

The image is a 5x3 grid of blurred photographs. The central cell, at row 3 and column 2, is a solid teal color and contains the text 'DIGITALIZATION and SOCIETY' in white. The other cells contain out-of-focus images of people and indoor settings. The overall aesthetic is modern and digital.

DIGITALIZATION
and
SOCIETY

»Digital technologies are naturally no panacea«

Interview with Friedericke Hardering, labour market sociologist

By Anke Sauter

The coronavirus crisis has changed a lot of things – in the working world too. However, above all it has strengthened our awareness of where digital technology really makes sense and where face-to-face communication is only hard to replace.

Anke Sauter: Germany, as the media always say, is lagging behind as far as digitalization is concerned. Is that really the case?

Friedericke Hardering: We've slept through digitalization to some extent. The Scandinavian countries, for example, but also Estonia, New Zealand and Israel are much further advanced. There, certain digital processes, for instance digital administration, are more easily possible. Here at home, even infrastructure is already part of the problem. A good internet connection is not yet a matter of course everywhere in Germany.

Is the internet, to mention a frequently quoted statement by Angela Merkel, still »uncharted territory«?

No. There are meanwhile quite enough stakeholders who want to make Germany

– analogously to Silicon Valley – Silicon Germany. People recognize that the topic is important. In education, there's the Digital Pact for Schools, which targets faster internet and better technical equipment in schools. In times of the coronavirus crisis, of course, the demand for faster action is increasing.

In your view, what are the reasons for Germany failing to keep up with developments?

It could be reservations, for instance regarding security. But much is also driven by necessity. In the Scandinavian countries, for example, there are far more rural areas, so the benefits of digital solutions can be seen much more clearly. Additionally, the German government's focus has long been on old industries such as the automotive sector. As a consequence, we've been able to blank out the topic of digitalization and put it to the back of our minds for longer, while others have adapted their structures accordingly.

And that puts us now at a competitive disadvantage.

Yes, we must attempt to catch up now in certain areas. I still believe though – or perhaps it's more a hope – that we haven't

yet missed the boat. Germany is still very innovative in many fields. We still file a huge number of patents and are still leading in some areas. There too, we still have great opportunities to strengthen our position in certain niches. However, this must naturally also be wanted and supported accordingly.

The state must do its duty here.

Absolutely. Without state help, Silicon Valley wouldn't exist as it does today either: It didn't evolve thanks to entrepreneurial initiative but instead only on the basis of massive subsidies. It cannot work without a good infrastructure and corresponding support.

What role does the coronavirus crisis play in the advancement of digitalization?

Awareness has definitely grown. This process has been evident for some years now, but there are naturally still some deficits. The crisis has contributed to a better understanding of what is really needed and what digital technologies can do.

Do we really need online video conferences when there are no distancing rules and contact ban?



»A balancing act for workers«: Lots of people are working from home during the coronavirus crisis and looking after their children at the same time.

Under normal conditions – without the coronavirus crisis – we always need a combination of online and offline, in the working world but beyond it too. The coronavirus crisis has heightened the demand for information and communication technologies. But naturally we also need these technologies when we return at some time to normal operations. However, we'll also then need our normal interrelationships in the working world, that is, normal offline contacts.

My question was also concerned with decision-makers in politics and the economy: Did it need the jolt of the coronavirus pandemic to get things tackled faster?

The urgency has certainly now become clear. We have the opportunity now to catch up on certain processes in politics and organizations. However, digital

technologies are naturally no panacea. When other crises come, for instance cyberattacks that threaten our entire system, we're equally fragile but in a completely different way. We shouldn't therefore think that all solutions to crises of whatever kind lie in us being better networked digitally.

You're a labour market sociologist. Do you have the impression that working from home is a good way to resolve the situation?

That greatly varies. Many employees use a lot of technology. Above all the more affluent and well-educated who work, for example, in knowledge-based professions and were already able to work from home before: They have both the expertise as well as the equipment at home and can work equally well in this situation. But many other households don't own a computer and a printer and perhaps don't have the corresponding software and skills to use them either. Then working from home doesn't work. What we're seeing now in the crisis is the following: As far

as material assets are concerned, society is very divided, but also in relation to skills. Digitalization is making inequalities appear in a new light and become even more pronounced.

An extension of the »knowledge gap« hypothesis relating to the reception of mass media in the 1970s?

Exactly. We need to keep an eye on this. Not only when we think of rich and poor, but also of young and old, there are lines of division everywhere with regard to digital technologies, and these are being exacerbated even further now during the peak phase of digital use.

Many people also find the juxtaposition of professional and family life when working from home a great burden.

This is naturally an extreme situation at the moment, especially for young families with small children or single parents who have to work from home and look after their children at the same time. This is by no means the normal situation when working from home and is now

really putting people to the test. In general, we always have these transient boundaries when working from home, normally of course with properly functioning childcare. But working from home is characterized by a far higher degree of self-organization compared to activities at the regular place of work. And this is always a balancing act for workers, as research also shows.

Have you conducted studies on this yourself?

