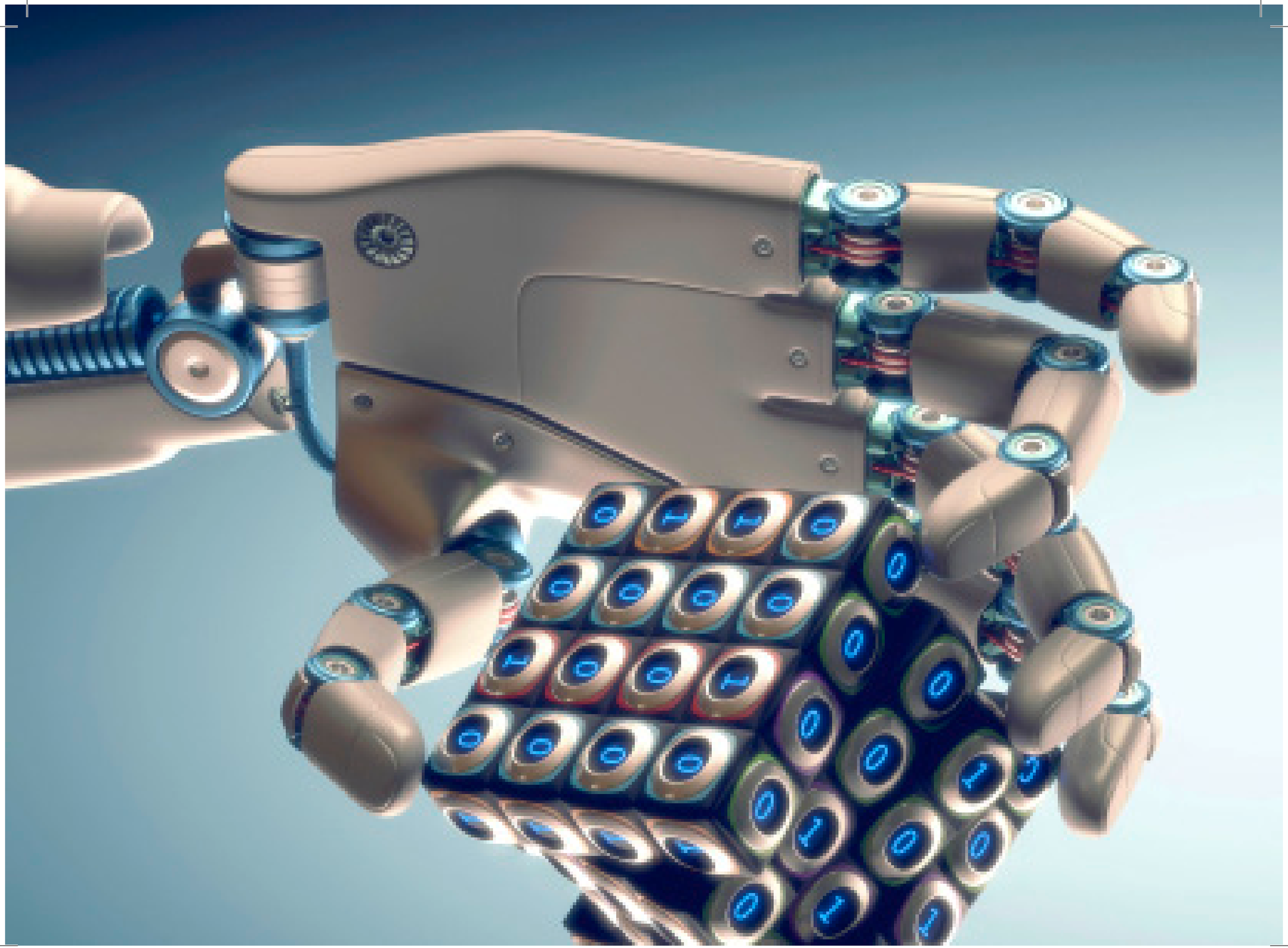

PHOTO: MASTER FILE

The Quest for the 'Brain Code'

ARTIFICIAL INTELLIGENCE. INTERVIEW: Pascal Kaufmann, neuroscientist and entrepreneur, is one of the world's leading researchers in the race for artificial intelligence. Kaufmann aims to make Switzerland a hotspot for research in decoding how the human mind works.

INTERVIEW: ANDRES BÜCHI | PHOTOS: THOMAS EGLI

Beobachter: You would like to connect all human knowledge. Tell us about this special endeavor.
Pascal Kaufmann: Let's take the company Swisscom for example, which has some 20,000 employees, who are the main carriers of information of the company. With our Starmind Technology, we were able to connect all employees and their expertise, in order to create a sort of communicating superorganism. You can now ask the Swisscom corporate brain any question and in 90 percent of all cases you receive an answer instantly and automatically, as the relevant information is already stored. If an employee asks a previously unanswered question, we immediately find whoever is the best person to answer that question within the company.

