ABOUT TRUST

THE MAGAZINE OF THE TÜV SÜD GROUP 03 — 2020

Add value.
Inspire trust.

Focus: **INTELLIGENCE**

There are many different types of intelligence. People have it, so do octopi, and even machines have had it for some time now. We've taken a closer look at some of these types of intelligence and learned a lot about aliens, algorithms and ourselves.

ABOUT
TRUST

DEAR READERS,

Everyone is talking about artificial intelligence—and discussions about how AI will affect our lives sometimes take on a euphoric character. What I'm certain of is that AI will offer us surprising opportunities and possibilities in the coming years. Yet the same premise holds true for AI as for every application: the system, the process and the environment must be designed in such a way that AI can be used for the benefit of humanity and the environment.

Our experience at TÜV SÜD is that AI's algorithms can provide great support to people in numerous areas. For instance, we use artificial intelligence for routine tasks in detecting damage to vehicles or workpieces, thereby freeing up our employees for the more challenging responsibilities that require human intellect and talent.

There is broad consensus that "biological intelligence" will remain superior to AI for a long time to come. The cover of this issue of our corporate magazine shows an especially impressive example: octopi are some of the most fascinating creatures on the planet—and researchers are just beginning to understand their high level of development. Over billions of years, evolution has brought forth many different types of intelligence—and the AI of our machines represents yet another aspect of this diversity.

Come join us on this journey through the world of intelligent life and artificial intelligence.

Wishing you a truly stimulating read!

PROF. DR.-ING. AXEL STEPKEN
Chairman of the Board of Management of TÜV SÜD AG

03 2020

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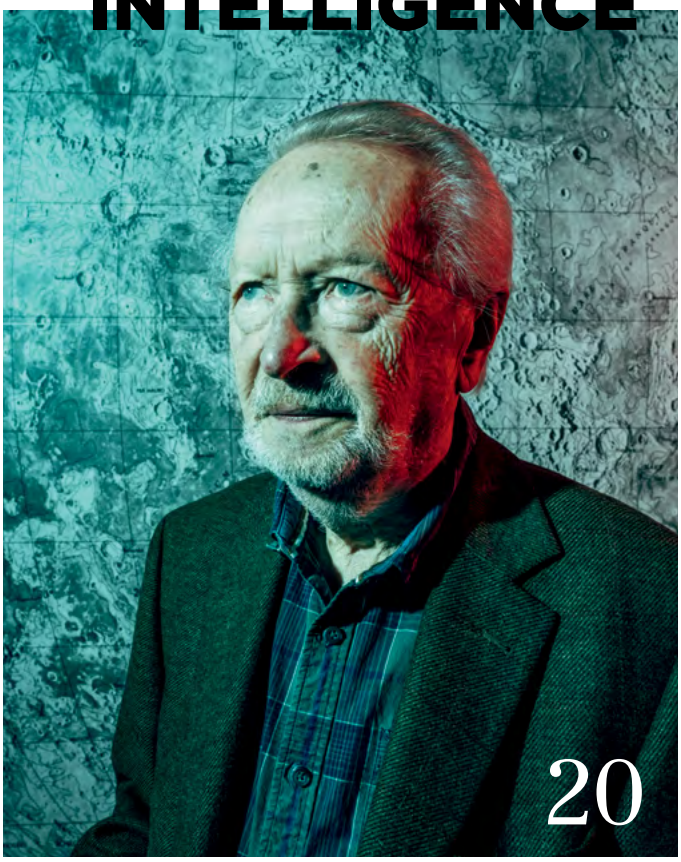
— **Artwork.** Can a computer be a creative artist?

Focus: INTELLIGENCE



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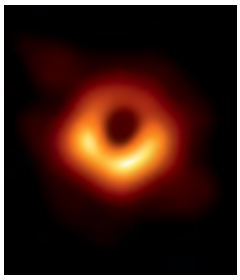

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"HEY SIRI, ARE WE DIGITAL YET?"

The World Economic Forum (WEF) and the Economic Development Board (EDB) of Singapore have joined forces with McKinsey, Siemens and TÜV SÜD to launch a new cooperation aimed at promoting the Smart Industry Readiness Index (SIRI) around the world and establishing it as an internationally recognized framework for evaluating and improving production facilities. The SIRI program is a tool for Industry 4.0 that helps manufacturing associations accelerate the digital transformation by providing a facility-specific interpretation of the most important principles, concepts and technologies of Industry 4.0. To increase the knowledge, capabilities and acceptance of the SIRI program, McKinsey, Siemens and TÜV SÜD have committed to conducting 1,000 SIRI assessments by 2021 with the help of certified SIRI auditors. The assessment is a two-day workshop that takes place within the respective company and removes the individual hurdles standing in the way of the Industry 4.0 transformation.

LEGAL FRAMEWORK FOR AI

A study by the TÜV Association looked at 500 German companies with at least 50 employees and asked about their attitudes toward artificial intelligence. A large majority of the companies surveyed are demanding clearer legal regulations for the use of AI. Only specific legal guidelines can create security and trust in AI, particularly in areas where health and legal risks exist, including automated driving, medical diagnostics and personnel selection. Eighty-five percent of those surveyed also called for AI applications to be tested for their security and safety by a manufacturer-independent testing facility before use.

PHOTOS: Getty Images/MR.Cole_Photographer (robot, AI); Adobe Stock (corona map); Stocksy/Marta Mauri (brain)

AI HELPS FIGHT CORONA

Artificial intelligence is increasingly being utilized in the fight against the coronavirus. For instance, it helps evaluate the effectiveness of various measures to help control the COVID-19 pandemic. To pool the masses of data about such measures, Aisha Walcott from IBM Research Africa in Kenya worked with colleagues to develop the Worldwide Non-pharmaceutical Interventions Tracker for Covid-19. It's a database that brings together all the world's knowledge about non-pharmaceutical measures. The data collected by the AI thus far includes around 6,000 such measures coming from 261 countries and regions. The data will help policymakers and researchers to predict the spread of the pandemic and thus estimate the likely outcomes of specific interventions in a given region.

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MILLION

is the number of fully and partially autonomous vehicles that will be produced by 2035 according to statistics gathered by Statista Research Department. This fleet of vehicles will include both private cars and autonomous mobility services such as robot taxis and shuttle buses.

SMART AS EVER

For a long time it was considered a certainty that humans were becoming more intelligent. This phenomenon was described by the Flynn effect, which documented the steady rise in scores on IQ tests since the 1930s. However, these test scores are now on the decline. Psychologist Jakob Pietschnig and the doctor and neuropsychologist Thomas Grüter believe they've found the reason for this drop in scores: the IQ test itself. The test evaluates cognitive abilities in various categories. If they improve, the overall IQ rises, but only to the point where one can no longer improve, or other abilities begin to deteriorate. What this means is that we're getting neither more stupid nor more intelligent, but that our cognitive abilities are changing. The change in the Flynn effect therefore has less to do with our intelligence but instead with the society and environment in which we live.

Artificial

Recommending products, taking care of office work, defeating human champions in games of strategy: these are all no problem for artificial intelligence these days. Now algorithms are also meant to penetrate the spheres of language, music and the fine arts. But how creative can a computer really be?

// **TEXT** JAN SCHULTE, LARS-THORBEN NIGGEHOFF, NILS WISCHMEYER

I

In the year 1950, the deputy director of the computing laboratory at the University of Manchester published an article that read like science fiction. Would it ever be possible, a certain Alan Turing asked, for a machine to think, in the human sense of the word? Turing suggested a test for this, which he called an *imitation game*, in which a person converses by text with a machine and with another person. If the person cannot tell which of the conversation partners is the machine and which is human, then the machine has passed the test—and has achieved something like artificial intelligence.

Scientists are still arguing about whether a machine has passed what has come to be known as the Turing test. And yet nowadays we're surrounded by so-called artificial intelligence (AI) in many areas. Translation software, stock price forecasts, product recommendations, language and facial recognition: they all work with artificial intelligence. Algorithms analyze enor-

PHOTOS: *Stocksy/Victor Torres (microphone); Ai-Da Robot (Ai-Da); Obvious (painting); Ross Goodwin (car)*

Creativity

mous amounts of data, recognize patterns and use them to solve problems. Over time the computers understand when they make mistakes and when they're correct. Thus they are also learning.

Just as machines became established in the factory production halls during the nineteenth century, computers are now ubiquitous in offices. There's just one arena in which they have been virtually absent to date: creativity remains a problem for even the cleverest of algorithms. Smart computers have been able to calculate, recognize patterns and perform many tasks better than humans for years, however they continue to show signs of weakness when it comes to creating completely new things or thinking independently.

Meanwhile, imagining a machine as an artist doesn't sound nearly as absurd as it may have in the past. "We must take a pragmatic approach to the topic of AI and art," says Reinhard Karger. Karger studied theoretical linguistics and philosophy and has been working in the German Research Center for Artificial Intelligence for the past 27 years. He argues that AI currently provides artists with fantastic tools but is really nothing more than a paintbrush. AI can already work combinatorially in an artistic fashion; it can combine familiar things in new ways and thereby imitate the style of famous authors or composers, for example. Yet it reaches its limits when it comes to actual creation. "It lacks the access to being human," Karger says.

But is that why an algorithm isn't creative? At the end of 2018, the auction house Christie's sold an artwork that had been "painted" with assistance from AI—for 432,500 US dollars. Computers now independently write sporting news and press releases. Singers use AI to help compose new sounds and complete songs. This all begs the question: how creative can a computer be?

// DECEPTIVE ALGORITHMS AND CAMERA EYES

Ai-Da is standing in front of a mint-green wall, ready for a difficult task. The artist, with black hair, dark eyes and wearing a white smock splattered with paint, is going to try to paint consciousness. But what does consciousness look like? Is it blue? Red? Abstract? Detailed? This is actually much more complex for Ai-Da, since she doesn't even possess the consciousness that she is supposed to express.

Ai-Da is a robot, created by gallerist Aidan Meller and equipped with an algorithm developed by researchers at the Universities of Oxford and Leeds. Her skin is made of silicone and her eyes are cameras. With the cameras she records what happens in front of her and that's also exactly what she puts down on the canvas. Her algorithm helps her to abstract the impressions. Meller doesn't wish to reveal exactly how this works, just this much: the images from the camera eyes pass through several layers that are similar to filters. The algorithm ensures that each decision process remains unique. This way, Ai-Da never takes the same "thought" pathway. Each of her artworks is unique.

