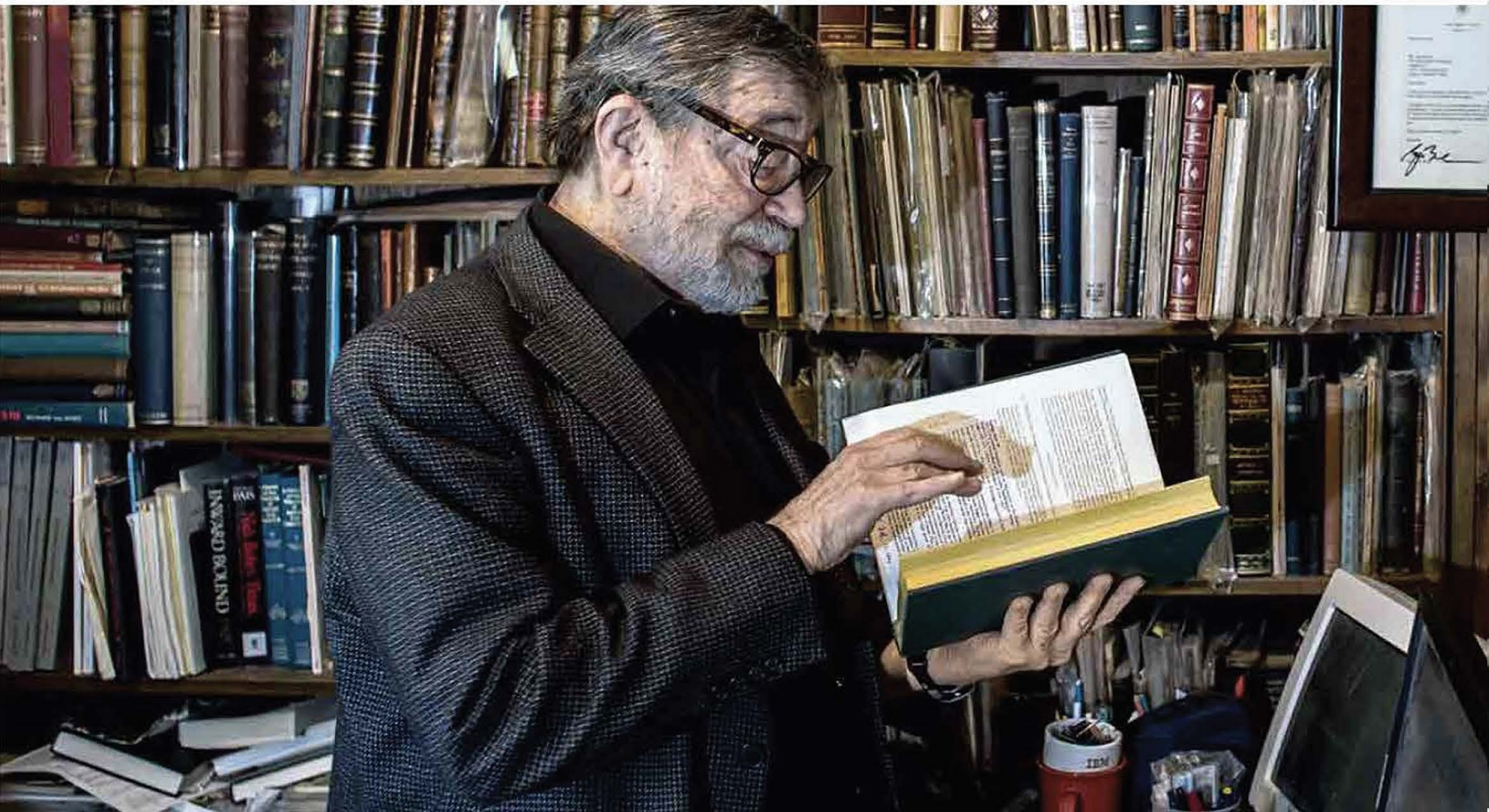


JUDEA PEARL

THE FATHER OF ARTIFICIAL INTELLIGENCE

«The robots will talk to each other, they will have their own will, desires... I don't know what surprises you about this»



It has revolutionized artificial intelligence and now it is ready to revolutionize our lives. This computational engineer and philosopher has laid the mathematical foundations for robots to think and feel like humans and not just accumulate data. For his findings, he has just received the BBVA Frontiers of Knowledge Award.