I recently wrote a review on the topic, in particular on how digital technologies in the working world have an impact on gender relations. On the one hand, it could be seen that digitalization makes it easier to combine work and family life, but on the other hand there is extremely high time pressure when working from home, so that the feeling of being overburdened is very high. It's not the simple path to a better working world, but rather the course has to be set very carefully so that working from home also means good-quality work. There are currently a lot of studies that are watching – on the basis of the coronavirus crisis – how the situation of working from home is developing. I'm already looking forward to seeing the data.

Digitalization also spawns new forms of work organization, such as crowdworking platforms. Have you already seen this in Germany too?

We have something like crowdwork and microwork here too. There are more and more solo self-employed people working in this domain, but overall it's still a small area. Mostly they are younger persons and students, but also highly qualified people. If you look at

clickworker platforms such as Amazon Mechanical Turk, you'll find relatively simple tasks. To that extent, it's interesting that in Germany it tends to be higher qualified people who try out these services. However, very little is known about this labour market because it's difficult to obtain good data. But it's definitely a growing area, which also poses major challenges for the trade unions. As we know, solo self-employment is always a relatively unprotected area with a lot of uncertainties and precarities, irrespective of digital technology. This constellation becomes even more exacerbated on such platforms.

Creating regulations here is probably off the legislator's radar.

Partly. The trade unions are staying on the ball. They are also reaching out to crowdworkers and recognize the problems. But the question is, how can we motivate the solo self-employed to act collectively? Overall, certain workers' rights in Germany and in Europe have been continuously stripped back over the last years and job security reduced. In fact, all we see now is a field of new, radically precarious employment in digital clickwork and crowdwork.

Does digitalization exacerbate precarious employment situations?

Yes, digitalization can exacerbate them. New actors and platforms are emerging and even before regulations have been checked, for instance how the legal situation is in general in the case of players such as Amazon Mechanical Turk, several thousands of people have already worked there. This means that we're always lagging behind the latest developments.

But back to the traditional labour market: How can it be that in some countries paying in the supermarket is already fully automated but Germans, now as in the past, like best of all to go to the cashier?

I think there are several reasons for this. As we know, Germans love cash, but now several things are changing during the crisis because they must change. More people are paying by debit card now or with their smartphone. Other countries have had self-service checkouts far longer, and the customers there have long been confronted with them. People have to become accustomed to new technologies and learn to trust them.



»Germans love cash«: In times of social distancing too, people in this country prefer to go to the cashier than pay at a self-service checkout.

Especially services are being delegated more and more to the customer.

Yes. In their consumer behaviour, normal people are more and more becoming workers. For example, when booking flights. We're taking on more and more of the work that used to be done by employees. As a result, you need less and less employees. Obviously, flights are getting slightly cheaper. But we're not just paying for this with a loss of jobs. It also means that certain interactive situations, which are also important for many people, are decreasing; a little chat at the checkouts is an important element of everyday life for many people. That's why we should campaign to ensure that there are always several options and that we can continue to choose. There should always be a non-digital way to solve things.

It's already been the case for a long time with bank transfers: Do it online or pay extra.

This is, of course, discriminating because online banking is impossible without certain material prerequisites. Or for groups with limitations. That the only way to do certain things is online constitutes a real problem. It's contingent on too many factors and ignores the realities of people's lives.

At the beginning, you mentioned your current research project on the alienation of people from work that goes hand in hand with digitalization. This sounds a bit Marxist.

Marx made a lasting impact on the concept of alienation, but it has a longer tradition and goes back to Rousseau, among others. In our project, we have a somewhat broader concept of alienation. We're looking at workers' experiences with regard to digitalization, how they appropriate work under the conditions of new digital technology. Appropriation is the antonym for alienation: How we can connect with new forms of work, how this can succeed and under which circumstances it also fails. We're examining areas of the old economy, such as insurance or retail, but also ones in the new digital economies. We want to see how these appropriation or alien-

ation processes look – and this at different qualification levels.

What, then, would be an alienation phenomenon?

An alienation phenomenon would be, for example, if people reported that there had been a certain type of group spirit at work in the past which now, as a result of acceleration processes, for example, no longer exists due to ever-increasing time pressure and pressure to perform. Work is always also a place of social interaction and thus very important for appropriating the world. And if workers report that there is no longer any exchange among colleagues because of changes, that they feel isolated and suffer greatly under pressure of work, then this would mean they are experiencing alienation. But it might naturally also be that work is losing its complexity. Perhaps in the past you monitored certain processes from A to Z but now there is a new device and you just check at the end whether the device has done a good job. This changes your work completely. Nice parts of the task disappear, and you're only entrusted with a remaining task that is less complex and thus makes your work less attractive.

Thank you very much for this interview, Ms Hardering.



About Friedericke Hardering

Friedericke Hardering, 39, studied in Aachen and earned her doctoral degree with a thesis on increasing insecurities in the working world. She has been working as a post-doctoral researcher in the field of sociology of work at Goethe University since 2012. Since 2019 she has headed a research project funded by the German Research Foundation on the digital alienation of work, which is being implemented in cooperation with Professor Oliver Nachtwey of the University of Basel.

