Daisy the Great: [00:05](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=5.59) [MUSIC](https://www.facebook.com/daisythegreatband/)

CRAIG: [00:07](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=7.13) HI. This is Craig Smith with a new podcast about artificial intelligence. [Alan Turing](https://www.turing.org.uk/publications/dnb.html), as most listeners know, was a British mathematician whose work laid the foundations for computer science and artificial intelligence. The [Turing Award](https://amturing.acm.org/) is now the highest distinction in those fields and this week I talk to one of the latest Turing Award recipients, [Yoshua Bengio](https://en.wikipedia.org/wiki/Yoshua_Bengio), whose work helped bring neural networks to where they are today. But what many people outside the field don't know is that Yoshua is one of a pair of brothers who began their journey into machine learning together. His brother, [Samy](https://ai.google/research/people/bengio), was an early partner in their research and has since become one of the most prominent computer scientists in the space. Samy eventually joined [Google Brain](https://en.wikipedia.org/wiki/Google_Brain) where he leads a team now focused on understanding how neural networks work. While Yoshua founded the [Montreal Institute for Learning Algorithms](https://mila.quebec/en/) and a company, [Element AI](https://www.elementai.com/?gclid=Cj0KCQjw1pblBRDSARIsACfUG13n90aGE1DM7lgZjGhGeIwbdgsw6m5zyp-BNMeggw_z69cKfMYpP2QaAoupEALw_wcB), which makes AI products for industry. I was lucky to find them both in the same place at the same time and got them to sit down for the first interview that they have given together. We talked about their unconventional parents, their first computer - an [Atari 800](http://oldcomputers.net/atari800.html) - and their early collaboration on neural networks, as well as what they see as the challenges going forward. I hope you enjoy the conversation as much as I did.

CRAIG: [01:37](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=97.9) So we're here at [NeurIPS](https://nips.cc/), sitting very cozily around a Canadian campfire. I've got the Bengio brothers together, I think possibly for the first time in an interview situation. Yoshua Bengio lives in Montreal. Samy, lives in [Mountain View](https://en.wikipedia.org/wiki/Mountain_View%2C_California), California.

SAMY: [01:55](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=115.631) Yes.

CRAIG: [01:56](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=116.92) Fortunately, they're together here today and I have always found it fascinating that there are such prominent brothers in such a rarefied space. You're some of the most recognized names in machine learning. So I wanted to hear a little bit about your background. I know you were born in France, but moved around. You spent some time in North Africa. Can you tell me a little bit about your childhood? What did your parents do that took you around the world?

YOSHUA: [02:23](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=143.86) Our parents were hippies - in the '60s, right? I think they gave us both the interest in science and the humanist values that we've kept and that today in AI are really important.

CRAIG: [02:36](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=156.611) Were they academics?

SAMY: [02:38](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=158.17) No, but for instance, they were in the, you know, [May '68](https://en.wikipedia.org/wiki/May_1968_events_in_France) revolution, so they were in the middle of it and

YOSHUA: [02:44](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=164.39) They were students at Paris's universities when we were very young.

CRAIG: [02:48](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=168.701) So you were like four or five years old in '68? Did they leave France after that?

SAMY: [02:54](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=174.281) No, no. We all left France in '77.

CRAIG: [02:57](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=177.311) And what was your father's profession?

YOSHUA: [02:59](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=179.591) He studied as a pharmacist. He also studied philosophy and eventually he ended up doing mostly working the arts and theater and the scene and not making a lot of money. My mother, she studied economics and she worked all kinds of jobs but eventually worked also in the same field, helping artists, basically managing artists.

CRAIG: [03:18](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=198.34) What took the family then to Morocco, is that right?

YOSHUA: [03:21](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=201.01) My parents were born in Morocco and in a way my brother and I are really lucky to have been among the few in this country and many other poor countries who ended up being raised and born in rich countries like France. And eventually we moved to Canada and I think we have a responsibility to look back at all these other people in developing countries who are not enjoying the privilege that we have here.