The robot's paintings have brought in one million euros so far. But is it art and is it actually creative? Or is it just replication of the known world as the algorithm dictates? "Humans create something new from what they see and call it art," Meller explains. "Ai-Da is doing the exact same thing." Of course, Ai-Da doesn't have consciousness, nor feelings, but she's still creative despite this, "because she creates something new from the known."

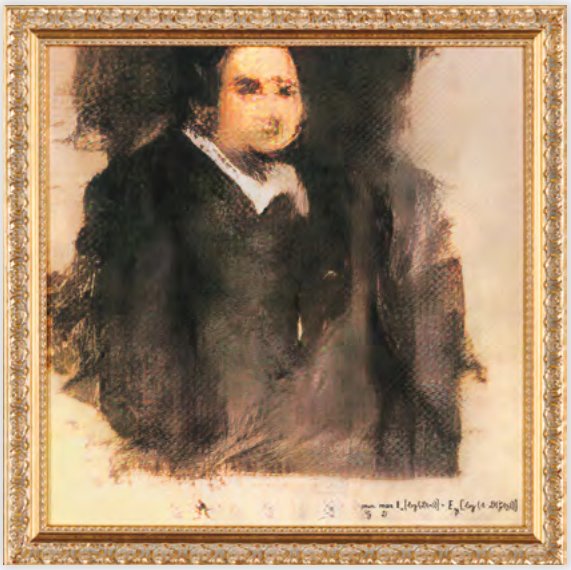
Around four hundred kilometers away, the three founders of Obvious Arts reveal a bit more about the technology of their art project, one that has already earned them quite a bit of money. The painting *Portrait of Edmond de Belamy* shows a man, dressed in black, slightly blurred—and was auctioned off for almost half a million US dollars. The algorithm that created the painting was written just for this single painting, as Gauthier Vernier, one of the group's three founders, explains.

The artists had two algorithms that played a sort of game with each other. Algorithm 1 was fed with many old portraits in order to define what a classic painted portrait looked like. Algorithm 2 was not told what was going on. Instead, it was instructed to paint a painting that Algorithm 1 considered "real." Then the game began. The first painting Algorithm 2 created had nothing to do with a classic portrait and was rejected. As was the second one. But the deception algorithm got better and better with each try. "You have to imagine a teacher who is familiar with all the Picassos in the world, and a student who's never seen a Picasso and must paint a deceptively real one," Vernier explains. "The student then practices until the teacher is convinced." As soon as Algorithm 2 was able to deceive the test algorithm in 51 percent of all attempts, they allowed it to create a painting from what it had "learned," based on the old patterns that define a portrait but still completely new.

The machine as artist, and a creative one at that? Vernier waves off the question with his hand. He views the algorithm similarly to the way AI expert Karger does, seeing it as a tool. After all, he says, people influenced it, wrote it and fed it with selected data sets. "We do believe that the algorithm can invent something because it makes something new of what's known, and there's a random factor that even we cannot influence," Vernier says. He also says the AI has its own style that a person can recognize, for instance because it places pixels where most people wouldn't expect to see them in portraits. "But the machine will never be able to completely 'think outside the box' like Van Gogh or other artists, creating what many would only then call creativity," Vernier says.

He still considers the algorithm's work to be art, as the auction of the painting has already shown. And in any case, art is in the eye of the beholder—whether a human being or a camera's lens.

LUCRATIVE ART
The algorithm-created *Portrait of Edmond de Belamy* sold for almost 500,000 US dollars.



PHOTOS: *Obvious (painting), Ai-Da Robot (Ai-Da)*

Genesis

Taryn Southern
DJ Beep Code

I AM AI

// BEATS AND ARTIFICIAL SOUNDSCAPES

Right at the start of her video to the song *Breaks Free*, Taryn Southern looks directly at the camera in a close-up shot and sings, "I wish I could see, beyond what I can see." The camera jerkily moves closer and closer to her face while Southern's expression remains calm. Everything looks like it does in dozens of other pop songs before this one, and it all sounds very much like pop as well. It's just that Southern didn't arrange the song completely by herself—she had some help from AI. Just like the entire album the song was released on.

Since Southern released her AI album back in 2017, she's become a sort of ambassador for artificial intelligence in the music business. While producing the album she tested a number of music AIs at once. "Basically, they all work using similar principles," she explains. "You feed the AI with data, for instance a series of music pieces from the 1970s, and the AI uses them to create new music that follows similar patterns and rules within the genre." In the next step, Southern is played an initial proposal piece. By adding even more data, she can steer the AI in the desired direction. After that, she can continue to make adjustments, for instance by increasing the beats per minute. Fundamentally, Southern isn't doing anything differently than when she goes into a production studio, except that she can control everything herself with the help of AI. She doesn't need other musicians or a producer sitting next to her.

Southern explains that this can be an enormous help, particularly in the beginning of a musician's career, since many cannot afford to hire an expensive producer. Depending on the program, the AI spits out an audio file of the finished song or several smaller snippets of the individual instruments. Some programs even output—very traditionally—actual notes and sheet music. "AI won't be turning the music industry completely upside down, but for many musicians it will absolutely be a new practical tool for their composing process," Southern finds.

Of course, AI can be used for much more than just producing a new music album. In Berlin, Oleg Stavitsky co-founded the app Endel, which he developed with a small team. It delivers sounds generated in real time that are adapted to the time of day, the weather or even one's own heartbeat. These sounds, often reminiscent of the soundtrack from a science fiction movie, are designed to help you concentrate, fall asleep or simply just relax. The data for the AI comes from composer and co-founder Dmitry Evgrafov. As soon as a user activates the app, it accesses the composer's work, incorporates parameters including the time of day, and then generates suitable new sounds.

In spring 2019, the record label Warner signed a contract with Endel and published twenty albums created by the AI on music streaming services including Apple Music and Spotify. The developers have set even more ambitious goals for themselves this year: Endel should soon be able to generate the perfect background music for a car drive.

AI HITS THE TASTE OF THE MASSES

That music is being created on a computer isn't surprising, but that the computer itself is doing the sampling is.

PHOTOS: *Devin Mitchell (album cover); Getty Images/oxygen (album cover background); unsplash/Bruno Araujo (music studio)*

// GHOSTWRITERS AND TEXT MACHINES

Generative Pre-trained Transformer 3: this unwieldy name caused an uproar in the world of professional copywriters in June 2020. Behind it is a copywriting machine, driven by artificial intelligence and developed by the San Francisco-based software company Open AI. The *New York Times* described it as "more than a little terrifying." The British *Guardian* newspaper commissioned an entire article about AI and its potential dangers—written by the AI itself. Even the program's developers warned about the technology's risks and spillover effects at the same time as they went public with the program.

To show what GPT-3 can do, its developers uploaded just half a press release for publication on its website. Anyone who wanted to read the rest of it could have it generated by GPT-3. There were hardly any noticeable differences to the first, human-written half.

Yet the technology behind this text machine is basically nothing new. The program is fed existing texts and learns the probabilities of words or sentences following one another. Still, the sheer mass of data fed into the algorithm, not to mention its finesse and fine-tuning, are better than ever. Even a novel written by AI could be conceivable in the future.

Ross Goodwin has even tried this idea already. Goodwin, an American, used to work as a political ghostwriter, but today describes himself as a researcher in the borderlands where AI, literature and cinema overlap. Goodwin has written screenplays with the help of AI and filmed them with actors such as Thomas Middleditch and David Hasselhoff. As if that weren't enough, he then started the project *1 the Road*, a machine-created piece of literature.

"I had wanted to let a car write a novel for quite some time," Goodwin says. As the foundation for his idea, he eventually took the novel *On the Road* by American Beat writer Jack Kerouac. Like the original it was emulating, Goodwin's work would be written on a road trip from New York City to New Orleans. Except that it wouldn't be Goodwin, pen in hand, writing down his experiences along the way, but a software made up of lines of code. In 2017, he converted a car according to his ideas: a camera mounted on the trunk to film the passing scenery, a microphone in the interior to record conversations, a GPS sensor to track the location. In other words, huge amounts of data for the algorithm to fashion a novel.

The result? It was "choppy" and full of typographical errors, as Goodwin himself admitted. "It was all an experiment and I published the results accordingly," he says. While the work of the original begins with the sober statement "I first met Dean not long after my wife and I split up," Goodwin's car begins much more mysteriously with the sentence "It was nine seventeen in the morning, and the house was heavy."

The reason for the different performances of GPT-3 and Goodwin's car: texts such as press releases, sports news or stock market reports follow clear formulas, patterns that an AI can learn. Literature, in contrast, lives precisely from the chaos of creativity. Here, patterns that can be meaningfully reproduced are something that artificial intelligence has been looking for in vain so far.

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Without such patterns, however, machines can hardly become "creative" on their own. They lack what humans call consciousness. Whether they will ever develop this is one of the biggest questions of the present day for Reinhard Karger from the AI Research Center. "Nobody has a satisfactory answer to this question," he says. From a scientific point of view, he says, it cannot be ruled out that machine consciousness could exist at some point. "But considering everything we know today, this is very, very unlikely."

AI WITH A PANORAMIC VIEW
A camera was installed on the trunk so the car would also receive visual input to write "its" novel.

WHAT DOES AI SOUND LIKE?
You can get an idea of the creative abilities of AI here: abouttrust.tuvsud.com/en/creativeai

PHOTOS: *Ross Goodwin*

“There will

NEVER BE an unbiased AI”

TEXT ANNA GAUTO **PHOTOS** DAMIEN MALONEY —— Vivienne Ming is one of the world’s most distinguished experts on artificial intelligence (AI). Ming, an American tech founder and neuroscientist, explains why algorithms aren’t objective and why the use of AI is already encroaching on people’s civil rights.

Ms. Ming, algorithms provide recommendations for action based on cool mathematical calculations. Does this make them neutral?

MING Many experts and professors actually believe it does. As if artificial intelligence consists solely of simple equations where you enter one number and another one pops out at the end. Sometimes I ask myself if people can actually be that naive or if they’re just pretending to be.