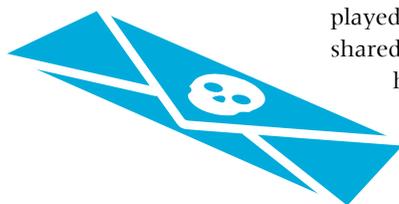
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Of shitstorms and »candystorms«

Interview with sociologist Christian Stegbauer

As a network researcher, sociologist Professor Christian Stegbauer also deals with communication in social media. That people prefer to stay in a bubble with like-minded others rather than get to grips with different opinions and ways of thinking was in his view inherent to digital communication from the outset. He considers many of the utopian ideas of a digital culture of participation to be exaggerated.



Dirk Frank: Professor Stegbauer, the noughties saw some very ambitious expectations in terms of what the internet and social media could achieve with regard to participation and democracy. Even representatives of the digital Bohème, such as Sascha Lobo, are meanwhile critical observers of Facebook, etc. Has the utopia transmuted to a dystopia?

Prof. Christian Stegbauer: When the internet started to take off back in the 1990s and the first web browser became available, lots of people thought that a type of communication would now be possible which was free of prejudices. Attributions regarding a person's appearance, origin, etc. supposedly no longer played a role. Many people in sociology shared this utopia too. However, if you had thought about it for a while, you would have realized even back then that this cannot be. A structure of inequality forms on the internet too, but it looks a bit different from when the people communicating with each other are present face to face.

In your book about shitstorms, you say the following: »The narrative of the internet, that it facilitates a better world, has survived into the present«: Remarkable that we're talking here today more about the negative effects.

The narrative still exists in the case of major internet companies such as Apple and Facebook. They tell us that with their products they're creating a better world, from which we all supposedly profit. And despite all the negative aspects of the internet we can also say, of course, that access to information has considerably improved. In the framework of a study, I dealt with Wikipedia, which can be seen as a positive alternative to the large internet companies because lots of people create knowledge there that serves the community as a whole. By contrast, Facebook and Google appropriate things that others create and make enormous profits with them.

One criticism of Facebook refers to the fact that we don't learn anything anymore about some of our friends. The multiplier effect makes sure that we only communicate with friends where there is lively exchange, the others are sidelined.



As a network researcher, I would say that Facebook is doing something here which accommodates our needs very well. The algorithm tries to make life easier for us by primarily displaying messages from people with whom we've previously interacted. Facebook wouldn't be possible otherwise because we wouldn't be able to process the countless messages in our network. What Facebook does here accommodates the user. However, the algorithm has a side effect, so to speak, which we call a filter bubble.

This filter bubble hypothesis is quite controversial.

That's right, critics say that most people not only gather information via Facebook. I would, however, argue to the contrary: It doesn't just depend on the filter bubble. In network research, the concept of homophily is very prominent; according to this, we surround ourselves with people who are similar to us and have the same opinions. If I express an opinion that my environment doesn't share, I run the risk of being shut out. What's more: Not everyone gets involved to an equal degree. There are activists who are much more strongly represented with their opinions and thus shape my perception of what my Facebook friends think. It's therefore not the case that everyone has the same voice, but instead there is a kind of power-law distribution. As a result, we get the erroneous impression that the opinion of particularly active people is also the opinion of all the others in our respective circle of acquaintances.

What advantage do network research tools offer in this context?

People are not alone in the world; they base their actions on others. This is at the heart of network research when we examine the structure of relationships. Because traditional social research does not consider this, network research is an alternative to traditional social research methods. This applies above all for standardized surveys in quantitative research, where no relationship between interviewees nor between interviewer and interviewee is allowed because that could falsify the results in the sense of a natural science measurement. However, that

which actually makes a person is first of all his relationships. These determine what he thinks and how he behaves. In qualitative research, by contrast, the focus lies on the individual and his subjectivity and the relationship aspect is thus neglected.

To call something a »shitstorm«, it's often enough that someone is pilloried in a few comments on the internet. But doesn't there, in your understanding, have to be a certain quantitative factor for a shitstorm?

I wouldn't know how we could define the term exactly or demarcate it. In some cases, a few attacks are sufficient if the person on the receiving end of the shitstorm feels strongly affected. Sometimes, shitstorms are even useful. ING-DiBa's advertising clip with former basketball player Dirk Nowitzki is a well-known example. In the video, Nowitzki is handed a slice of ham by a butcher who asks him: »What did I always says to you back then?« And Nowitzki answers: »So that I grow up big and strong«. A wave of indignation from vegans and vegetarians ensued. The agency which made the clip for ING-DiBa later reported that lots of customers had taken the bank's side in these shitstorms.

In Germany, this positive feedback is known as a »candystorm«.

Yes, there are several examples for this. The Miniatur Wunderland theme park in Hamburg received a letter from someone who had spoken out against allow-

ing not only needy people free entry in the framework of a special deal but asylum seekers too. The company published the letter on Facebook and a huge »candystorm« followed.