SAMY: [03:43](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=223.061) We did move to Morocco for a year for my father to do his military service there. So that's what brought all of us there.

YOSHUA: [03:51](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=231.97) That's right. That's right. Just after the revolution, a lot of Jews, you know, [left Morocco](https://en.wikipedia.org/wiki/Migration_of_Moroccan_Jews_to_Israel) in the early sixties and actually a lot went to France and went to Canada and the US and Israel.

CRAIG: [04:05](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=245.47) After Morocco you went back to France?

SAMY: [04:08](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=248.021) To France for two years. But we all decided together that it was good to immigrate in Canada to start a new life.

CRAIG: [04:14](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=254.23) Was there a particular reason, the political climate in France?

SAMY: [04:18](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=258.82) No. They had this dream of going to the New World and start over and we had family already there, so it was easier to immigrate in Canada.

YOSHUA: [04:26](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=266.98) My grandparents were here.

CRAIG: [04:28](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=268.33) Oh, I see. Yeah, so Canada's fortunate in that way.

SAMY: [04:32](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=272.89) We're also fortunate.

CRAIG: [04:33](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=273.85) That's, that's right, that's right. You came then to Montreal.

YOSHUA: [04:37](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=277.06) So I've been living in Montreal for 40-odd years.

CRAIG: [04:41](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=281.02) Wow. And when did the interest in computer science or science generally start?

YOSHUA': [04:46](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=286.03) That's a really interesting question.

SAMY: [04:47](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=287.42) Very early.

YOSHUA: [04:48](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=288.03) Because it's not independent events.

SAMY: [04:49](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=289.39) No, no. Together we were fascinated by the early small computers we could find.

YOSHUA: [04:54](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=294.94) So early as teens.

SAMY: [04:56](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=296.35) We went to the US to buy our first computer together with money that we had been able to find because we were really not rich and we bought our first small computer, an Atari 800.

CRAIG: [05:08](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=308.94) Oh, is that right? An Atari 800.

SAMY: [05:08](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=308.94) We started playing together with it and understanding how it works, what kind of program we could do.

YOSHUA: [05:13](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=313.3) Programming in [Basic](https://en.wikipedia.org/wiki/BASIC), with the programs being stored on tapes. There were not even disks. This was before [floppy disks](https://en.wikipedia.org/wiki/History_of_the_floppy_disk).

SAMY: [05:19](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=319.961) It was the early days.

CRAIG: [05:21](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=321.63) And from the Atari, then you went on to ...

YOSHUA: [05:24](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=324.64) We both went into studies in universities that were computer related, so I did computer engineering and then computer science.

SAMY: [05:32](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=332.21) And I did computer science from the beginning. And I did [University of Montreal](https://www.umontreal.ca/en/) and Yoshua did [McGill](https://www.mcgill.ca/).

CRAIG: [05:38](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=338.83) From that point, did your paths diverge or have you always?

SAMY: [05:43](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=343.87) Not at this point. No. No, actually we converged first.

YOSHUA: [05:46](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=346.3) Right. That's where the neural net thing really came together. So in '85, I started my Masters and I read a few neural net papers and I started reading some [Geoff Hinton](https://nyti.ms/2tWNIfb) papers and the [connectionists](https://www.iep.utm.edu/connect/). In '86 the first really important book, the [PDP book](https://stanford.edu/~jlmcc/papers/PDP/Chapter1.pdf), came out and all of that was transformative for me and I fell in love with AI and with neural networks research trying to both understand the brain and intelligence and build intelligent machines.

CRAIG: [06:12](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=372.981) And Hinton was where then?

YOSHUA: [06:14](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=374.781) He was at [CMU](https://www.cmu.edu/).

CRAIG: [06:16](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=376.67) CMU, yeah.