Why would they do that?

MING To more easily sell their AI. Especially for human resource departments, AI is often advertised as providing objective support for selecting new employees. But it’s downright ridiculous to suggest that algorithms are neutral.

Why is that?

MING There are a number of examples that prove the opposite. Let’s look at facial recognition. Twenty-two years ago, when the technology was first being developed, it didn’t recognize the faces of people of color. At the time, the explanation was that the faces from the internet used to train the algorithm were mostly white people and that this error would be corrected. This was understandable at the time, but nothing has changed to this day.

Why not?

MING Because the people who are programming the algorithms feed them—albeit unconsciously—with racist information.

How do you accidentally build algorithms that treat minorities worse?

MING By forgetting or ignoring those people who aren’t white and male like the majority of programmers. And by assuming that mathematics and truth are the same. Of course, taking the technical perspective, algorithms are made up of equations. But they are fed with assumptions about the world—and those are based on human prejudices.

For instance?

MING For an educational start-up, I once built a small AI system to reunite refugee children with their missing families. To train the system, I used scientific data for facial recognition and enriched it with faces from the internet, for instance from Facebook and Twitter. At first, I just wanted to make sure that my neural network understood what faces are. Then it learned a few really interesting things.

Namely?

MING The majority of smiling faces belonged to women. So the system assumed that women always smile. If a woman wasn’t smiling, the network believed that the face must belong to a man. We didn’t teach the network about gender roles. It learned them itself.

You’re alluding to a phenomenon that science calls “social smiling”: many women smile even if they don’t feel like doing so because they believe it is desirable to be friendly.

MING Exactly. And the AI couldn’t help but notice it.

Even Amazon was quite surprised when they discovered the conclusions reached by a seemingly neutral algorithm that was

supposed to select personnel. It's said that you warned Amazon about the algorithm.

MING Yes. Amazon wanted to hire me as its chief scientist. I was told: "In seven years, a million people will be working for us. Your job will be to make their lives better." It was actually a fascinating job offer. Everything that I'm doing today with Socos, my think tank—crazy, data-driven science—I could have had there.

You turned them down. Why?

MING One of my projects would have been to build an AI to make more diverse personnel selections. It was supposed to find the best software developers based on historic Amazon data. That meant the algorithm should determine the best candidates for the job using information about who received promotions during their first years at Amazon.

That initially sounds plausible…

MING But only at first glance. I had already built an AI for recruiting as the head scientist at another company and knew that this method wouldn't work. I told this to the people at Amazon as well, but they still wanted to do it their way.

Why didn't it work?

MING Like other tech companies, Amazon believed that they just needed the smartest programmers and enough data to be able to program anything. However, what these first-class computer engineers didn't realize was that their data sets did not contain objective indicators for performance, but rather twenty years of subjective personnel decisions and promotion practices. The system very accurately read from the data who the company had predominantly hired and promoted: men. So it consistently eliminated women from consideration.

They stopped using the algorithm at some point?

MING Yes, because it was still screening out women even after the company removed all the obvious references to gender from the data. The system had already internalized too much of what had long been crucial for a successful career at the company—being male. The algorithm then found a way to determine if an application was likely to be from a woman, even without gender markers, and then rejected it. By the way, the same thing could have occurred at many other tech companies.

Why is that?

MING When students today are getting a degree in machine learning, in most cases they are improving existing systems. For instance, they're trying to make a certain photo recognition program a little bit better. In order to do this they are given the program, the data, the problem and even the answers. Based on this experience, they are suddenly supposed to program an unbiased AI later on. No wonder it doesn't work.

The computer engineers are following a recipe and that's the very reason they're failing?

MING Of course. They've never had to compile their own data set or develop their own sets of questions. They've only learned how to make systems more accurate and more powerful. In the twenty years that I've been working on really tricky problems, not once did I receive a data set and even less often the appropriate question about it. I had to find out both of these myself. Many software developers who go to the big tech firms dutifully perform their assignment: What's the best possible algorithm based on my data? They don't question whether the data set itself is suitable, whether the assumptions in it reproduce biases, or where such biases might be hidden in the data. They build outstanding tools. But they keep building more tools, when it's really houses, not tools, that are needed. They haven't learned to develop real solutions.

And how do you build an algorithm that doesn't discriminate?

MING My advice is not to use any historical data and instead to incorporate scientific findings. Psychology, sociology and economics have known for a century what is crucial for someone to be good at their job. Simply ignoring this knowledge is insane.

You've built AI for recruitment yourself: what approach did you take?

MING We programmed small AI systems that simulated scientific experiments. We know from psychology that a core characteristic for quality on the job is, for example, resilience—that is, whether or not you are discouraged by failure. Our AI then searched for such indicators for resilience or queried for them in the form of a psy-

"It's downright ridiculous to suggest that algorithms are neutral."

chological questionnaire on a website. We know a lot about the world. If we enrich machine learning with it, we can achieve a lot.

AI seems to be holding a mirror up to us as people, in which we can see our own prejudices. Couldn't AI be used in a very targeted way to make such unconscious biases visible to us?

MING Absolutely. In the end, the systems that we build are really only a reflection of ourselves. After training a language AI only with American literature, it connected positive concepts to men and all things negative to women and people of color. The media turned this into "AI is racist." But AI isn't racist, we are. AI is just a reflection of us.

Do neutral algorithms even exist?

MING I don't believe they do. But there are significant differences. For instance, it's important how complex the equations are. In modern vehicle engines, machine learning can help use energy more efficiently. In those sorts of simple, closed systems, biases play hardly any role. But when a cognitive system has to make decisions with many uncertain variables, it gets difficult: How fast do I drive heading into a curve? What move do I make next in this game of chess? Who do I consider criminal—and how do I prevent discrimination in hiring? There are so many possibilities that prejudices always play a role. There aren't any unprejudiced people, which means there will never be an unbiased AI.

Should AI be banned from particularly sensitive areas?

MING It's something worth thinking about, at the very least. San Francisco has used the flaws of facial recognition technology as a reason to ban the technology in public institutions. On the other hand, I've also used that sort of AI to help autistic children understand facial expressions. Or to reunite refugee children with their families. Bans will always also affect AI that helps people or even saves lives. Despite this, I find facial recognition technology highly problematic, for instance in police work.

The use of AI seems to require a continual balancing of pros and cons.

MING This is important, since AI is working its way deeper and deeper into our lives. AI doesn't just influence who gets which jobs. It decides about loans, the type of news we see, social connections, who the police check and many other facets of our lives. We ask ourselves if AI discriminates, and it does. But the problem runs much deeper.

Where, for example?

MING AI is undermining people's civil rights. Not because it invariably discriminates, but because it shifts a tremendous amount of power to a very small group of people that AI ultimately serves.

There are guidelines for using AI. What do you suggest to prevent the large data collectors from becoming too powerful?

MING AI must be established as a civil right in order to restore the balance of power between citizens and tech companies. Each individual must have access to AI that is focused on that person's well-being, like a person's doctor or lawyer. This also requires having access to the AI infrastructures and algorithms. After all, how else will we know whether there isn't some hidden system responsible for our not being promoted at work? In the United States, the model of the "public option" for AI has emerged, a sort of voluntary alliance between the state and the citizens. There are some ideas about how this would work, for instance public funding for machine learning or a type of escrow function for private data. None of this means that I think badly of Jeff Bezos, Jack Ma or Larry Page. But because the interests of some billionaires aren't likely to be congruent with those of the users, we should have the right to an AI that is committed to our well-being.

PHOTOS: *Siemens Energy*

Inside View

MASTER OF THE WIND

Offshore wind parks generate almost one fifth of the total wind power in Germany. To get this clean energy from the sea to the coast, the alternating current that is generated must be converted into direct current. Of the two, only the latter can be transported ashore—through undersea cables as thick as an arm—without major losses. If the energy were sent as alternating current, hardly any of it would be left after the eighty-kilometer trip through the lines.

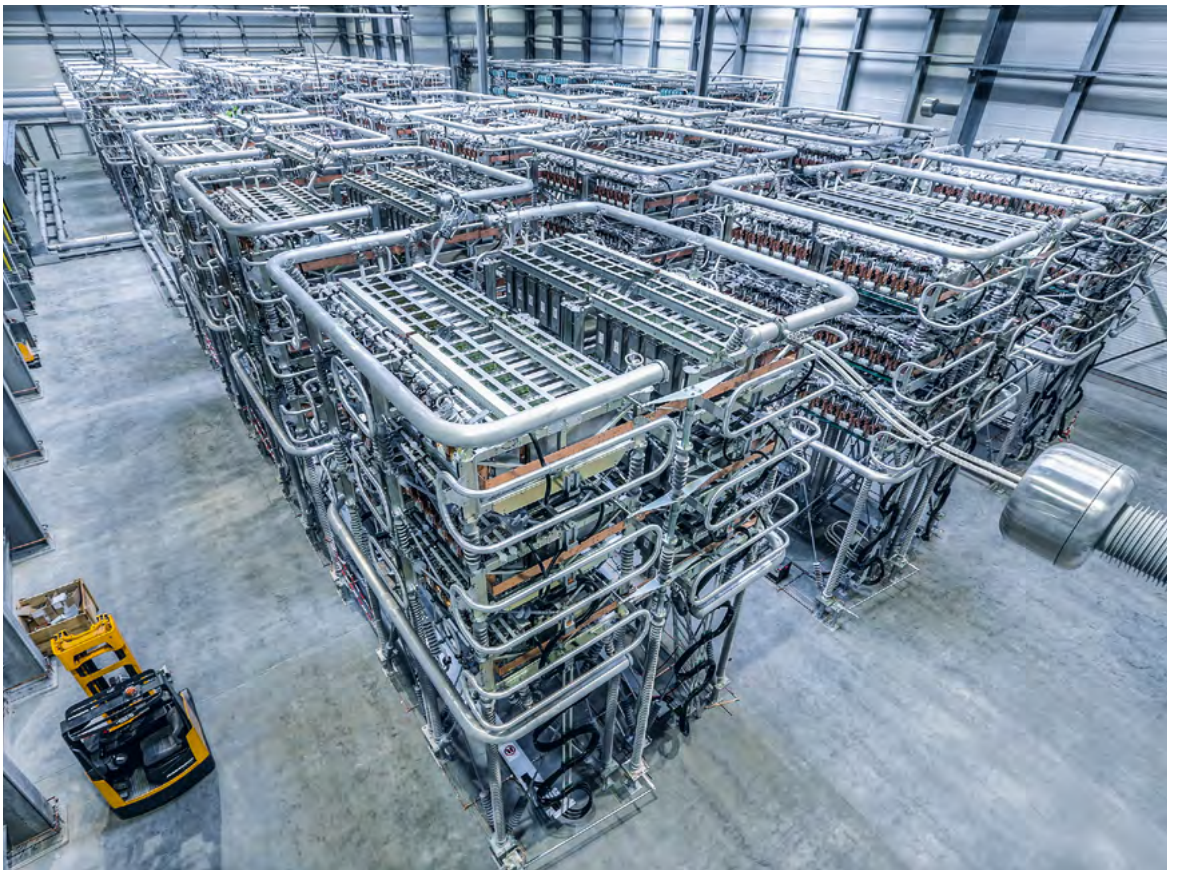
The current is converted at sea by gigantic converter platforms like the BorWin 3 (large photo) or HelWin 1, which are connected to transformer stations on land, to which the electricity is transmitted. TÜV SÜD has been inspecting both the onshore and offshore facilities since early 2020. Our experts take a close look at the cranes and elevators, fire alarms, fire extinguishing and tank systems, and various pressurized containers. "We can offer a one-stop shop for all the expert testing in accordance with Germany's Industrial Safety Regulations," says Group Manager Timo Brenneisen in the Offshore Wind Energy Division in Hamburg. This view of the big picture is something customers appreciate—and helps set TÜV SÜD apart from the competition.