You say that shitstorms occur when the demarcation from other groups increases to such an extent that we no longer encounter any other way of thinking.

I've studied a forum called Multikulti-Watch where it explicitly says: »Anyone who does not believe that we Germans are discriminated against compared to asylum seekers and foreigners will be blocked without prior warning.« That's an official threat: If someone speaks out against it, he'll be kicked out. As an individual, the fact that people contradict you is apparently hard to bear. From a social science perspective, however, it can be explained by the theory of structural balancing: If you have a liberal opinion and everyone in your own circle is against foreigners, then you could suddenly have a whole bunch of people against you. Indeed, different-minded people are frequently unfriended on social platforms. This is a social mechanism that also leads to opinions in the social domain aligning themselves with the ostensible majority opinion.

In your opinion, do shitstorms cause lasting damage?

Negative communication destroys the basis for a possible discourse. You can argue your point, provided you both



Wave of indignation: The ING-DiBa clip with Dirk Nowitzki triggered a shitstorm and a »candystorm«.

acknowledge each other and each other's opinion. At that moment when the basis is destroyed, a negative reciprocity emerges or a reciprocity in conflict, as Georg Simmel once called it. In fact, we should try to be forbearing and not join in at the same level. However, that is in fact against the social rule of paying back like with like. In the case of famous people, such shitstorms mostly subside after a couple of days. But with politicians who have taken a stance against the right wing, for example, it's likely to be more protracted.

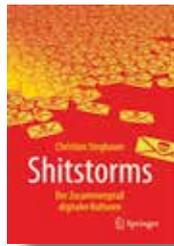
I guess we just shouldn't simply allow everything. But that's exactly what you're also lamenting, that many mass media switch off the comments function due to vast public pressure.

For the media, it's often the only possibility to moderate this in a very regulated manner. However, moderation is expensive, and then – under certain circumstances – an accusation of censorship follows.

You also mention in your book that criticism of right-wing populist positions is very often associated with people's limited abilities to express themselves in writing.

In milieus such as the middle-class and conservative FAZ newspaper, for example, readers who write letters to the editor attach great importance to meticulously respecting every full stop, comma and upper and lower case. There, you're only acknowledged if you write correctly. However, as a matter of principle we should not disparage people because of their education. The better educated are at an advantage in terms of political participation anyway. However, as far as communication on the internet is concerned, the threshold has lowered. People without the ability to express themselves in sophisticated language will surround themselves accordingly with people to whom that's not so important. However, this widens the social divide even further.

A very topical issue right now is right-wing radicalism, whose representatives also and above all organize themselves on the internet. Does network research have something to say about this phenomenon?



Christian Stegbauer
Shitstorms.
Der Zusammenprall
digitaler Kulturen
Springer, 2018

When examining a shitstorm against the Hessenpark museum, I came across some extreme cases of threats of violence. When the solution offered is to »just burn Hessenpark down« and employees there are threatened, this stirs up hate. You ask yourself when this violence will one day erupt in reality. In the rhetoric of the Alternative for Germany political party, for example, people like to talk about »knifemen«. That does not now mean that the people who talk like that necessarily resort to violence themselves. But it creates a mood that gives a certain backing to those ready to do so. Right-wing groups attempt every day to scandalize topics, which also includes staging shitstorms. Sometimes such an operation transfers out of a small circle of sympathizers to a wider public. In the case of the Hessenpark museum, the complaint was that asylum seekers were allowed in free of charge, while Germans, even those on income support, had to pay. Now we could, of course, say that in a certain way this was unfair. On the other hand, for the purpose of integration it's important that migrants learn something about the culture of the country that has taken them in. The line of argument then looks quite different again.

At one point in your book you say that the indignation exhibited on the internet stands not only for the »broken promises of future technology« but also for their »partial fulfilment«. Does the internet also give citizens a certain »power«?

As a citizen, you no longer have to hide from »those at the top«, the authorities. In terms of democracy, that is something fundamentally positive. There are shitstorm-like protests which are positive in a certain sense because they campaign, for example, for consumer rights. If a company has brought a product onto the market that does not deliver what it promises, through massive protests consumers can get the company to back down. But in a constitutional state, you also need certain protection for specific groups as well as respect for institutions. We should therefore not tear down all barriers, even if that would sometimes be desirable from the perspective of radical democratization.

The interview was conducted by Dirk Frank.



About Christian Stegbauer

Already in the 1980s as a student assistant at Goethe University, **Christian Stegbauer** was entrusted with a small study on mailboxes. Later he wrote an article for *Forschung Frankfurt* (Issue 4, 1995) on the introduction of email there: He is now an associate professor for sociology at Goethe University and currently conducting research on the formation of microcultures in social situations. How this occurs is explained in the book »Grundlagen der Netzwerkforschung: Situationen, Mikronetzwerke und Kultur« on the basis of everyday behaviour. His book on »Shitstorms« shows under which conditions shitstorms develop.

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Digitalisation and sustainability – not a contradiction

Energy-efficient computers such as that of Volker Lindenstruth and his team provide an ecological cushion for growing data hunger

By Regina Kremer



Coffee from a machine, the online edition of our daily newspaper, a traffic update: our day starts digitally and continues digitally. This requires energy, a lot of energy. But do we know how much?