YOSHUA: [06:17](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=377.331) And later came to [UofT](https://www.utoronto.ca/) in Canada.

CRAIG: [06:20](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=380.21) That's right.

SAMY: [06:20](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=380.451) And on my side, after my Masters, I was looking for something to do and Yoshua's was telling me about neural nets. And I started a PhD in '89 in neural nets. At that time there was actually nobody in my university doing anything like that. So although I found a supervisor, I worked mostly with Yoshua, trying to find interesting research.

YOSHUA: [06:39](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=399.711) And we had several really cool papers then.

CRAIG: [06:42](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=402.55) Is that right?

SAMY: [06:43](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=403.22) So the topic of my thesis that we jointly discussed was about something that is now called [AutoML](https://en.wikipedia.org/wiki/Automated_machine_learning). So it's something that

YOSHUA: [06:50](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=410.691) Learning to learn.

SAMY: [06:51](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=411.71) Learning to learn, that was not a big thing for 25 years, but in the last two, three years is has come suddenly to be very important. Of course, when we worked on it 25 years ago, it was much smaller.

YOSHUA: [07:01](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=421.161) We didn't have the computational power to really execute on these ideas.

SAMY: [07:05](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=425.031) I think most of the ideas were there, it's just that we did not exploit them as much as we can now.

CRAIG: [07:10](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=430.041) Yeah. What drove you to stick with neural nets during that 'winter' that everyone talks about it?

YOSHUA: [07:16](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=436.261) I'm kind of stubborn and I believe in my own vision and I thought everybody was wrong and I was right, you know? I think another reason is I had a few friends who believed the same thing as me, like Yann and Geoff.

CRAIG: [07:27](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=447.94) Yeah.

YOSHUA: [07:28](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=448.3) And that made a whole world of difference because when you have a support network - with [CIFAR](https://www.cifar.ca/), that eventually formalized this - it really helps to keep you psychologically, you know, into the direction you've chosen.

CRAIG: [07:40](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=460.7) That's right.

SAMY: [07:40](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=460.941) There were clearly more things to learn and more things to understand in this field and so there was no need to change and to do like everyone. We could keep working on that.

YOSHUA: [07:51](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=471.111) Another important thing as far as I'm concerned is in Canada, the government for many decades has been investing in curiosity-based funding of research, so you didn't have to do something that would have an application that was clear. And so I got reasonably well-funded even through the hard times, even when it was not fashionable.

CRAIG: [08:11](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=491.75) I know from my talks with Geoff Hinton that one of the reasons that he came to Canada was CIFAR and that freedom.

YOSHUA: [08:18](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=498.141) I would say one of the reasons for the success of [Mila](https://mila.quebec/en/), the institute that I founded, and of the group that, you know, I've been leading, is the importance we give to freedom to, you know, letting people explore what they want. And at the same time a lot of collaboration and these are the values of scientific research, which allow to do more than incremental progress.

CRAIG: [08:37](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=517.611) Yeah. Before I go on to the research, do you have siblings?

YOSHUA: [08:40](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=520.88) Nope.

CRAIG: [08:41](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=521.09) You are them. You're the Bengios.

SAMY: [08:48](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=528.28) We're all of it.

CRAIG: [08:48](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=528.28) At what point did you start to diverge?

SAMY: [08:51](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=531.921) So after I finished my PhD and did a few postdocs, I decided to accept a position of research scientist in Switzerland where there was a small research lab that let me keep working on neural nets and do the research I wanted to do. And I felt it was important to maybe go somewhere else rather than staying with Yoshua because you want to explore new colleagues, new ways of thinking. That's how research works. And so it was very important to go somewhere else. And that lab was small but very interesting. And I could have PhD students and get funding. In Switzerland it's very easy to get funding so you could do your research. We had enough compute power, so it was all good. And so on my side I started working on the same topic and more, but in Switzerland, while still working together. We actually had a PhD student that was first my PhD student, then became his PhD student, then came back and was my PhD student.