900
MEGAWATTS
of output can be generated by the BorWin 3

132
KILOMETERS
of submarine cable and 28 kilometers of underground cable connect the offshore platform with the Emden-Ost onshore converter station.

Anyone wanting to work as an expert inspector out on the open sea must be physically fit and have taken ocean survival training. "For instance, there's very practical training on how to survive extreme situations like a helicopter crash at sea or a fire on the platform," Brenneisen says. The assignment itself starts with a safety briefing at the airport. After that, a helicopter flies the team out to the station. The inspectors usually stay on board for three to five days, during which they work in close cooperation with the maintenance crews there.

"Admittedly, it can get uncomfortable out at sea," Brenneisen says. On the other hand, the work is extremely interesting and satisfying because the technologies being used offshore are ones you never get to see on land. He continues, "It's incredibly interesting from a technological point of view and there's an excellent working atmosphere." Everyone working on the station has a similar mindset and a commitment to the same goal: the sustainable energy supply of the future.



INNER LIFE OF A STATION An interior view of the converter station HelWin 1 in Büttel, Schleswig-Holstein, Germany. Commissioned in 2015, the station has a capacity of 576 megawatts—which is enough to supply more than 700,000 households.

Is there ou

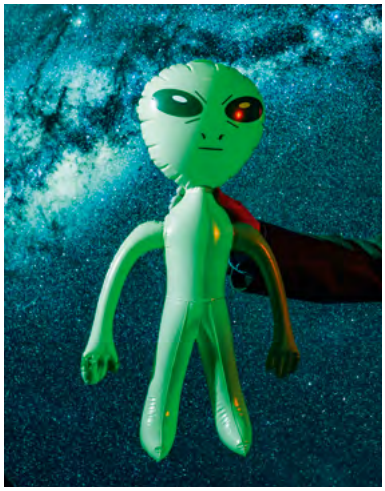
ANYONE
t there?

TEXT JULIUS SCHOPHOFF **PHOTOS** NIKITA TERYOSHIN ——— Little green men, mysterious auras, writhing tentacles: the idea of intelligent life in space has been captivating people for decades. We set out on a search for the extraterrestrial with three leading researchers—and found some sobering answers.

When Dieter B. Herrmann stands up from his desk at night, steps outside the door of his apartment in the Archenhold Observatory in Berlin and looks up at the sky, each time he realizes how little humankind knows about the universe. There are supposedly one hundred sextillion stars, and probably at least as many planets. One hundred sextillion is the number one followed by 23 zeros. "We've only discovered 4,281 planets so far," Herrmann says. The majority of which were detected only with indirect measurements. "We've only actually seen three or four outside our solar system."

Herrmann was twelve when he opened his first book about space in the school library. The year was 1951. Nobody knew if a person would ever make it to the moon. Quite a few believed in Martians, which Herrmann thought was science fiction, and science fiction was never his thing. "I always had the feeling it was a crackpot idea." Today, he's not so sure anymore.

This late summer day, the 81-year-old is sitting in the library of the observatory in Treptower Park in Berlin and is talking about whether there could be intelligent life out there somewhere. For almost thirty years he directed the research station, from the center of which protrudes the world's longest movable lens telescope. Today the retired director lives in an apartment at the back of the building complex. The press used to call him "the stars professor" because he was the long-time host of the science program *AHA* on East German television. The International Astronomical Union named the small body 2000 AC204 Dieterherrmann in his honor. He's currently at work writing his forty-seventh book and still gives forty to fifty lectures a year: about constellations and astrophysics, about the Big Bang and dark matter, about white dwarfs and red giants. And about the question of whether or not we're alone in the universe.



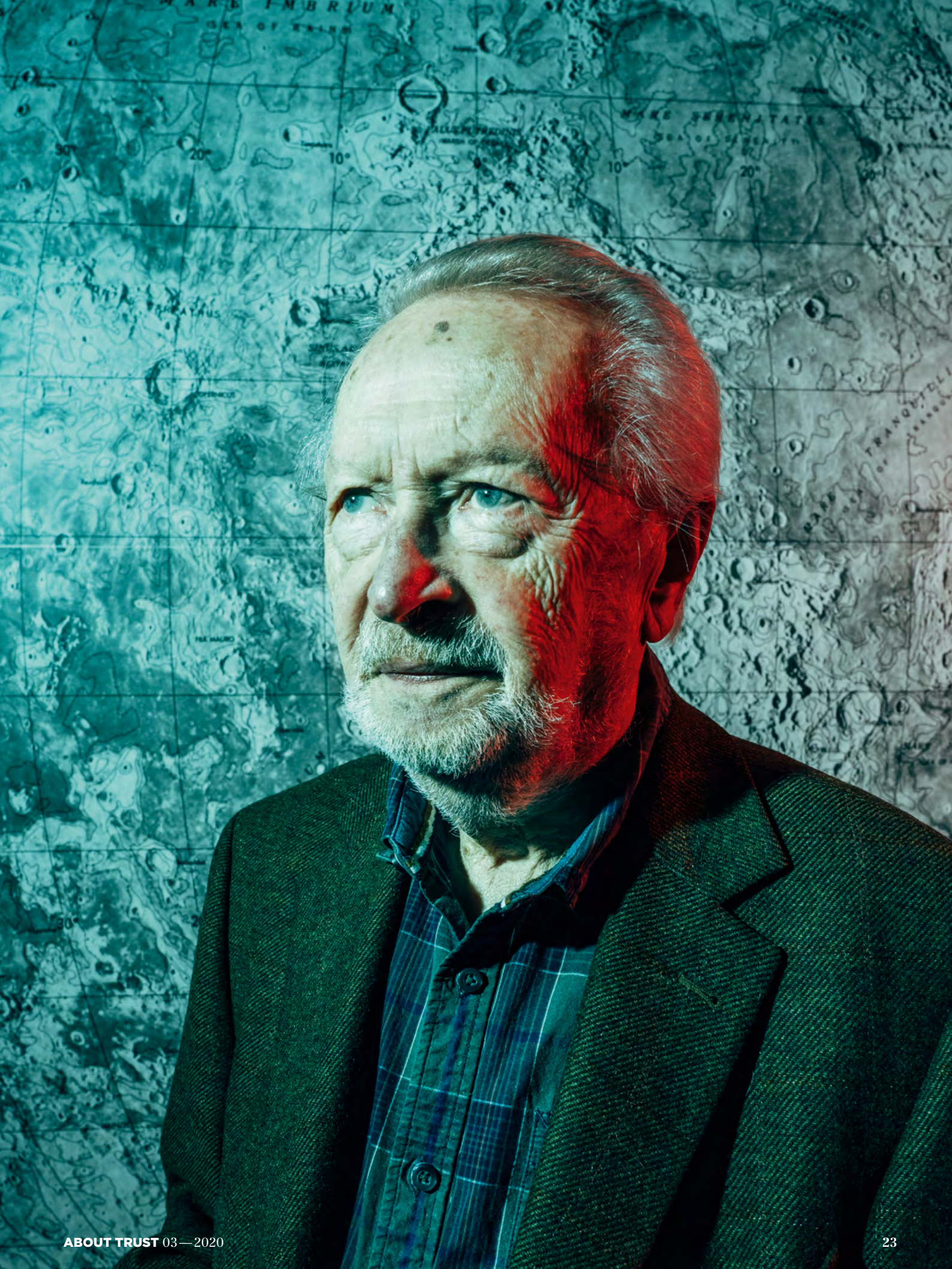
STAR WATCHER
Dieter B. Herrmann has spent a lifetime looking into outer space. Intelligent life only on Earth? A paradoxical concept, he says.

AND WHAT DO YOU BELIEVE, MR. HERRMANN: IS ANYONE OUT THERE?

"Belief belongs in the church," he says. "But since you've asked: there are hundreds of billions of suns in the Milky Way, and there are hundreds of billions of such galaxies. It would be paradoxical to think that we're the great exception and that intelligent life can only be found here."

As a scientist, Herrmann knows that only that which has been proven is considered to be true. And as of yet, no proof has been found for extraterrestrial life. According to the Rare Earth hypothesis, it is quite unlikely that complex life has developed outside of Earth. The composition and position of our planet, which is so hospitable to complex lifeforms, is something quite rare in the universe. Yet it is precisely these sorts of considerations that fascinate Herrmann when he considers the question of intelligent life in the universe. This question has captured humanity's imagination for centuries but remains a question without a satisfactory answer, despite all the research undertaken thus far.