BY ANA TAGARRO | PHOTO: MONICA ALMEIDA



T

He has an overwhelming resume. The Turing Prize –the Nobel Prize in mathematics–, doctorates in Engineering, master's degrees in Physics, prizes in psychology, statistics and philosophy and, now, the BBVA Foundation Frontiers of Knowledge Award in Communication Technologies. And, to top it off, he is a gifted pianist.

Judea Pearl, however, prefers to define himself as a poet. After all, he makes metaphors with equations. In the eighties he developed a mathematical language, Bayesian networks, essential today in any computer, but now, at 85 years old, he declares himself an 'apostate' from artificial intelligence. Why? Well, precisely for that reason. It is not a play on words. It is that Pearl affirms that as long as we do not teach the machines to understand cause-effect relationships in its very complex variants, they will not think like us. And he knows how to achieve it. He explains it to us from his house in Los Angeles. There, at the University of California, he is still a professor. As lucid as that young Israeli, raised in a small Biblical town, who arrived in sunny California 60 years ago.

XL Weekly. His goal is to build machines with a human level of intelligence, that think like us.

Judea Pearl. Yes, because until now we haven't made machines that 'think'. They only simulate some aspects of human thought.

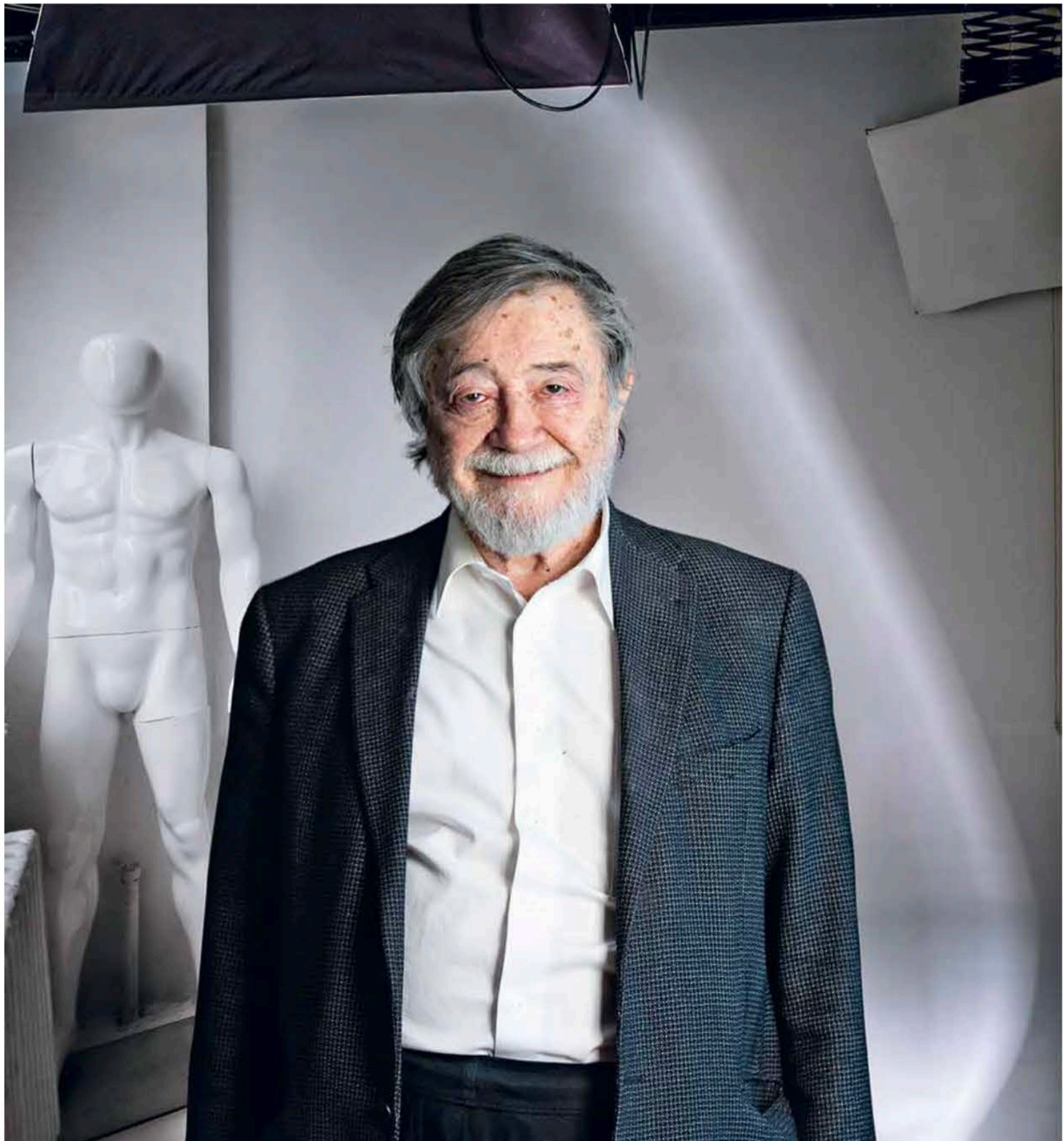
“Between humans and machines, only the 'hardware' is different; the 'software' is the same. Perhaps there may be a difference: the fear of death. But I do not know...”