CRAIG: [09:41](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=581.4) That's great.

SAMY: [09:42](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=582.91) And that person has a very nice career now. So he's at Facebook.

CRAIG: [09:48](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=588.82) You were in Switzerland what years?

SAMY: [09:49](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=589.741) '99 to 2007

CRAIG: [09:51](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=591.69) Okay. And then you joined Google.

SAMY: [09:54](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=594.39) Then I joined Google in California. Yes.

CRAIG: [09:56](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=596.191) And that was kind of a big moment in each of your careers.

SAMY: [10:01](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=601.2) The reason I joined Google, so I was able to keep working on my research. There was no difference. The difference was the attraction of, at that time, I would say, access to more data, which was what I thought was important at that time. And access to more compute power to actually develop and consider machine learning models that could work on bigger problems.

CRAIG: [10:19](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=619.68) Yeah.

SAMY: [10:20](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=620.28) That was the attraction point. And also I was told that I could do my own research without having to work on product if needed. But as long as I could have impact, I said that sounds like a good deal.

CRAIG: [10:30](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=630.66) Yeah, sure. And Yoshua, you've been very [outspoken](https://www.quora.com/What-are-the-benefits-and-challenges-of-doing-deep-learning-research-in-academia-as-opposed-to-in-industry?redirected_qid=6578672) about why you did not go into industry.

YOSHUA: [10:37](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=637.41) There's a bottleneck for training the next generation, right? Which are the professors who can supervise the next grad students.

CRAIG: [10:44](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=644.071) So there is a bottleneck in that regard. But also Google has the data, or not only Google, but industry has the data, they have the compute and academia is left with much less data.

YOSHUA: [10:55](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=655.89) But academia has the students!

SAMY: [10:57](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=657.31) Yeah. I think the boundaries are much more subtle than that today. We can find a lot of data everywhere. We can find a lot of compute power everywhere. And we have research scientists that are both in academia and in industry. I think things have been, it's not one or the other. You can do both if that's what you think is the best.

YOSHUA: [11:16](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=676.161) It's a gray zone.

SAMY: [11:17](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=677.57) There are also industry places where you do more applied work. So you actually only work on things that are useful for the company in the short term. And there are industries that are looking further because maybe they have enough money to do that. And so they actually do research that looks a lot like academic research where they think further, they also publish their work. So the distinction is by far not like it was.

CRAIG: [11:37](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=697.73) Yeah. Right.

SAMY: [11:38](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=698.6) It's a continuum.

CRAIG: [11:39](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=699.73) Right. Google, or companies like Google, are funding institutes. They gave quite a bit of money to Mila recently.

SAMY: [11:47](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=707.41) They see that It's both - two way thing where everybody can benefit.

CRAIG: [11:50](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=710.95) And does that make a difference to you, that kind of funding?

YOSHUA: [11:53](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=713.861) Sure. But the vast majority of our funding is government.

CRAIG: [11:56](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=716.351) It's still government.

YOSHUA: [11:57](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=717.371) Yeah. Yeah.

CRAIG: [11:58](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=718.27) Do you think that will change over time? That industry will see the need to keep the research institutes well-funded?

YOSHUA: [12:05](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=725.37) Well, for now, industry funding is only increasing as the interest in deep learning and AI is booming like crazy.

CRAIG: [12:11](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=731.54) Yeah.

YOSHUA: [12:12](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=732.15) So, I don't have a crystal ball, but what is important is to keep a strong base of government funding because that's generally more stable. Industry can go up and down.

CRAIG: [12:22](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=742.72) Yeah.

SAMY: [12:23](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=743.41) I was about to say when I started at Google, I don't think the industry was interested in the kind of research that say Yoshua is doing or even what I was doing. I did my research, but it didn't have the impact that it has today. So it changes because suddenly the industry sees that it actually works for solving their problem and they also think that they need to understand more so that they would solve their problem of tomorrow. So today there's big funding. Tomorrow we don't know. We'll see how it goes.