Surveys have found that about half of Germans believe there is intelligent life out in the universe. Back in 1938, when the US radio station CBS broadcast the *War of the Worlds* radio play, some American listeners thought they were listening to a live report about an actual invasion from Mars. Artists, musicians and Hollywood have been exploring the theme for decades. There are people who fear that the arrival of aliens will wipe out humanity, while others hope for salvation to be brought by alien beings from outer space.


MARE IMBRIUM
SEA OF RAINS
MARE SERENITATIS
SEA OF SERENITY
PARATAUS
PRA MAURO
TRANQUILLITY

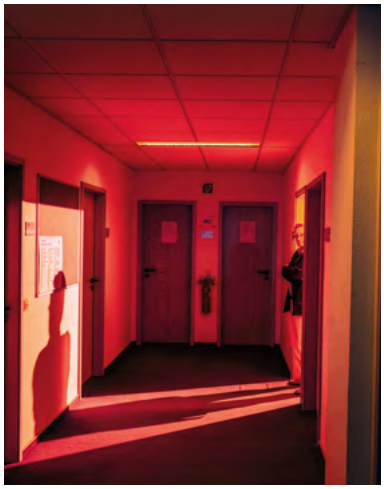

Michael Schetsche
Andreas Anton
Die Gesellschaft der Außerirdischen
Einführung in die Exosoziologie
Springer VS

Those who wish to take a more sober approach to the question can speak to scientists such as Herrmann, who has researched planets, stars and galaxies for decades as an astronomer and physicist. Other scientists are looking to determine the conditions under which life can develop and are designing scenarios of what an encounter with alien beings might be like. Such scientists include the astrobiologist Dirk Schulze-Makuch and the exosociologist Michael Schetsche, with whom Herrmann discusses such questions in the Research Network Extraterrestrial Intelligence—and in so doing arrives at astonishing but also frightening prospects.

"Basically, the efforts of the past decades have achieved very little," Herrmann says. Because optical telescopes quickly reach the limits of what is physically possible, radio telescopes began searching for signs of life. In the United States, scientists from SETI—the Search for Extraterrestrial Intelligence—have long been searching for artificial radio waves from space. The researchers' thesis is that if there is a technically developed civilization, it should also have radio technology. Gigantic research stations have been built at sites such as the Arecibo Observatory on Puerto Rico, which had a reflector dish measuring 305 meters in diameter. For the SETI@Home project, millions of people provided access to their private computers to help evaluate the masses of astronomical data being received. Yet on March 31, 2020, the project was stopped—without any results.

BUT DOES THAT MEAN THAT THERE'S NOBODY OUT THERE?

"We don't even know if the search for radio signals was the correct strategy," Herrmann says. Perhaps intelligent alien life forms have completely different technologies at their disposal that aren't even showing up on our technology horizon yet. "It's like setting up a radio telescope while the other side is trying to get your attention by yodeling from a mountaintop."



ALIEN RESEARCHER
Michael Schetsche researches what might happen upon contact with extraterrestrials. Things don't always turn out well for humanity in his scenarios.

Former SETI Director Jill Tarter once described the dilemma of the search as follows: to claim that there wasn't any extraterrestrial life based on previous investigations would be like taking a glass of water from the ocean, not finding any fish in it, and then using that to conclude that there were no fish in the ocean.

Perhaps completely different approaches are needed. Like the one Dirk Schulze-Makuch is taking. A professor of astrobiology and planetary habitability at Berlin's Technical University, he's investigating places where the hostile conditions are closest to those found on Mars: the snow-free, high mountain valleys in Antarctica or the dry Atacama Desert in Chile. There are hardly any plants or animals there, but a multitude of microbes call these places home. Schulze-Makuch is continually amazed at the conditions these microorganisms can defy. "Life," he says, "is incredibly resilient."

For Schulze-Makuch, Mars is by no means the only possible habitat for life in our solar system. For instance there's the Saturn moon of Titan, which is covered by oceans of liquid methane and ethane, with an atmosphere denser than Earth's. Or the icy moon Enceladus, also a satellite of Saturn, which has huge fountains of water shooting up from its surface like cosmic geysers. For a long time, it was considered impossible for life to develop under such conditions. Yet now that strange crabs, worms, mussels and starfish have been discovered in the deep sea—creatures that get their energy not from sunlight but instead from the hot gases and minerals of the Earth's crust—some researchers believe that the origins of life are to be found deep in undersea crevices. Schulze-Makuch considers it possible that on Jupiter's icy moon Europa there are ecosystems similar to those found at hydrothermal vents in the deep sea, with lifeforms at a similar stage of development as crabs and tube worms. Of course, tube worms cannot build spaceships—but the possibility that there are relatively highly developed organisms in our solar system, practically at our doorstep, illustrates how megalomaniacal it is to believe that Earth is the sole cosmic exception.

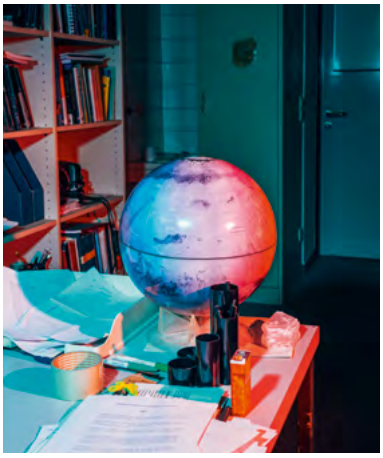
A weakness of astrobiology, Schulze-Makuch admits, is that it al-

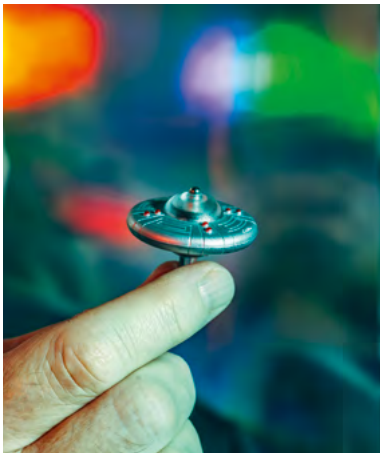
ways starts from the Earth, from life as we currently know it. But biology in outer space may also be completely different. Perhaps life has originated somewhere else on the basis of silicon; maybe methanol works as primordial soup instead of water; what if, according to the idea of a colleague of Schulze-Makuch, genetic information could be passed on by magnets instead of DNA? But perhaps whatever's going on out there is also "completely out of the box," as Schulze-Makuch says. So inconceivable that it would be paradoxical to have any idea of it at all.

Michael Schetsche calls this inconceivability the "maximum foreignness." Schetsche, a sociology professor in Freiburg, together with his colleague Andreas Anton founded a new discipline: exosociology. The scientists are investigating what would happen in our society if we really came into contact with such an alien—and have worked out three scenarios: one that is harmless, and two with more serious consequences.

In the first scenario, humanity receives a signal. It's a harmless mind game. The signals probably came from so far away that whoever sent them could never visit us, and probably vanished long ago. "It would be a sensational discovery," Schetsche says. "It would change our view of the world because we would finally have proof that we aren't alone—but it wouldn't really give us any cause for worry."

In the second scenario, we find an artifact of an extraterrestrial expedition somewhere in our solar system: a probe or a station, but perhaps even just its trash. From that moment onward, we would know that there is a technically advanced civilization that has mastered interstellar spaceflight—and that they were here at some point. "This would lead to a general sense of insecurity," Schetsche explains. "We would have to ask ourselves: Who are they? What do they want? And will they return?" Such a find would also be risky because it would contain valuable technical information and a race would break out among nations and multinational corporations as to who should be allowed to recover the artifact. Schetsche says that under no circumstances should such a find be brought back to Earth. "Experimenting with the propulsion of a probe for interstellar space travel could quickly destroy an entire continent."





PLANET CHECKER
Dirk Schulze-Makuch investigates what conditions are necessary for life to arise. Surprisingly few, he says.

Yet the greatest levels of shock are found in the third scenario: an actual encounter. If a space vehicle controlled by an extraterrestrial intelligence enters our solar system, it could cause mass panic, stock market crashes and religious upheavals. The fears wouldn't even be that irrational. You just have to look at the history of asymmetrical cultural contacts on Earth, Schetsche says: "When one civilization visits the territory of another, things usually turn out badly for those being discovered."

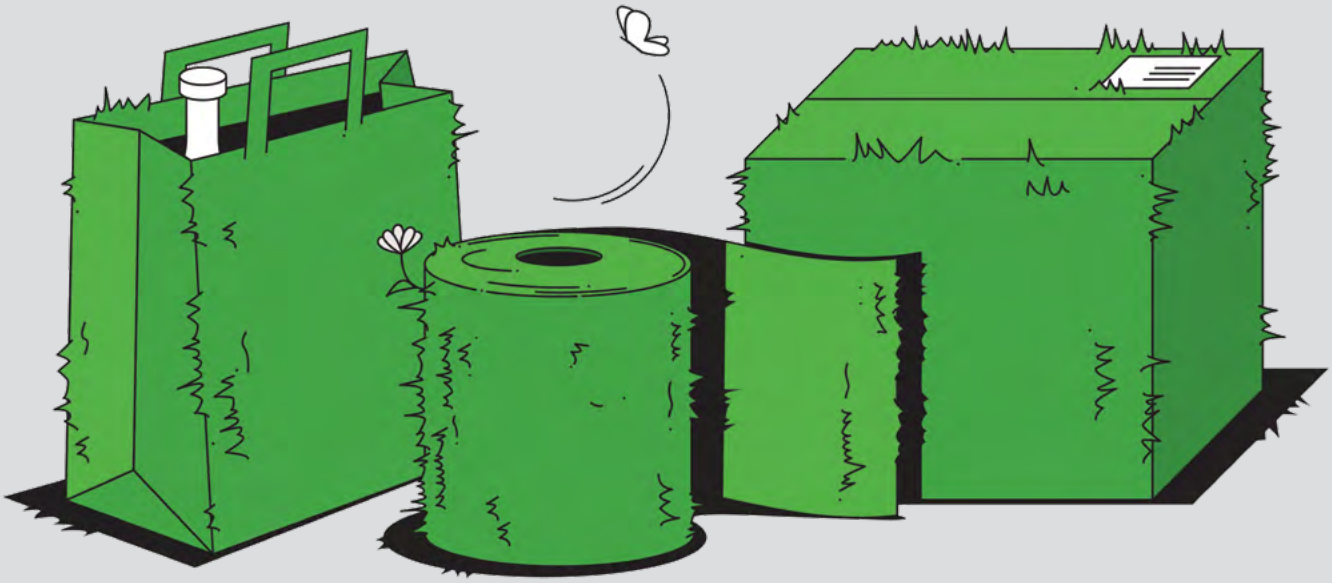
Which is why he's therefore strictly against turning the tables and sending targeted radio signals into space ourselves, as some members of the SETI community do in the METI—Messaging Extraterrestrial Intelligence—program. Alien civilizations could have a completely different relationship to living and dying, Schetsche warns. He isn't thinking about Martians here, or any tentacled creatures—what's much more likely is that we would end up dealing with "post-biological secondary civilizations": with machines that were once built by biological beings, but who long ago left behind their creators and their mortality—which is how they can overcome the enormous, interstellar distances.

