful for myself as well. And I think I'm fortunate to have friends that know about my weird idiosyncrasies about the areas of technology I am excited about that will point me in the right direction when this new technology that has business implications or implications on some of the things I am working on. So I think all of our social networks and friends, they can point us at the relevant technologies, so the right partners really helps as well.

**Beena:** For our viewers who want to stay connected with you, where can they follow you? Are you on social media? How can they stay connected with you?

**Andrew:** In addition to The Batch newsletter, you can follow me on Twitter @AndrewYNg or follow the Landing AI LinkedIn page, which talks about what we are trying to do to help companies jumpstart AI adoption.

**Beena:** Andrew, thanks again for being with us on this show, and I want to thank our audience for tuning into AI Ignition. Thank you. Have a great day.

Thanks for tuning into another episode. Check out our AI Ignition page on the Deloitte AI Institute website for full video and podcast episodes, and tune in next time for more thought-provoking conversation with AI leaders around the world.