CRAIG: [12:49](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=769.72) Yeah. On the research you've been involved in, in neural nets, supervised learning has been very well explored at this point.

YOSHUA: [12:58](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=778.661) Right.

CRAIG: [12:59](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=779.47) Where do you see the future? I mean, a lot of people now are talking about unsupervised learning or reinforcment learning.

YOSHUA: [13:05](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=785.891) And reinforcement learning, that's right.

CRAIG: [13:06](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=786.34) Yeah. You have a project at Mila ...

YOSHUA: [13:09](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=789.491) [The baby AI project](http://www.iro.umontreal.ca/~bengioy/yoshua_en/research.html#baby-AI)

CRAIG: [13:10](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=790.71) The baby AI project. Exactly.

SAMY: [13:13](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=793.27) It's not a baby anymore!

YOSHUA: [13:14](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=794.88) Well, so we had a first version like six years ago and the techniques were not ready. Today, we have something, but it is also showing that the current level of understanding of the world, the best machine learning systems have, is completely insufficient to do things that are really very easy for even babies. And so the good news is you don't need like huge data from Google or Facebook or whatever to explore those problems. There are lots of really hard problems that you can explore in toy environments that can be simulated fairly cheaply. So that's one of the things we are doing. There's a lot of conceptual questions in machine learning and even theoretical questions that academia can handle without having huge means. That being said, at Mila, we're very lucky because we've been extremely well funded. So compared to other labs in the world, in academia, we're doing quite well in terms of equipment. And in terms of data, you know, there's a lot of data that is out there for free and anybody can go and gather web pages from the Net. And there's lots of public datasets that scientists use. Even people in industry use those data sets because they want to be able to compare their algorithms with other researchers from the community.

CRAIG: [14:28](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=868.07) Right. Are you both going in that direction? Away from supervised learning?

YOSHUA: [14:31](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=871.96) Let me start by saying that the phrase 'deep learning' and that the ideas there really came about with unsupervised learning methods. So unsupervised learning methods were the first ones that allowed us to train deep networks. And then around 2010, 2011 there was a switch where we realized that we could - in fact, thanks to some we did in my group - we didn't need these unsupervised learning techniques. We could train directly supervised models that are very deep and then the industrial applications started coming very quickly, with computer vision, speech recognition, machine translation and you know, things like that. But it's not going to be enough for human level AI, like humans don't need that much supervision.

CRAIG: [15:11](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=911.45) That's right.

SAMY: [15:11](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=911.661) I think also it's not just supervised and unsupervised. There's multiple things in the middle. There's [self-supervised](https://project.inria.fr/paiss/files/2018/07/zisserman-self-supervised.pdf), there's reinforcement learning, for sure. There's many ways to get supervision cheap from the data you already have. So it became a much more complex space, I think. But what links all of that is more about how do you represent the data in a better way so that it can actually solve some task, either the one you have at hand on or further, later. So representation learning is actually becoming more central.

YOSHUA: [15:40](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=940.4) Well, we created a conference[, Yann Lecun](http://yann.lecun.com/) and I created a conference, called [International Conference on learning Representations](https://iclr.cc/), because we thought that the crux of deep learning was about representations and how you learn them. And still today and for many years this is going to, you know, become a central question in AI.

CRAIG: [15:57](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=957.68) I should stay on the topic, but I want to ask you about the intersection between machine learning and neuroscience.

YOSHUA: [16:03](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=963.57) Oh sure. The reason I got into this field in the first place is because I fell in love with the hypothesis, which is still a hypothesis today, that there might be a few fairly simple principles like the laws of physics, which could explain both our intelligence, animal intelligence, and could help us build intelligent machines.