Schetsche believes that when it really does come to contact, we will be surprised at how alien the aliens are. "It could be artificial intelligence at the cellular level, a kind of biocomputer. And perhaps it won't be so easy for us to distinguish: Is civilization primary, secondary—or even tertiary?"

Tertiary civilizations? Artificial intelligence created by artificial intelligence? Immortal bio-computers traveling through space? It all sounds just a bit like "crackpot ideas," as the twelve-year-old Herrmann would have claimed. However, towards the end of our conversation in the observatory, Herrmann also said that over the past seventy years, science-fiction authors were often much closer to the truth than scientists. "And the history of science shows that the world is much more diverse than we ever could have dreamed."

THE GRASS (PAPER) IS ALWAYS GREENER

Paper devours almost half of the world's wood production. Uwe D'Agnone, an entrepreneur from Düren, Germany, thought about how paper could be produced in a smarter and more ecological way. His answer grows almost everywhere.



Nine years ago, Uwe D'Agnone first asked himself how paper could be produced in a more environmentally friendly way. D'Agnone is a specialist in exactly this field, having trained as an industrial management assistant in a print shop. He later founded a company specializing in environmentally friendly promotional items such as calendars. In his search for more ecologically responsible paper, he eventually found a solution that grows on every field and in every garden: grass.

As he explains, grass fibers are a perfect fit for ecological paper production. Wood must first go through a number of processing steps to become paper, consuming large amounts of water and chemicals along the way. Grass, in contrast, gets by with just a fraction of the water and no further additives. The reason: wood consists largely of lignin, a sort of organic glue that must be removed for paper manufacturing. Grass contains hardly any lignin at all.

For the paper D'Agnone manufactures at his company, Creapaper, mown grass is initially dried, pressed into bales and then brought to Creapaper's production facility in Düren. There the grass is cleaned, chopped and ground, and the prepared fibers are compressed into pellets, which are turned into paper in a factory. The finished product consists of up to 50 percent grass fibers, while the rest is made up of wood pulp or recycled paper. D'Agnone doesn't want to switch to completely using grass just yet. His goal is to use perfectly customized blends to create the best possible products for different applications such as writing paper, cardboard, shopping bags and facial tissues. D'Agnone can already supply the entire array of products right now with his current material blend. "We can basically manufacture everything with a portion of grass fibers, from toilet paper to the thickest cardboard," he says. Various retail chains are already using fruit and vegetable trays made of grass fibers.

The road to market acceptance was a rocky one for D'Agnone. "At the beginning, the paper manufacturers told me to get lost when I asked if I could use their facilities to produce paper products made with grass," he recalls. D'Agnone hopes that, in a few years, grass paper will have outgrown its market niche and be making a measurable contribution to fighting climate change.

The signs are all pointing in the right direction at the moment. D'Agnone is currently working with 23 paper mills and employs 51 people. In Düren, he can manufacture 25,000 tons of grass pellets annually—enough to produce more than 60,000 tons of grass paper. And his product is very much of the zeitgeist. "I'm convinced this would never have gotten off the ground if we had started ten years earlier," D'Agnone says. In addition to the greater amount of attention now being paid to climate protection in society, the paper industry has also become more open to environmentally friendly solutions. "Today we're no longer being ridiculed for producing paper from grass fibers."

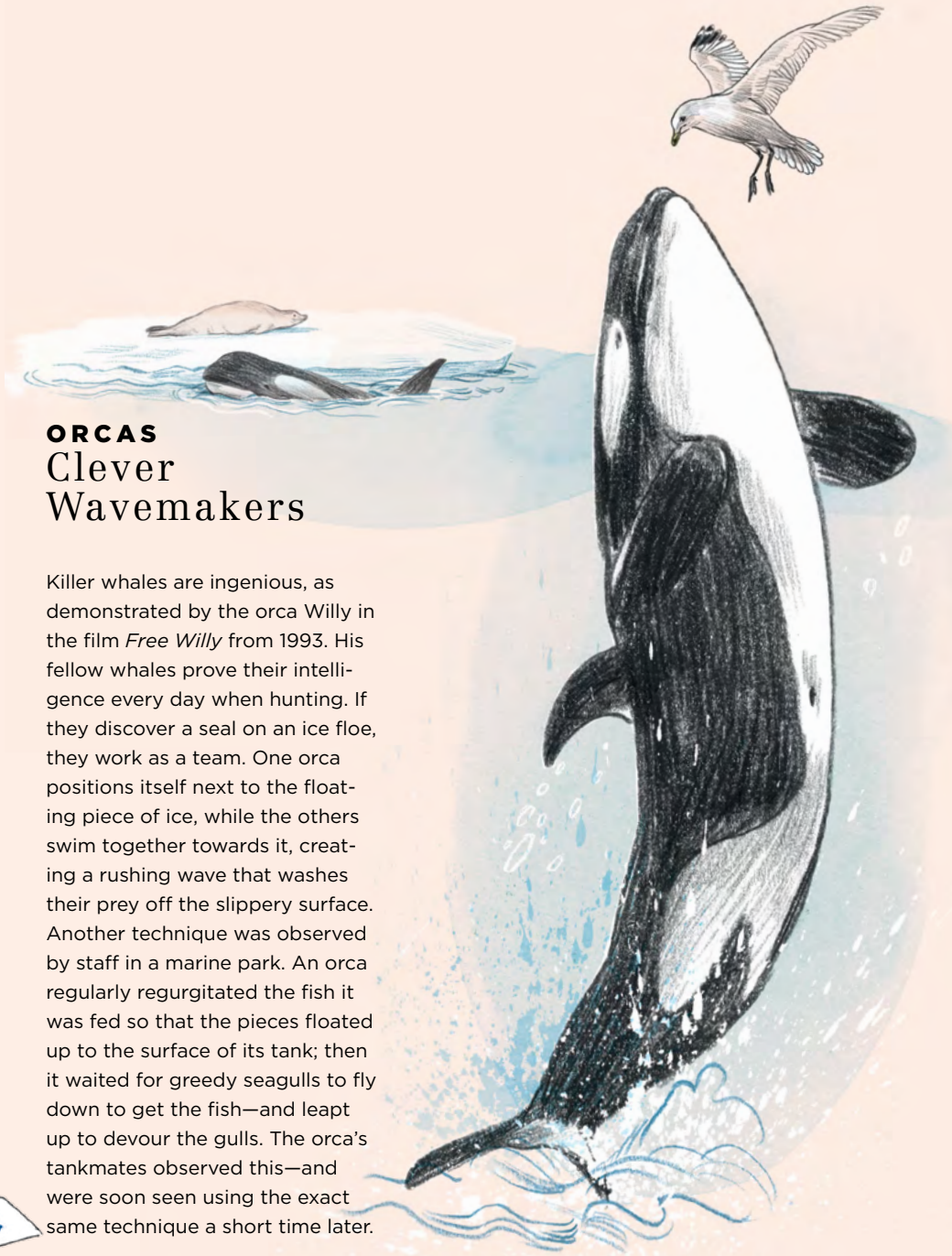
ILLUSTRATION: *Matthias Seifarth*

INHUMANLY clever

TEXT THOMAS SCHMELZER **ILLUSTRATION** ANJA STIEHLER-PATSCHAN —— Goats that solve puzzles, pigeons that can read, octopi freeing themselves from screw-cap jars: animals surprise us with their intelligence time and again. Here we present a few of them and their amazing abilities.

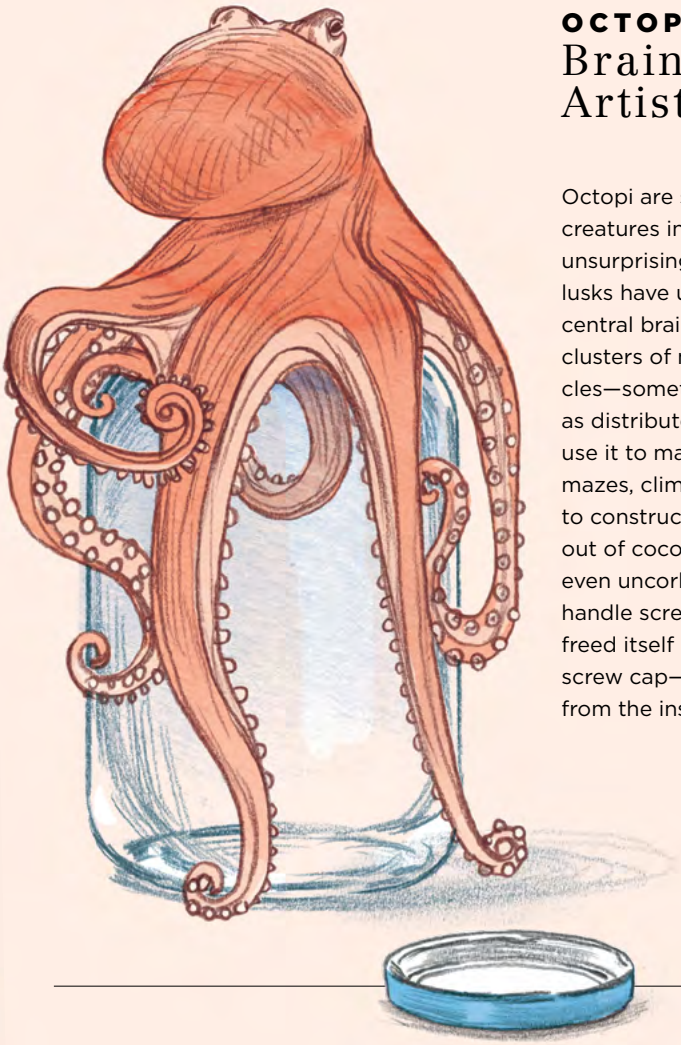
PIGEONS
Bookworms of the Air

Pigeons have an impressive sense of direction and, as carrier pigeons, have been appreciated as feathered messengers for centuries. An experiment showed that aside from just transporting words, they can also recognize them. On a computer screen, they accurately distinguished real English words such as "bust" from fantastical combinations of letters such as "bewk." The pigeons had learned the probability of letter sequences in English—and were thus using a mechanism that is also used by elementary school students. Despite this, however, the sanctity of the mail is not in danger—although pigeons can recognize words, they probably don't understand their meaning..