XL. And, to make machines that think, he argues that they have to think about causes and effects, asking 'why'.

JP Yes, but there are levels. It is what we call 'the ladder of causality' . Current machines only create associations between what was observed before and what will be observed in the future. It is what allows eagles or snakes to hunt their prey. They know where the mouse will be in five seconds.

XL. But it's not enough...

JP No. There are two levels up on that ladder that the machines don't do. One is to predict actions that have never been carried out before under the same conditions.



XL. But there is more...

JP The next step is retrospection. For example: I have taken an aspirin and my headache is gone. Has the aspirin taken away my pain or has it been the good news my wife gave me when I took it? Think along these lines: could an event have taken place if another event in the past had not occurred. For now, this is only done by humans.



+ You may also be interested

The ladder of artificial intelligence

The definitive leap of the machines

XL. Because until now that way of thinking could not be translated into mathematical formulas, but now it can, thanks to you...

JP Yes, now we have mathematical tools that allow us to reason on all three levels. It only remains to apply them to artificial intelligence.

XL. Let me clarify what you have said; it means that you translate imagination, responsibility and even guilt into equations...

JP Yes, correct.

XL. Correct and amazing, right? Robots will be able to imagine things that don't exist. And you yourself say that this capacity has been key to the dominance of the human being over the rest of the species. Now the machines are going to do it?

JP Right, totally. We humans create that 'market of promises', convincing someone to do something in exchange for a promise of the future. And the machines will be able to do it.

“We create robots for the same reason that we have children. To replicate ourselves. And we raise them in the hope that they have our values. And most of the time it works out.”

XL. You state freely, for example, that robots will play football and say things like "you should have passed me the ball sooner."

JP Yes, of course, and football will be played much better then. Robots will communicate like humans. They will have their own will, desires ... I'm surprised that this surprises you [laughs].

XL. What surprises me is the naturalness with which you speak of these very 'human' machines...

JP Look, I've been in artificial intelligence for more than 50 years. I grew up knowing that anything we can do, machines will be able to do. I see no impediment, none.