In Germany alone, the use of the internet releases as much CO₂ every year as total air traffic. But how can the possibilities of IT be exploited while saving environmental resources at the same time? The Frankfurt physicist, Professor Volker Lindenstruth has developed impressive and pioneering technologies toward this goal.

Lindenstruth has been working as professor for high performance computer architecture at Goethe University since 2009. Using unusual ideas, creativity and confidence, he mastered the challenge of building a high-performance computer for the university's research network that is fast and high performing, and both cost-saving and energy-efficient. In 2010 the supercomputer he developed, Loewe-CSC located at the Hoechst Industry Park, took up operation as the most energy efficient computer in Europe at that time. At the same time the corresponding data center is one of the most efficient ones world wide. It was followed by the Green IT Cube data center for the GSI in Darmstadt in 2016, and the GOETHE-HR – as

successor to the Loewe-CSC – in 2017. An innovative construction principle that pairs high energy savings with high performance forms the basis. In February 2020, Lindenstruth and his team received a European patent for the overall concept of an energy-efficient cooling structure for data centers. Now this concept can be used economically worldwide.

Enormous opportunities for the future with digitalisation

The developments of the past year have made it clear: digitalisation offers enormous opportunities for the future, both globally as well as for individuals. The economy, society and environmental protection all stand to benefit. High performance computers (supercomputers) provide calculations, security and predictions in a vast number of areas such as:

- the automobile industry for highly developed efficiency and security in driving,
- medicine for the prediction of diseases and calculation of their progression (see Forschung Frankfurt 2/2019 »Prevention is better than healing«),
- meteorology, with long-term prognoses for economic planning for the economy, medicine and politics – for farmers in the management of arable land, for insurance companies in adjusting premiums to probabilities of unusual weather situations, but also for hospitals for emergency planning in extreme weather conditions,
- for sustainability and climate protection with computer simulations on the future of electric cars and autonomous driving.

In the future, continually increasing amounts of data will be collected by ground stations, ships, airplanes and satellites with the help of computers, and more and more data will be stored, searched, distributed and visualised. The worldwide volume of data will continue to grow. With 40 zettabytes in 2020, it is already 50 times greater than in 2017. (For comparison: the maximum storage capacity of the human brain corresponds to about 2.5 petabytes in digital units, with a petabyte being a 1 followed by 15 zeroes.) The demands made on the performance of computers and processors, and on the speed with which data is accessed and processed are continually increasing. And there will also be ever larger amounts of data to manage on private computers, smartphones, tablets, external hard drives and in the cloud.

Green IT Cube, computer centre of the GSI Helmholtz Centre for Heavy Ion Research in Darmstadt.



What is ...?

Hardware

the »body« of the computer, can only be changed by reconstruction. Hardware includes:

- **processor or CPU (Central Processing Unit), centrepiece:** computing unit that carries out the assigned tasks/ computing operations, to date it consists of multiple CPU cores
- **CPU core Rechenkern:** smallest computing unit of a processor
- **graphic card,** typically serves two functions. It generates the signals for the display monitor and implements compute functionality to perform operations directly on the image data. In the computing context this computing capability is used for processing. The video functionality of a graphics card remains unused in this context.
 - CPU-dependent, converts data computed by the processor
 - GPU (Graphics Processing Unit)-dependent, computes data independent of CPU, works faster



Graphic card with ventilator for cooling.

Software – the »brain« of the computer

Programmes, responsible for system operations, information processing and all the data this produces. Can be changed by, for example, updates. Example: navigation system in a car

Server

A computer with typically several multi-core processors, large amounts of memory and a fast network. Servers are usually hosted in data centers.

Data centre

Centralised facility for hosting a typically large number of servers including mass storage servers. The storage, management and processing of data and information in servers is organised according to a certain area of knowledge or belonging to a specific company.

Supercomputer – the giants among the computers

Greatest possible computing power, difficult to imagine, »in its own league« Performance is measured in FLOP: floating point operations per second, Example: The fastest computer in the world, Fugaku in Japan has 415 petaFLOP. One petaFLOP means a quadrillion (1,000,000,000,000,000 / 10 to the 15th power!) floating point operations per second! 20,000 to 50,000 times faster than a »normal« computer

Internet nodes = Central train station/ Internet train station

Merger of various networks or servers at central hubs, data exchange between the different networks



Global internet nodes, centres for the organisation of data communication.

Toward this end, data centres are being developed and built all over the world, in which computes from one or more companies are located. Here, a server is a computer that sends, receives and stores data to and from other computers (clients) on request. The available IT resources are assigned according to an organised schedule and ideally work to capacity, allowing the simultaneous accessing of several data units in these servers. In terms of dimension: experts estimate that Facebook's data centres comprise 30,000 computers.