ORCAS
Clever Wavemakers

Killer whales are ingenious, as demonstrated by the orca Willy in the film *Free Willy* from 1993. His fellow whales prove their intelligence every day when hunting. If they discover a seal on an ice floe, they work as a team. One orca positions itself next to the floating piece of ice, while the others swim together towards it, creating a rushing wave that washes their prey off the slippery surface. Another technique was observed by staff in a marine park. An orca regularly regurgitated the fish it was fed so that the pieces floated up to the surface of its tank; then it waited for greedy seagulls to fly down to get the fish—and leapt up to devour the gulls. The orca's tankmates observed this—and were soon seen using the exact same technique a short time later.



OCTOPI

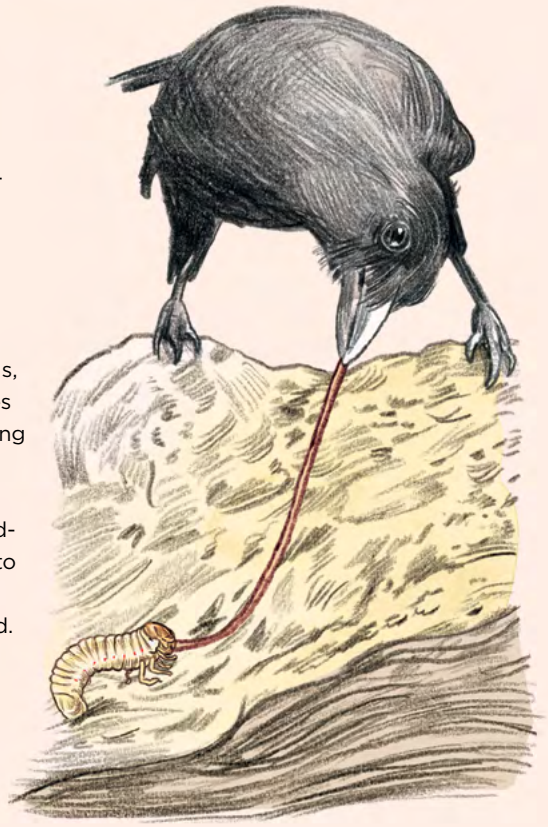
Brainy Escape Artists

Octopi are some of the smartest creatures in the ocean. Which is unsurprising, since these mollusks have up to nine brains. The central brain is joined by additional clusters of neurons in the tentacles—something science describes as distributed intelligence. Octopi use it to make their way through mazes, climb out of aquariums or to construct a rolling mobile home out of coconut shells. Octopi can even uncork bottles and can also handle screw caps. One octopus freed itself from a glass jar with a screw cap—by unscrewing the lid from the inside without much ado.

NEW CALEDONIAN CROWS

Cawing Tool Maker

Members of the crow family are considered especially clever. They put nuts in front of passing cars to get them cracked and throw stones into containers to get to the liquid as it spills out. The New Caledonian crow, which lives on the eponymous islands, takes things a step further and makes its own tools. To get to grubs in rotting tree trunks, it hacks at twigs to get them to the right length, then pokes the twig into where the grubs are hiding and thereby agitates the grub into biting the twig. Then the crow then pulls out the twig with grub attached. In experiments, some crows even connected up to four twigs together to form a composite tool—thereby managing to reach their snack.



DOMESTICATED GOATS

Cunning Lockpickers

Farmers tell stories time and again about goats opening gates to get to lush meadows. British researchers decided to take a closer look at this ability. In order to get to rich fodder, goats had to pull levers out of an apparatus and flip them upward—much like on a gate latch. Nine of twelve goats had learned the technique by the twelfth try. And they still remembered the trick even ten months later—and could get to the desired treat within seconds.

Genealogy of the **BRAIN**

TEXT MATTHEW COBB **ILLUSTRATION** SAM GREEN ——— It was once believed to work like a hydraulic machine, then researchers imagined the human brain as a telephone switchboard. Today, the dominant idea is that our brain functions like a supercomputer. Why even this idea is most likely only half the truth.

In 1665 the Danish anatomist Nicolaus Steno argued that our brain functions like a machine. If we want to understand what the brain does and how it does it, we need to treat it like a machine and take it apart to see how it works. For over 350 years we have been following Steno's suggestion—peering inside dead brains, removing bits from living ones, recording the electrical activity of nerve cells (neurons) and, most recently, altering neuronal function with the most astonishing consequences.

We can now make a mouse remember something about a smell it has never encountered, turn a bad mouse memory into a good one and even use a surge of electricity to change how people perceive faces. In some species we can change the brain's very structure at will, altering the animal's behavior as a result. Some of the most profound consequences of our growing mastery can be seen in our ability to enable a paralyzed person to control a robotic arm with the power of their mind. And yet we still have no clear comprehension about how billions, or millions, or thousands, or even tens of neurons work together to produce the brain's activity.

We know in general terms what is going on—brains interact with the world, and with our bodies, by sending stimuli across neural networks. Brains predict how those stimuli might change in order to be ready to respond, and as part of the body they organize its action. This is all achieved by neurons and their complex interconnections, including the many chemical signals that envelop them.

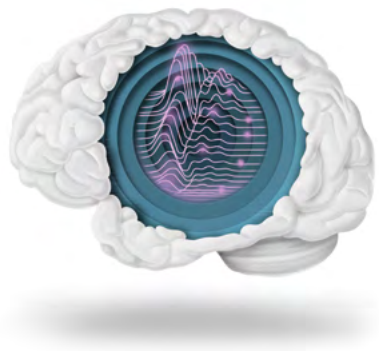
However, when it comes to really understanding what happens in a brain at the level of neuronal networks and their component cells, or to being able to predict what will happen when the activity of a particular network is altered, we are still at the very beginning.

OF ZEITGEIST AND METAPHORS

A key clue to explaining how we have made such amazing progress and yet have still barely scratched the surface of the astonishing organ in our heads is to be found in Steno's suggestion that we should treat the brain as a machine. "Machine" has meant very different things over the centuries, and each of those meanings has had consequences for how we view the brain.

In Steno's time machines were based on either hydraulic power or clockwork mechanisms. The insights that could be gleaned about the structure and function of the brain were limited, and no one now looks at the brain this way. In the nineteenth century the brain was seen first as a telegraph network and then as a telephone exchange, allowing for flexible organization and output. Since the 1950s our ideas have been dominated by concepts from computing—feedback loops, information, codes and computation.

Even the simplest animal brain is not a computer like anything we have built, nor one we can yet envisage. The brain is not a computer, but it is more like a computer than it is like a clock, and by thinking



about the parallels between a computer and a brain we can gain insight into what is going on inside both our own heads and those of animals.

Over the centuries, each layer of technological metaphor has added something to our understanding, enabling us to carry out new experiments and reinterpret old findings. But by holding tightly to metaphors, we end up limiting what and how we can think.

A number of scientists are now realizing that, by viewing the brain as a computer that passively responds to inputs and processes data, we forget that it is an active organ, part of a body that interacts with the world and that has an evolutionary past that has shaped its structure and function. We are missing out key parts of its activity. In other words, metaphors shape our ideas in ways that are not always helpful.

A LOOK INTO THE FUTURE

The tantalizing implication is that tomorrow our ideas will be altered yet again by the appearance of new technological developments. We will reinterpret our current certainties, discard some mistaken assumptions and develop new theories and ways of understanding. When scientists realize that how they think—including the questions they can ask and the experiments they can imagine—is partly framed and limited by technological metaphors, they often get excited and want to know what the Next Big Thing will be and how they can apply it to their research. If I had the slightest idea, I would be a very wealthy person.

The history of how we have understood the brain contains recurring themes and arguments, some of which still provoke intense debate today. One example is the extent to which functions are localized in specific areas of the brain. That idea goes back thousands of years, and there have been repeated claims up to today that certain parts of the brain appear to be responsible for a specific thing, such as the feeling in your hand, or your ability to understand syntax or to exert self-control.

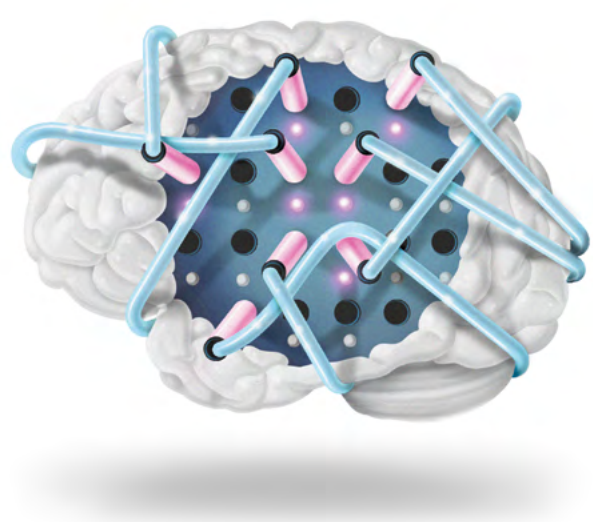
Such claims were often quickly qualified by the revelation that other parts of the brain also influence or supplement those actions, and that the brain region in question is also involved in other processes. Repeatedly, localization has not exactly been overturned, but it has become far fuzzier than originally thought.

AN ORGAN, NOT A MACHINE

The reason is simple. Brains, unlike machines, have not been designed. They are organs that have evolved for over five hundred million years, so there is little or no reason to expect them to function like machines that people construct.