XL. But, then, what differentiates us from the machines?

JP That we are made of organic matter and the machines, of silicon. The *hardware* is different, but the *software* is the same.

■

“Artificial intelligence has the potential to be terrifying and the potential to be extremely convenient. For now, it's just 'new'. It is too early to legislate

XL. Little difference ...

JP Perhaps there can be a difference: the fear of death. But I am not sure it makes a very big difference, maybe.

XL. And fall in love?

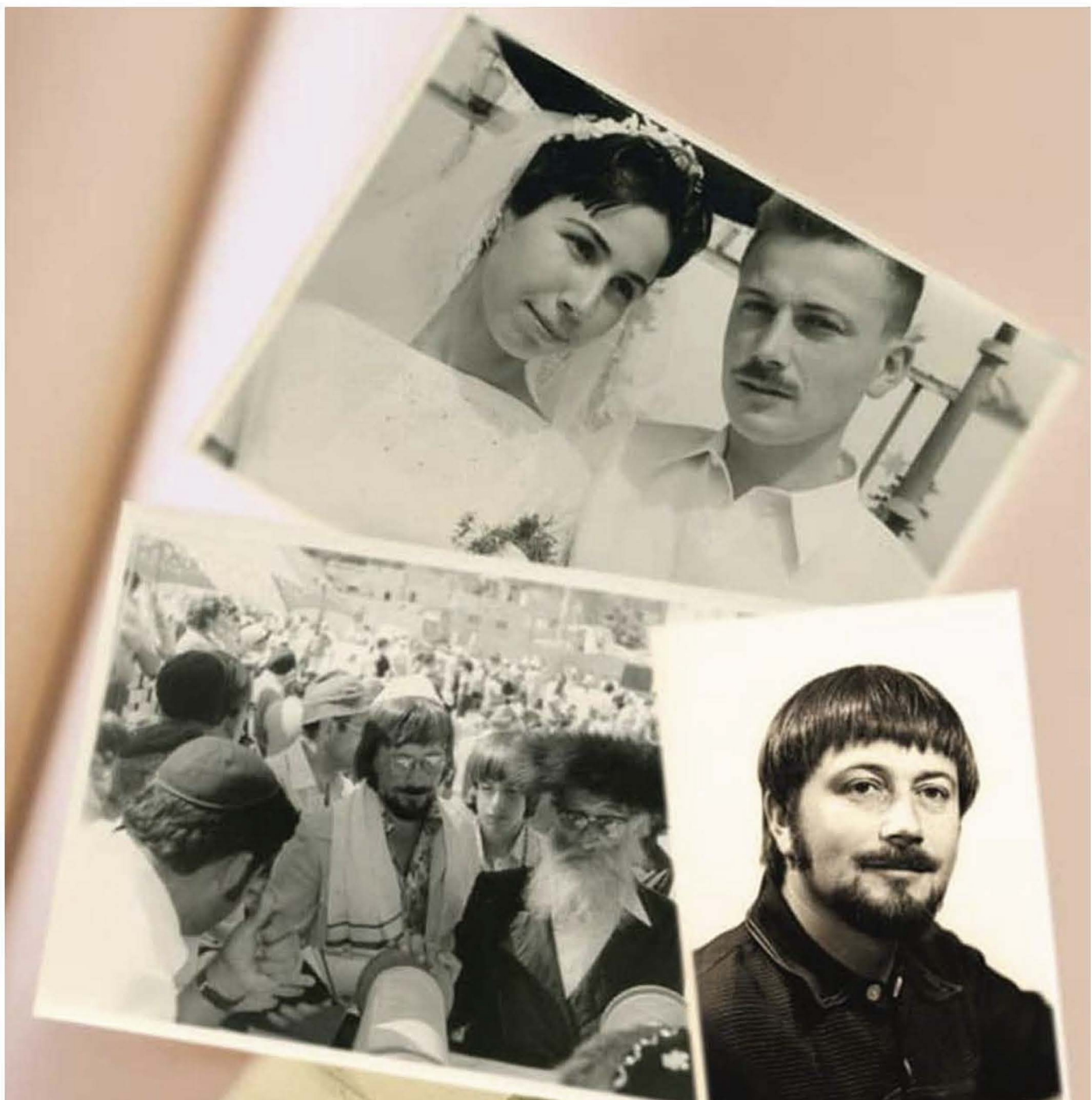
JP Machines can fall in love . Marvin Minsky has a whole book on the emotions of machines, *The emotion machine*, it's from years ago...