Corona crisis: heyday for digitalisation

The most recent example of network use is the corona crisis: networks were used here to follow the course of the infection worldwide. With the supercomputer of the GoetheUniversity, the evolution of the pandemic was predicted. This work was carried out by Dr. Maria Barbarossa (FIAS) and Prof. Dr. Thomas Lippert (Goethe-University/FIAS). As a consequence of the social distancing decreed by governments, digital forms of contact and leisure activities increased with a vengeance. The central German internet node DE-CIX in Frankfurt, the largest exchange point for internet data traffic worldwide, reported a 50 percent increase in the video conferencing rate and 25 percent increase in online and cloud gaming.

The TOP500 is a list of the highest performing computers in the world, compiled since 1993 by four experts at the universities of Tennessee and Mannheim. First place is taken by the high performance computer Fugaku at RIKEN in Japan with a performance of 416 petaflops. Its areas of application are various research fields such as nuclear physics and stem cell research. Its power consumption amounts to 28334 megawatts. The computer SuperMUC-NG at the Leibniz Rechenzentrum in Munich is at 13th place. It carries out calculations for climate research, earthquake and seismology research.

Growing electricity consumption due to digitalisation

Scientists believe that that by the year 2030, 13 percent of worldwide electricity consumption will be caused by data centres. The city of Frankfurt, an extremely important exchange point (»network node«) for internet data traffic, already consumes 30 percent of total local electricity for data centres.

The Borderstep Institute in Berlin for innovation and sustainability in the future calculated the CO₂ emissions: a thousand tons of CO₂ are formed by the sending of a million emails per day in Germany, one gram per email. An hour of video streaming produces the same amount



View of some of the GSI's 768 computer cabinets, resting on green steel girders.



About Volker Lindenstruth

Volker Lindenstruth studied physics at the Technical University of Darmstadt. From 1989 to 1993 he did research at the Helmholtz Centre for Heavy Ion Research (GSI) in Darmstadt, and received his doctorate degree at the Goethe University Frankfurt. As part of a research fellowship, he went to the Ernest Orlando Lawrence Berkeley National Laboratory in Berkeley, USA, for two years as a postdoctoral fellow in computer science. From 1995 to 1997 he was a member of the UC Space Science Laboratory, USA, before founding iCore Technologies in 1997. Since 1998 Prof. Lindenstruth is back in Germany. Until 2009 he held the chair of Computer Engineering at the University of Heidelberg and director of the Kirchhoff Institute. Since 2009 he is professor for High Performance Computing Architecture at Goethe University. The chair focuses on the architecture, application and further development of high-performance computers in the natural and life sciences. At the European Research Centre CERN near Geneva he developed an intelligent readout technique for the data of the ALICE experiment. He is also a member of the board of the Frankfurt Institute for Advanced Studies (FIAS) at the Goethe University.

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of CO₂ as a kilometre of driving. The search machine Google handles about 5.6 billion search requests per day worldwide, with an electricity demand of 0.3 wathours per search request according to Google – to make it easier to imagine: with 200 search requests you could iron a shirt.

In Lindenstruth's view, this immense energy consumption, and the cost intensity of the machines cannot be attributed solely to use. Both aspects could already be positively influenced in the constructions of these machines according to Lindenstruth. His innovative concept

for an effective computer architecture and architecture of data centres, combined with the development of a high-performing, energy efficient and cost-saving supercomputer is composed of different approaches:

- He takes a critical view of existing data centres with regard to energy efficiency, degree of use, architecture and arrangement of the many computers. The software-based servers must run day and night due to use, but often at a work capacity of only 25 percent. The data centres in Europe and the

One of Google's largest computer centres worldwide in Douglas County (Georgia, USA), not far from Atlanta.



What are the units a high performance computer works with?

Bit: a binary figure or unit for information content or data volume: alphanumeric symbols (0, 1 ..., A,B ...)

Byte (B): measuring unit for digital technology and information systems 1 byte = 8 bits

1 kilobyte (KB) = 10^3 B (about a fourth of a printed page)

1 megabyte (MB) = 1 000 000 bytes (500 pages of text, for comparison: long-term stored information units in the brain of a 60 year-old 150 to 225 MB)

1 gigabyte (GB) = 10^9 bytes (storage capacity of USB sticks up to 64 GB)

1 terabyte (TB) = 10^{12} B (current maximum storage capacity of an external hard drive 16 TB)

1 petabyte (PB) = 10^{15} B (memory content of all living 6 billion people today about 1350 petabytes as of the 1990's)

1 exabyte (EB) = 10^{18} B (in 2019 customers of the mobile net O₂ caused more than an exabyte in traffic for the first time – this is more than 1 billion gigabytes)

1 zettabyte (ZB) = 10^{21} B (presumably, the NSA stores data volumes of several zettabytes)

US alone have an energy use of 40 gigawatt. »Forty gigawatts are equal to about the half of total German electricity consumption, which is about 70 GW. Overall, 10 GW worldwide could be saved alone by optimizing the data centers,« says Lindenstruth.

- He furthermore explains that due to poorly written or outdated software, many computers work at lower levels of performance, with high energy consumption and low perfor-

mance speed, comparing this to a car that only drives in one gear. The unused capacity of the computer is lost as heat. An increase in the performance of the software by the factor 100 to 1,000 could be achieved by a revision of the algorithms.