YOSHUA: [16:22](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=982.94) So like the laws of physics, there would be something fairly simple that we can explain, understand. Of course, the consequences of those simple principles could be extremely complex because our brain is extremely complex. And very likely for this hypothesis to make sense, those principals would have a lot to do with learning because you may have a fairly simple learning procedure, but now it can learn very complicated things. That's what our brain does. And so, I've always been interested in the intersection between brain sciences and AI. So brain sciences I'm saying because that includes neuroscience but also cognitive science and even things like, one of the things I'm interested in these days is child development. In other words, learning from how humans are intelligent and that has been from many decades way before I started an inspiration for neural nets. I mean the name, neural nets, comes from there, from the fifties. One of the questions I've been working on for the last five years or so is, 'is there a biologically plausible analog of backpropagation for the brain?'

YOSHUA: [17:24](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1044.59) So [backpropagation](http://neuralnetworksanddeeplearning.com/chap2.html) is the main algorithm we are using in neural nets and deep learning and it works extremely well. But for many decades it was thought that it was not plausible that the brain couldn't do that for all kinds of technical reasons. So a number of researchers like myself, we've been trying to find somewhat different ways of achieving the same result, but that would be more compatible with what we know about the brain.

CRAIG: [17:47](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1067.111) I want to ask you about [equilibrium propagation](https://arxiv.org/abs/1602.05179). There isn't a pass through the neuron and then a pass back.

YOSHUA: [17:54](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1074.201) No, it's the neural net settling two answers and then reacting to signals that tell it about the errors it's making and then using the difference between the two states when it was making a prediction and then it got some feedback to infer how to change the neurons, how to change the weights of the neurons.

CRAIG: [18:15](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1095.78) Do you feel like this is a field of research that is progressing or,

YOSHUA: [18:19](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1099.59) Yeah, I'm pretty excited about the progress we've made and to the point where now we're starting to do actual experiments on animals, to test some of these theories. So there's still a long way because unfortunately being able to monitor what is going on in the brain is difficult at the level of individual neurons or even more synapses, which we don't know how to do yet. But I think we've reached a point where the theory is sufficiently advanced that we can start testing it in real brains.

CRAIG: [18:46](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1126.44) Hmm. That's fascinating. Are you also working on that? Is that an area that you've worked on?

SAMY: [18:51](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1131.811) Not I'm not really touching neuroscience, but touching more representation learning in general and sometimes applied to vision, speech translation, but also a bit of robotics nowadays, so but not neuroscience. Our team is about trying to explore machine learning and deep learning in general to more understanding what can we do, what doesn't work, why it doesn't work to really more fundamental research of machine learning, but not particularly targeting any relation or necessarily a relation with the brain. It stays at the level of inspiration. What interests me today is not just developing a new algorithm, but more just trying to understand what's currently going on and what are the limits. I'm also fascinated not particularly by the dangers of adversarial training, but more about what it says about our understanding of training neural networks. Our poor understanding of what works and what doesn't so, and again it's about understanding.

CRAIG: [19:45](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1185.41) That neural nets are in fact very fragile...

SAMY: [19:48](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1188.66) They are in fact fragile, so it might not learn the functions we think we learn.

YOSHUA: [19:51](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1191.451) They're working in a way that is very different from humans, so they seem to have a very superficial understanding of the underlying causes that humans understand. It's that they capture low level clues that work well on the training data or even the training distribution, like the test data. But when you then take those trained systems and you show them something like adversarial examples, which are weirdly modified, or you bring them to a different country, often it doesn't work that great. But humans are very good at that kind of generalization, which is across different types of distributions.

CRAIG: [20:26](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1226.88) Yeah, yeah. I had a fascinating conversation with a guy named [Julian Togelius](http://julian.togelius.com/) at NYU who uses video games and he talked about this problem, that neural nets are trained on a specific instance. They become very good at that instance, but you change even

YOSHUA: [20:44](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1244.25) The lighting, for example

CRAIG: [20:45](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1245.42) the aspect ratio or lighting and it breaks down. Because, in fact, there are no neural nets that at this point can really generalize, is that, right?