XL. It gives a little scary...

JP It's not to be scary, it's just that it's new. It has the potential to be scary and the potential to be extremely convenient. For now, it's just 'new'.

XL. Will machines be able to tell right from wrong?

JP Yes, with the same reliability as human beings, perhaps even more. The analogy that I like is that of our children. We believe that they will think like us, we raise them with the hope that we will instill our values in them. And yet there is a risk that my son will turn out to be just another Putin. But we all go through the process of raising our children in the hope that they will acquire our values. And it usually works fine ...



Family album. Judea Pearl, in various family photos: his wedding day to Ruth, at his son Daniel's Bar Mitzvah celebration, and a portrait from the 1960s. His wife, who died last year, was also a brilliant mathematician and software developer, of Israeli and American nationality, but born and raised in Baghdad, Iraq. They met at the Technion university in Israel and never parted ways.

XL. But is there anyone working on the ethical and moral foundations of this artificial intelligence?

JP Many people, yes. But I think it is too early to legislate.

XL. I'd say it's late...

JP We have a new kind of machine. We have to watch it because we still don't know how it's going to evolve. And we cannot legislate from fear, from unfounded fears.

XL. But you yourself say that the creators of a highly successful artificial intelligence, DeepMind's AlphaGo, do not know why it is so effective, that they themselves do not 'control' its creation...

JP Correct. But look: we don't know how the human mind works either. We also do not know how our children will develop their minds, and yet we trust them. And do you know why? Because they work like us. And we thought: he probably thinks like me. And so it will be with machines.

XL. But then the children come out as they want... Although you defend that free will is "an illusion". And us believing that we decided something! What a disappointment...

JP For you it is a disappointment, for me it is a great consolation. Since Aristotle and Maimonides, philosophers have been thinking about how to reconcile the idea of God with free will. A God who predicts the future, who knows what is good and what is bad, and yet punishes us for doing things that he has programmed us to do. This is a terrible ethical problem that we couldn't solve.

XL. And you are going to solve it with artificial intelligence?

JP Sure, because the first premise is that there is no free will. We have the illusion that we are in charge when we decide, but we are not. The decision has been made in the brain before. Our neurons are the ones that say how we have to act, the ones that, due to excitement or nervousness, make me move my hand or scratch my nose. It is deterministic and there is no divine force behind it.

■

"We will carry implants and they will interact with other people's. It's scary, huh? (Laughs). But we all already have implants: they are called 'language', 'culture'... we are born with them»

XL. What can we do so that mathematics is taught or learned better?

JP Bill Gates asked me the same thing. And having looked at my education, I think I was lucky to have excellent teachers. These were German Jews who came to Tel Aviv fleeing the Nazi regime. They taught science and math chronologically, not logically. When they told us about Archimedes, how he jumped out of the bathtub and came out screaming "eureka, eureka!", we got involved. The basis of our intelligence are the stories, because they connect people. Stories make history. It is easier to implant abstract ideas, like mathematics, through stories, through narratives.

XL. And what about philosophy, which is now being relegated to education?

JP It's terrible. Philosophy is very important. It connects us with at least 80 generations of thinkers. It creates a common language and builds a civilization.

XL. But it is not useful to find a job ... or so they say. And priority is given to the engineering that makes those robots that, precisely, are going to take away our work ...