- Graphic cards are necessary computational tools for a computer to work. Today, all graphic cards have their own storage. The internal GPUs normally installed, however, are not super-fast. Moreover, the image resolution is not very high. Lindenstruth prefers GPU graphic cards developed for computer games that can operate independently of the computer's processor. The idea of integrating them in the computer as independently working graphic cards has proven to be pioneering and highly efficient. They are particularly high performing with fast computing power, because the individual computing power does not interact with others, and simultaneously-running algorithms accelerate the computing process. In addition, the computing power is produced in its own GPU processor. The cost of these graphic cards is manageable, as rising demand means they are manufactured at low cost in high number. Eight hundred of these graphic cards were built into the first supercomputer Loewe-CSC. At CERN, the European organisation for nuclear research, Lindenstruth tripled the computing power of the two-million euro computer by using graphic cards with a value of 500 euro per card.
- Lindenstruth sees one of the greatest need for action in the cooling of the computer.

Whether desktop or high performing computer, the processors emit heat while working. Until now, cooling has been carried out by the intake and release of air which is passed on to the exterior air by the computer's built-in fans. This leads to a rise in room temperature; in rooms containing supercomputers sometimes to more than 50 degrees Celsius. In addition, the fans themselves require about 4 percent of the energy required by the processor itself.

The cooling system developed by Lindenstruth and patented in February 2020 is based on a simple trick: a cold water cooling system is built into the back door of the rack containing the computer by means of a heat exchanger. The hot air of the system is transferred to the water and cooled. The heated water is cooled according to the principle of a refrigerator. »When you sweat in the summer and the water on your skin evaporates, you begin to shiver,« Lindenstruth says, describing his concept. The room temperature can be maintained at a constant using this cooling system. The server's waste heat can be used to heat other rooms or distributed beneficially through district heating systems.

»Green IT Cube« as a guide to more energy efficiency

With »Green IT Cube«, Lindenstruth was able to achieve the ambitious goal of building a large scale data center with these requirements. This data centre was completed in January 2016 in Darmstadt at the GSI Helmholtzzentrum für Schwerionenforschung. Stacked shelves stand in the »cube« which measures 27 m x 30 m x 22 m, in which 768 computer cabinets can be arranged on six levels. The three-dimensional structure – next to each other, on top of each other – is 10 times more compact than conventional building methods. The connections – i.e., the cable lengths between circuits are therefore shorter, signal transmission is faster, allowing experiments or simulations of extraordinary intensity and speed, and it is overall an environmentally friendly architecture. At least 300,000 computing engines Rechenkerne (1 processor contains several several computing units = computing engine Rechenkern) are planned, with storage space totalling up to 100 petabytes, which is equal to 100.000 conventional computer hard drives. The data transmission rate for experimental computing processes is one terabyte per second, which is equal to 500 000 private DSL connections. The cool water cooling system developed by Lindenstruth in the back doors of the computer cabinets cools 12 megawatts of the total computer performance and

requires less than 7 percent of the total required energy of the data centre for cooling – compared to 30 percent for other cooling systems – making Green IT Cube an important step toward sustainable digitalisation.

Without doubt: our future is digital

It opens possibilities to make the rapid economic, social and – no contradiction – climatic changes easier to plan and shape successfully. The unavoidable increase in energy consumption does not have to be in conflict with sustaining the natural foundation of life. The research by Lindenstruth and his team, and of many other research groups in the field of green IT are promising. Sustainable technology contributes to the protection of climate and natural resources. Every individual can act in a »digitally sustainable« way. Digitalisation and sustainability do not have to be a contradiction. ●



The author

Regina Kremer, born in 1956, studied biology and chemistry for secondary teaching degree at the University of Gießen. She teaches at the Claus-von-Stauffenberg-Schule, a secondary school in Rodgau in the district of Offenbach. As senior teacher, having contact to the nearby universities is important to her. She regularly arranges for her students to participate in scientific projects at the universities in Frankfurt, Mainz and Darmstadt. She developed an affinity to IT through planning her classes and putting together the most up-to-date working materials.

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A row of red bowls is arranged on a light-colored wooden table. The bowls are in focus in the foreground and become increasingly blurred as they recede into the background. The setting is a bright room with large windows in the background, through which green foliage is visible. A semi-transparent yellow circular graphic is overlaid on the bottom right of the image, containing the text.

LAW
and
ORDER

The »Criminal Law« of predictive society

... or how »smart« algorithms (could) change the administration of criminal justice

By Christoph Burchard

Applying AI to criminal law and justice – a threatening vision of the future or a utopia of security and freedom?

It is the year 2054. An imminent double murder, a crime of passion, is reported to the pre-cop department of Washington D.C. After consulting a face database and other databases, the detective in charge quickly identifies the perpetrator and the crime scene. A pre-cop team rushes over and at the last minute (the weapon was already being raised for action), they are able to prevent the crime from taking place. The perpetrator is then arrested for the future killing of his wife and her lover. This is the opening of *Minority Report*, a science fiction thriller from 2002. In it, the pre-crime programme – preventing crimes before they happen – has made crime a thing of the past. »That which keeps us safe will also keep us free« – this is how the programme is promoted: as the perfect reconciliation of security and freedom.