YOSHUA: [20:53](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1253.69) No, no. They do, they do.

SAMY: [20:54](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1254.52) It depends on what you mean by generalize.

YOSHUA: [20:54](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1254.7) So they do generalize to examples that are from the same distribution. So they're, like, let's say, we collect images from the setting in the same city. It will work if you collected data for a whole year and then you know the next year you can use it around the same places. It's going to work quite well. It's pretty amazing. But maybe if you've been doing this in California and then you want to use your network in Montreal, the weather is so different, if you're building self driving cars, for example, that you're going to be in trouble.

SAMY: [21:23](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1283.08) It generalizes enough that we can actually do real applications. Recognizing objects in photos that were never seen before, that works, as long as the photos are similar to the ones that were used for training. So that still enough to do something.

YOSHUA: [21:36](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1296.37) And so if you're a company and you want to build a system that's going to be robust. Well, you're going to train it in many different places, for example, and you're going to use all kinds of techniques to show to the network the kind of variations, deformations that could happen. So it could be robust to these things.

SAMY: [21:51](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1311.431) But we shouldn't be fooled by the fact that it works for what we do today. We investigate for when it doesn't work because that's the goal.

CRAIG: [21:59](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1319.31) Of course

SAMY: [21:59](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1319.731) Not just saying, oh, it seems to work. Let's try to understand when it doesn't work and why and what's missing. Is it just data? Is it the algorithms? Is it limitations that we just can't solve? I think these are critical.

CRAIG: [22:13](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1333.29) There's been enough done in the research institutes, that it's going to take decades to implement and for it to work through the economy.

YOSHUA: [22:21](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1341.7) No, no. I think much faster.

CRAIG: [22:25](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1345.23) Oh, is that right?

SAMY: [22:25](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1345.44) With the kind of you libraries that are now available. It's very quick and we see it in companies like Google, but Facebook does the same, to go from an idea that is implemented in a very simple framework to go like in a matter of few months to a product that is actually used by millions of people.

YOSHUA: [22:40](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1360.701) So I want to mention because he's talking about the libraries that we have an interesting connection there because I started library called [Theano](https://en.wikipedia.org/wiki/Theano_%28software%29), with, of course, my students who did most of the work, and he started a library called [Torch](https://en.wikipedia.org/wiki/Torch_%28machine_learning%29), whose descendant is now [PyTorch](https://en.wikipedia.org/wiki/PyTorch) and he's been involved in [TensorFlow](https://www.tensorflow.org/), which is

SAMY: [22:58](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1378.371) inspired by...

YOSHUA: [22:58](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1378.671) inspired a lot by Theano. So there's a lot of - but, that's how science proceeds as well. We get inspired by each other's work.

CRAIG: [23:06](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1386.771) That's right. But it's not often it's within a family, you know. Are your parents still with us?

YOSHUA: [23:12](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1392.081) Yes. Yes.

CRAIG: [23:13](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1393.46) They must be amazed.

YOSHUA: [23:14](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1394.691) Yes, yes. My mother especially.

CRAIG: [23:17](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1397.091) Do they understand any of this stuff?

SAMY: [23:18](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1398.761) High level, I think.

YOSHUA: [23:20](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1400.361) They understand that it's highly mediatique because they get to see a lot of it.

CRAIG: [23:23](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1403.54) Well, the reason is, it's transformative.

YOSHUA: [23:26](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1406.001) That's right.

CRAIG: [23:27](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1407.051) Do you have any futurist vision?

YOSHUA: [23:30](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1410.091) Yeah, so, I think that there is a responsibility for researchers like us to not just do our very important research, very technical, but also think about how what we're doing is starting to have an impact on society and that we can play a role in how this is going to unfold, that we have a voice, we have some authority because where we are in our careers and that we can participate in the debates in our society about what do we want to do with this technology.