This may also underlie why some researchers sense we are approaching an impasse in how we understand the brain. This might seem paradoxical—every day we hear about new discoveries that shed light on how brains work, along with the promise (or threat) of new technology that will enable us to do such far-fetched things as read minds, detect criminals or even be uploaded into a computer. In contrast to all this exuberance, there is a feeling among some neuroscientists that our future path is unclear. It is hard to see where we should be going, apart from simply collecting more data or relying on the latest exciting experimental approach.

That does not mean that everyone is pessimistic—some confidently claim that the application of new mathematical methods will enable us to understand the myriad interconnections in the human brain. Others (like myself) favor studying animals at the other end of the scale, focusing our attention on the tiny brains of worms or maggots and employing the well-established approach of seeking to understand how a simple system works, and then applying those lessons to more complex cases.



Many neuroscientists, if they think about the problem at all, simply consider that progress will inevitably be piecemeal and slow, because there is no Grand Unified Theory of the brain lurking around the corner.

The problem is twofold. Firstly, the brain is mind-bogglingly complex. A brain—any brain, not just the human brain, which has been the focus of much of the intellectual endeavor described here—is the most complex object in the known universe. Second, despite the tsunami of brain-related data being produced by laboratories around the world, we are in a crisis of ideas about what to do with all that data, about what it all means.

THE COMPUTER METAPHOR REACHES ITS LIMITS

I think that this reveals that the computer metaphor, which has served us so well for over half a century, may be reaching its limits, just as the idea of the brain as a telegraph system eventually faded away in the nineteenth century.

Some scientists are now explicitly challenging the usefulness of some of our most basic metaphors about the brain and nervous system, such as the idea that neuronal networks represent the outside world through a neuronal code. This suggests that scientific understanding may be chafing at the framework imposed by our most deeply held metaphors about how the brain works.

It may prove to be that even in the absence of new technology, developments in computing, in particular relating to artificial intelligence and neural networks—which are partly inspired by how brains do things—will feed back into our views of the brain, giving the computational metaphor a new lease of life. Perhaps. But leading researchers in deep learning—the most fashionable and astonishing part of modern computer science—cheerfully admit that they do not know how their programs do what they do. I am not sure that computing will provide enlightenment as to how the brain works.

Properly understanding the human brain, with its tens of billions of cells and its incredible and eerie ability to produce the mind, may seem an unattainable dream. But science is the only method that can reach this goal, and it will reach it, eventually.

There have been many similar moments in the past, when brain researchers became uncertain about how to proceed. In the 1870s, with the waning of the telegraph metaphor, doubt rippled through brain science and many researchers concluded it might never be possible to explain the nature of consciousness. One hundred and fifty years later we still do not understand how consciousness emerges, but scientists are more confident that it will one day be possible to know, even if the challenges are enormous.

Understanding how past thinkers have struggled to understand brain function is part of framing what we need to be doing now, in order to reach that goal. Our current ignorance should not be viewed as a sign of defeat but as a challenge, a way of focusing attention and resources on what needs to be discovered and on how to develop a program of research for finding the answers. This highlights why the four most important words in science are "We do not know."

THE BRAIN IN NUMBERS

It is easier to measure the brain than to understand it.

86
BILLION
nerve cells form the basic structure of our brain.

5.8
MILLION KILOMETERS
the nerve tracts of our brain are long overall—measuring approximately 145 circumnavigations of the Earth.

400
KM/H
is the speed at which impulses are transmitted in the nervous system of the brain—this is faster than driving a car in Formula 1.

MATTHEW COBB
is Professor of Zoology at the University of Manchester and his research focuses on the sense of smell, insect behavior and the history of science. In early March, he published *The Idea of the Brain: A History*, on which this essay is based.

Just One Word

Mr. Youlden, what do you think about ...

M O T I V A T I O N ?

ILLUSTRATION: *Anje Jager;* PHOTO: Getty Images (sheep, modification: *Deep Dream Generator*)

Matthew Youlden, 37,
is a linguist and language learning coach. He has taught as a lecturer in Romance linguistics (Spanish, French, Italian) at the HU Berlin and has been teaching people from all over the world for years, together with his brother, as Superpolyglotbros. Youlden is originally from Manchester and lives in Barcelona and Berlin.

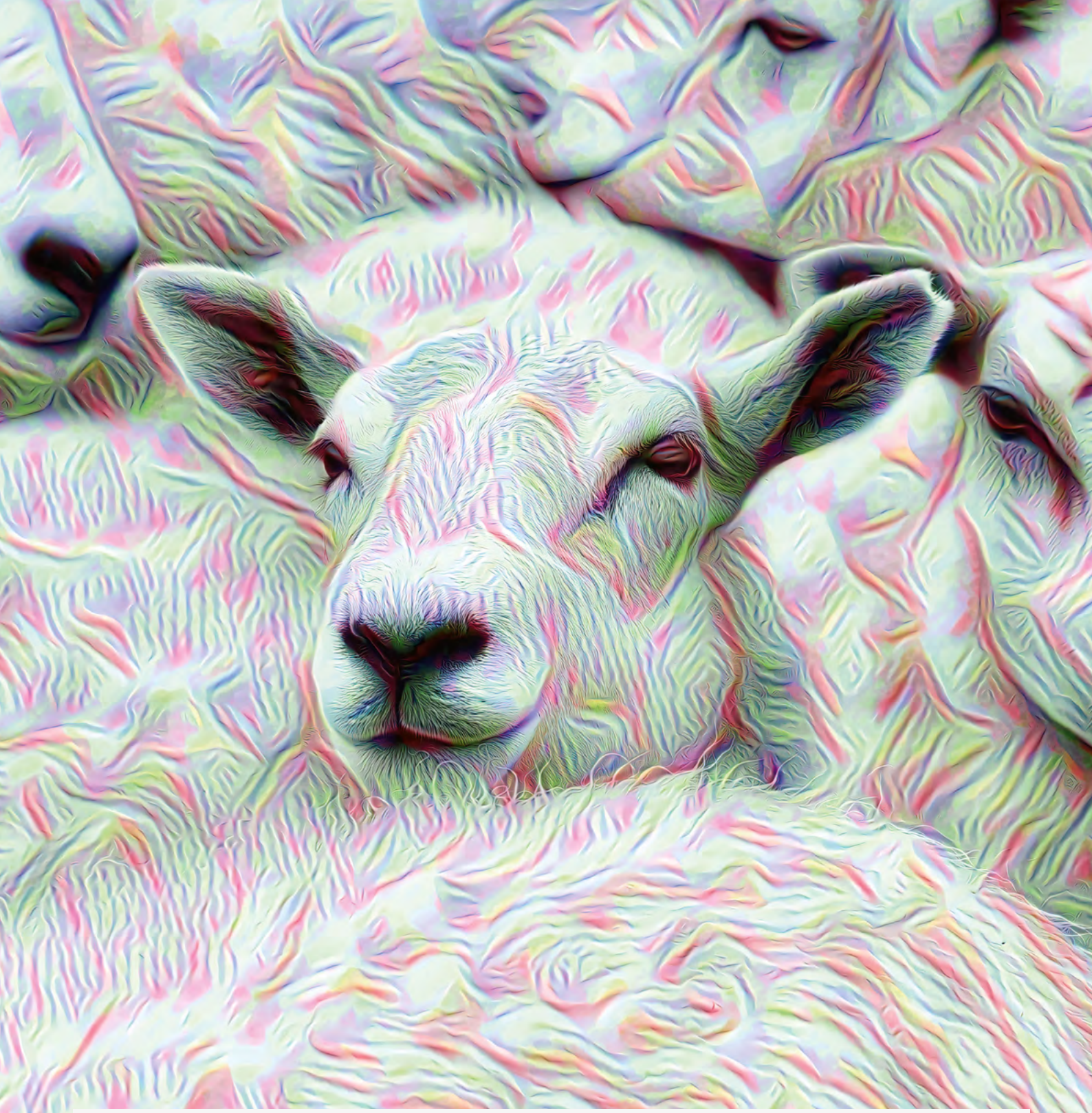
When I was nine years old, my parents shot a video of my brother and me on vacation in Spain. We are lying on the beach and my brother and I are trying to speak a few scraps of Spanish with other kids. Nobody will ever see the video except us, but I still like to talk about it because, for me, it shows that you don't need as much to learn a language as people always think. My brother and I just wanted to learn a little Spanish so we could play with the other kids and buy ice cream. That was our motivation. Of course, our Spanish wasn't particularly great at the end of the vacation, but it was enough for what we needed.

Ever since that vacation, I've been fascinated by languages. Today I am 37 years old and have learned 25 languages, ten of which I can speak fluently. For me, languages aren't just a tool for making myself understood. They open a door to completely different worlds. Through language you really learn a lot about how other people see the world and how they talk about it.

I believe that everyone can learn as many languages as I have, and it has very little to do with talent. It's more about developing your own motivation and experiencing learning as fun rather than a chore.

For instance, when I decide to learn a new language, I almost always do it together with my twin brother Michael. We are both fascinated by languages and have developed our own methodology to learn languages faster and more effectively. We are convinced that the new language must immediately become an integral part of everyday life. So we do virtually everything that can be done in the language—without having mastered it yet. Sometimes we push each other and make a little game out of it to keep each other motivated.

Of course, most people don't have endless amounts of time to learn a new language. In my experience, however, it's enough to invest just under thirty minutes a day in active learning. If you are also learning passively, like listening to the radio in the language, watching Netflix series in the original language or reading the newspaper, it's enough.



Picture This

This unusual photo of a flock of sheep was produced by a technology called Neural Style Transfer—a series of algorithms that manipulate digital images until they take on the look or style of another image. Deep neural networks are used for this image transformation. The process works like this: two pictures—for instance a selfie and a famous painting—are deconstructed by being run through a network that has been trained to recognize objects in pictures. The pictures are broken down into various layers—one contains the style of each picture, another layer contains the contents and another just patterns or textures. These layers are then used to construct a new image. The results can be a selfie that looks like a famous painting, for instance—or a flock of sheep with an expressionistic touch.

Kaloyan Chernev is a team member of the deepdreamgenerator.com platform. The algorithm was originally developed to help scientists visualize neural networks.

What happens in
BLACK HOLES?
Why this and many other
questions still have
NO ANSWER as of yet.

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