But you are not only looking to make knowledge accessible, you also want to decode the way an organism learns. How do you plan on reaching this goal?
The Mindfire Foundation was formed with the objective of creating human-level artificial intelligence for the benefit of mankind. We want to achieve a breakthrough and take on a leading role in the race for artificial intelligence (AI) by connecting thousands of leading scientists and enabling us to crack the Brain Code.

What can Switzerland contribute in the race for artificial intelligence?
Efforts are currently underway to unite all of the existing AI micro-initiatives in Switzerland, as well as to launch an AI academy and establish a new kind of AI lab. Through collaboration with leading research institutes, the lab will be capable of competing on the global stage and achieving a genuine breakthrough. We shouldn't sit around waiting until an Asian lab or big tech company gets there first. Understanding the principles of intelligence will probably be the most important discovery in human history and it is vital that this knowledge does not fall into the wrong hands. It must be used for the benefit of mankind. It's only a matter of time until someone cracks the code, we need to take action now.

"We will not make real progress until we abandon the notion that the brain works like a computer."

Pascal Kaufmann (40), studied biology at the Swiss Federal Institute of Technology in Zurich (ETH). He specializes in neuroscience and is affiliated with the Artificial Intelligence Laboratory at the University of Zurich and several other institutions. In 2010 Kaufmann co-founded Starmind, a company that develops self-learning knowledge networks. In 2017 he launched the Mindfire foundation, whose mission is to create human-level AI.

Many AI specialists today focus on big data. However you suggest that 'small data' is more promising. Why is that?
For example, it takes a computer up to 300 million sample images to be able to reliably recognize a cat. I don't find that particularly intelligent. Our brain can do this much more effectively. It is nothing like a big data machine. We require relatively little data to classify objects. A child only needs to see a cat once. After cuddling it, the child will not only know what a cat looks like, but also what it feels and smells like. In other words, they will know what makes a cat a cat. We should not necessarily see big data as the key to AI. We will not be able to make real progress until we abandon the notion that the brain works like a computer. The computer metaphor has slowed down progress in our attempts to understand the nature of intelligence.

But advances are being made at a breathtaking rate.
More and more processes are going to become automated in ever more sophisticated ways, that is true. But if we stick to this approach, a breakthrough ▶

PHOTO: MASTER FILE

in the field of artificial intelligence is unlikely—even in five years from now. You can keep digging deeper, but you won't find more potatoes if you're not digging in the right place to begin with.

What would it take to build a truly intelligent computer?
First of all, let's clarify the term. I don't think that artificial intelligence exists today, even though the term has been used since around 1956. Mankind has been inventing automated processes for more than 2'000 years. For example Archimedes' water screw makes it easier to draw water and can even run completely automatically. Nowadays we are trying to perfect automation using computers. To me, artificial intelligence is the opposite of that. It requires us to break free from our established approaches and break the rules. It means working creatively in fundamentally new ways.

As a neuroscientist, do you think we can compare human intelligence with artificial intelligence?
Let me give you an example. If you could build eleven robots that could play soccer and defeat a human team in the World Cup, then I'd be willing to say they are intelligent. Because each machine would have to be able to function as a member of a team. They would also have to be able to pull their opponents' jerseys every now and then—to break rules when the situation demands it. A machine like that would have to exhibit such a broad spectrum of behaviors that it would be virtually impossible to pre-program them all.

But playing soccer also requires an ability to make gut decisions. Will computers be capable of that any time in the near future?
I don't see any reason why we should not be able to recreate an artificial human being someday. But to make that happen, we have to decode the principles of intelligence rather than attempting to develop an artificial brain using today's technologies. That is doomed to fail. The development of aviation wouldn't have been possible if we tried to simulate feathers. The breakthrough only came once people understood the nature and shape of the wing profile.

But the 'brain code' is far more mysterious. We still don't even know how a thought is formed in the brain.
That's true, the brain is one of the greatest mysteries of our time. We barely know how it works. There are even many organisms that have no brain cells at all, yet are quite intelligent. They are able to react to their environment, to adapt to it and reproduce.

"You can keep digging deeper, but you won't find more potatoes if you're not looking in the right place to begin with."

Is it possible that our definition of intelligence is too narrow?
Yes, it's possible that our focus on brain cells has led us on the wrong track. After all, even unicellular organisms with no brain still have a genetic regulatory network. Our brains are most likely a sort of superorganism that consists of a vast range of individual components. When we eventually understand how this interplay works, we will be able to build machines that can act intelligently, irrationally, or even human-like.