JP Yes, that is already happening. And more will happen. This has two aspects: one, how are we going to feel useful when we don't have a job. The other, what are we going to live on, how do we get a salary. The second is a matter of economy and management. I don't have a solution for that. But there is. There will be.

XL. And for the first?

JP We can work it out. I am 85 years old, I am useless and I find joy every hour of the day.

XL. [Laughter]. You are not useless at all and you know it.

JP Look, almost everything is illusory. I live with the illusion of the response of my environment, my children, my students. If I give a class, I feel happy because I have the illusion that someone benefits from it. It is possible to create illusions. You create them for yourself.

«The basis of our intelligence is the stories, the story, because they connect people. Stories make history. It is easier to implant abstract ideas, like mathematics, through narratives»

XL. We talked before about good and evil. You have suffered evil in an unimaginable way, when your son was murdered (see box); now there is a war... Can the machines change that, make us better?

JP I don't have the answer. But perhaps, when we implement empathy or regret in machines, we will understand how they are formed in us and we can be a little better.

XL. And what do you think of incorporating technology into our body? To be transhumant...

JP I don't see any impediment to that. We will carry implants and they will interact with implants of other people or other agents.

XL. Would you like to have a brain implant?

JP Scary, huh? [Laughs]. I already have an implant. We all have: they are called 'language', 'culture'... we are born with them. But, as we are used to them, they do not surprise us.

XL. But why do you insist on making machines smarter than us?

JP Because we are trying to replicate and amplify ourselves.

XL. So that?

JP For the same reason that we have children.

XL. I 'buy' the simile, but we created machines to help us; now they replace us.

J.P. No, no. We create machines to help us. They will replace us, yes. But we create them to help us [laughs]. Although they will surpass us.

XL. Is there a mathematical formula for justice?

JP There has to be. To make sure that no dictator would tell us what is fair. To fight a Putin, more math would be needed.

«I do not make predictions, but the future is going to be totally different, a revolution. I am optimistic, although I do not know where it will take us »

XL. He has a lot of old books.

JP I collect them. I have a first edition of Galileo [he picks it up].

XL. You travel through time. It goes from those books to artificial intelligence. I can't help but ask him, although he already told me not to, how he sees the world in 10 or 20 years...

JP [Laughs]. I don't make predictions. But it will be totally different, a revolution. I don't know where it will take us, but I'm optimistic. Although it is sad that my grandchildren no longer enjoy, for example, reading my old books. The cultural gap between generations will increase. And that worries me. Because they are going to lose all that wisdom that we pass on from parents to children.

XL. And you say so, you're making thinking robots!

J.P. _ Yes, but I make machines that think to understand how we think.

XL. What is the advice for young people still 'salvageable'?

JP Read story.

XL. Read? You are too optimistic...

JP Okay, so let them watch documentaries. About civilizations, evolution, how we got to be the way we are. Be curious! That's my advice: try to figure things out for yourself.

DANIEL PEARL

The drama of having your son's murder broadcast



Judea Pearl's son, Daniel, a reporter for *The Wall Street Journal*, was kidnapped and murdered in Pakistan by a jihadist group in February 2002. His captors, who began a path of terror that the Islamic State would later follow, released a video on the one that showed his beheading. Daniel's wife, Marianne Pearl, was pregnant at the time. The terrible tragedy failed to undermine the principles of the Pearl family. They created a foundation named after Daniel to foster "understanding between cultures through journalism, music and innovative communication." Judea says that the foundation embodies the spirit of his son, for whom "a stranger was an object of curiosity, not of fear."

They organize concerts because Daniel was also a talented violinist, but above all they are focused on supporting journalistic and educational initiatives; many of them in Pakistan. Judea and his wife, Ruth (who died last year), have two other daughters. Daniel's son, Adam Pearl, was born in Paris three months after his father's murder.