YOSHUA: [24:00](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1440.23) It's not just data privacy. There are like really ethical questions involved and in fact that is why in Montreal we at Mila have been working with philosophers and economists and legal people and medical people to develop what is called the [Montreal Declaration for the Responsible Development of AI](https://ai.quebec/wp-content/uploads/sites/2/2018/12/News-release_Launch_Montreal_Declaration_AI-04_12_18.pdf). And it has 10 principles and 60 sub principles and a lot of thinking and trying to articulate what we should do with this technology and what we should not do. It sounds easy, but it's not. These ethical principles are going to come sometimes in contradiction with the desire to sell more products or some military ambitions, right? So ethics is about trying to reconcile opposite values and objectives and where we have to find the right balance. So stating these things and making sure that there's a real rational discussion about them is very, very important.

SAMY: [24:51](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1491.26) I'd like to add as well that companies are also very interested in that, and a few months ago Google also wrote their [AI principles](https://www.blog.google/technology/ai/ai-principles/), which basically states about the same, what we can do, what we shouldn't do, what other positive things that AI can do and what are the negative things that we should be careful about and not work on or not favor when we have a choice.

CRAIG: [25:11](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1511.66) But algorithms once they're created and released into the wild can't be ...

YOSHUA: [25:16](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1516.24) No, I disagree. So think about airplanes and airlines, right? They are under very strict regulations because governments are aware that they need to regulate and provide a common playing field for all the companies even though it costs them something to deal with all those security issues. At the end of the day, it is better for everyone, for, of course, the passengers, and for all the companies, that there's an international agreement about what is acceptable and what is not acceptable. And I think something like this needs to happen for AI as well. It's never going to be perfect. There will be rogue states, there will be rogue companies, but if we at least have a consensus on what is right and what is wrong, then we can do things like, you know, certifying products. We do this in many fields. There's no reason why we couldn't do it in AI as well.

CRAIG: [26:00](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1560.861) Yeah, that's right. I guess it's the rogue, it is the hacker community. Those are the things that I worry about.

YOSHUA: [26:06](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1566.29) But that's always possible. Think about any industry, right? Somebody can take progress in chemistry and use it to kill people, but that's criminal. That's, you know.

CRAIG: [26:17](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1577.47) In your lifetimes, what do you hope to achieve?

YOSHUA: [26:20](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1580.02) I'm always after understanding every day that my understanding of the things I'm studying improves, it makes me feel good. And I don't have a crystal ball. I'm going to continue trying to understand.

CRAIG: [26:31](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1591.76) And Samy?

SAMY: [26:32](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1592.05) Same.

CRAIG: [26:32](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1592.05) Same. And you're going to see each other more often.

YOSHUA: [26:35](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1595.71) We try. Well, he comes to Montreal every Christmas.

SAMY: [26:39](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1599.1) We also see each other at conferences that we either coordinate or run

YOSHUA: [26:42](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1602.17) The main places we meet are the conferences.

CRAIG: [26:44](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1604.31) Okay. I've probably run out of semi intelligent questions. Yeah, it was great. I really appreciate it.

CRAIG: [26:52](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1612.83) That's it for this week's podcast. I want to thank Yoshua and Samy for their time. For those of you who want to go into greater depth about the things we talked about today, you can find a transcript of this show in the program notes along with a link to our [Eye on AI newsletters](https://www.eye-on.ai/subscribe-page). Let us know whether you find the podcast interesting or useful and whether you have any suggestions about how we can improve.

CRAIG: [27:18](https://www.temi.com/editor/t/ETj1204gBUTTa27yzyaK06RbSDNH6e4Czy1yEpnFykp4M_a8R95jgahePB6Z54z1uZNtb1su5KM1o2BKtkx1ACXpc9M?loadFrom=DocumentDeeplink&ts=1638.15) [The singularity](https://en.wikipedia.org/wiki/Technological_singularity) may not be near, but AI is about to change your world, so pay attention.