The Blue Brain project was launched in 2005 at the Swiss Federal Institute of Technology in Lausanne with the aim of recreating the human brain. Apparently a tiny piece of a rat's brain has already been successfully recreated. Is this the wrong approach?
It is admirable, that the Swiss Federal Institute of Technology in Lausanne has earned a worldwide reputation as the leader in this field of research. Blue Brain has generated a lot of knowledge and expertise for large-scale digital projects. But in my opinion they are asking the wrong question. They wanted to recreate one cubic millimeter of brain tissue, however this cannot succeed without an understanding of the fundamental principles at play.

We construct our reality based on what our brain identifies as relevant, filtering out thousands of sensory impressions per second. Yet the exact opposite is true of current AI systems: they look specifically for information that has been predefined as relevant. So what happens to all the rest?
Switzerland is globally leading in precisely this area. It's about 'embodiment', which is a theory that Professor Rolf Pfeifer helped to establish at the AI Lab at the University of Zurich. The theory suggests that intelligence requires a body in order to interact with an environment. Having a huge brain is pointless if it can only perceive the outside world through a single camera lens. We need the sensory capabilities of our body that interact with our brain. A vacuum cleaner

robot can recognize a door, for example. The problem with artificial intelligence is that so far, it is only able to perceive its environment through a tiny peephole. People, on the other hand, are able to feel an apple—smell it, taste it. It even produces impulses in our brain. The complexity of the sensory system matches the complexity of the brain.

Our ability to classify all these perceptions puts us ahead of AI.
Correct. Take for example a classic robot hand with metal fingers. Its capabilities of picking up objects are completely inferior to the human hand. The human hand is intelligently designed. The skin is soft and can get slightly moist when we're nervous. You can use your hands to grasp any object. So even something like the construction of the human hand contains a huge amount of intelligence.

And yet these days we hear that computers are even able to perform creative tasks, such as composing music and painting. Please elaborate.
The computer itself plays a minimal role in the process of creating a musical piece. Behind it there are programmers who, to put it simply, compose the pieces by using information about harmonies and the rules of music. This same technique is used to 'teach' computers how to paint. To me, that is not creativity.

Scientists like British biologist Rupert Sheldrake say that knowledge and intelligence exist beyond the brain to some extent and that our brain can access those resources. Should we reassess how heavily we attribute intelligence to a specific organ?
That's an interesting question. Only about ten percent of DNA found in humans is actually human. The other 90 percent of the genetic material in our bodies originates from microorganisms in our environment. Therefore, we are a product of our environment. We have also learned that microorganisms from the gut migrate into the brain where they can influence our thoughts, which makes us ask: who am I, if I'm made up of trillions of living things?

"The construction of the human hand contains a huge amount of intelligence."

How do you answer that question?
I see myself as a 'holobiont'—an organism comprised of lots of tiny smart beings. We consist of billions of such creatures and each of them contains intelligence. That's why I like the approach that suggests the principles of intelligence are essentially found everywhere and that we are only part of a greater whole. However I do not believe in a sort of Platonic hyperspatial realm into which we can somehow communicate via brain signals. The brain is probably a superorganism that exists and operates according to a set of relatively simple rules. It's up to us to find out what these are.

Many discoveries that have advanced mankind emerges through analogies. Will computers ever be capable of this?
Today's computers are just incredibly fast calculators. Analogical reasoning, however, is a special skill. For example, if you ask a computer what a shoe can be used for, it will tell you that shoes are made for wearing and walking. Yet a human can also see that a shoe could be used to hammer in a nail, or perhaps represent a small boat. Realizing that the shoe can be used as a hammer or even something to throw at someone, if necessary, is intelligent. In order to build a computer that is capable of logical reasoning, we first have to crack the 'Brain Code' and then teach this skill to a computer or another device. To crack the code, we need to understand the principle of intelligence and work out what facilitates our capacity for abstract thought.

Tesla CEO Elon Musk is taking a different approach. His company Neuralink is looking to enhance the human brain by connecting it to a computer. Is there more to this than just an ambitious goal?
(Laughs) Considering that we still have a very limited understanding of the language of the brain, it seems unlikely that we will be able to enhance our ability to think or to decipher individual thoughts encoded in our brain signals. First we have to be able to explain the principles underlying human thought.

So you don't think such goals are currently achievable?
If you ask neuroscientists and researchers in this field, most of them are skeptical. What exactly does Musk want to achieve? Increase our brain power? That can already be achieved temporarily by consuming sugar or caffeine. Musk is a good marketeer and a visionary, which is important to get people even talking about innovative topics.

Can Switzerland compete against these kinds of people?
It's true that we are not very skilled at selling our innovations, although we make excellent products and are ideally positioned to play a leading role in AI research. For years we have been publishing the world's most-cited neuroscience and artificial intelligence publications. We have also managed to attract some of the brightest minds from around the world, thanks to our reputation as an intellectual hub with excellent infrastructure. On July 21st 2019, the 50th anniversary of the moon landing, we aim to announce that Switzerland is a significant player in the race for artificial intelligence and that our country will be a hotspot for AI development. I really hope we'll be able to make that announcement. ■