The future is now – even in criminal law and justice!

As fantastical as it seemed in the film – this future has already begun. However, whereas in *Minority Report*, Hollywood still had to depend on individuals with clairvoyant abilities, today »smart« algorithms are employed. Driven by artificial intelligence (AI) and ever faster computational possibilities, they are able to analyse large and apparently unconnected datasets (big

data) in such a way that individual behaviour can be predicted with increasing accuracy.

This has long been established in many areas of life: who will buy what online? Who will with what probability be unable to repay their loan? These questions, directed at the future, are answered algorithmically in the present, in order to be able to »re«-act immediately. In these areas, our society is being transformed into something like algorithmic predictive society. Traditionally, uncertainty about how the future will develop is processed by human prognoses, and also by trust in certain institutions, especially the law. In predictive society, this task is assumed by probability calculations from »smart« algorithms, whose capabilities far exceed human data processing capabilities. In predictive society, therefore, the accuracy of the algorithms and the availability of the necessary data are the actual currency, and consequently the actual source of societal power.

Criminal law is no exception here. The »criminal law« of predictive society is already in the making. Here are just a few examples:

- Predictive and big-data policing promises to be able to identify crime scenes (abstract) as well as victims and perpetrators (individually) before the crime is committed. In this

manner, patrol cars should be able to be sent to hotspots before break-ins etc. occur. These kinds of programmes are being used globally, including in Hessen, where we use software from the US provider Palantir, making ourselves to some extent dependent on such firms in the process.

- Risk assessment programmes promise a more precise estimate of the harmless/dangerousness of criminals. Those posing a threat to society should be removed from society longer, harmless criminals released from custody sooner or put on parole from the start. This not only provides security, it also saves money – which is the reason that these programmes are already being widely applied in the USA.
- Government agencies are not alone in relying on predictions to prevent crime; in fact, the government is a shrinking subset of predictive society. Crime prevention and even more importantly pre-emption are both being »privatised«. Monitoring programmes are being developed for grocery stores among other things in order to identify shoplifters before they shoplift. And predictive policing algorithms can also be used by employers. The buzzword is digital criminal compliance: the digitally supported real-time prevention of compliance violations such as corruption in business dealings or market manipulations.
- But the risk emanating from potential perpetrators is not the only future that can be determined predictively. Judges and prosecutors are increasingly viewed as a risk because they may evaluate subjectively and with bias – be swayed, for example, by racial prejudice. There are considerations to review the relative reasonableness of penalties by algorithm before they are imposed. This falls on sympathetic ears in Germany, too. After all, penalties vary significantly throughout Germany, and not just between north and south.

»Thou shalt not kill!«

– becomes »Thou cannot kill!«

How should one react to all these developments? A frequent reaction is the with the defence of one's vested interests: »Algorithms can't do what experienced crime officers and experts (judges, prosecutors, defence attorneys, etc.) can do. Algorithms cannot grasp the complexities of penalties, not to mention let common sense prevail.« So one hears, time and again. But this is often just whistling in the dark.

Can crimes really be predicted? In 2002, Tom Cruise plays a police officer in »Minority Report« who himself gets caught in the machinery of the pre-crime programme. The movie takes place in the year 2054 and is based on a short story from 1956.



Algorithms in the administration of criminal justice may be accompanied by considerable shifts in power, especially to the benefit of those actors »behind« the algorithms – such as the IT company, which in the USA does not even have to make the algorithmic foundations of its risk assessment programmes public (!). Democratic lawmakers must also be taken into consideration, however. They would seem to be able to »finally« govern completely through algorithms. Defending vested interests (»We have always done it this way!«) is, however, not an argument against the »criminal law« of predictive society. Even less so, when this appears to fulfil the promises of criminal justice better than the original. Where criminal law can only operate contra-factually and normatively (»Thou shalt not kill! But you can.«), predictive society promises factuality (»Thou cannot kill!«).

Technically, these promises are still difficult to fulfil. In the USA, predictive policing programmes have already been discontinued because they have not proven to be sufficiently effective. Comprehensive face recognition is switched off, because it is discriminating for technical reasons. And it has become clear that risk assessment algorithms are not – as had originally been hoped for by citizen rights movements – a valid means for overcoming the deeply rooted racism in the US criminal justice system. Predictions »today« are normally only as neutral as the data that was collected »yesterday«. If the data input is racist, the prediction output is also racist (bias in, bias out – or more bluntly: crap in, crap out). If this is coupled with blind faith in technology, the bias – such as a racist bias – of the prediction goes socially undetected.



As serious as these objections are, they are ineffective overall against the new »criminal law« of predictive society. They act instead as arguments for technological development and more innovation. The causes and justifications for more prediction in the administration of criminal justice remain unaffected. Certainly, smart algorithms are like a black box, whose prognoses cannot be comprehended – but doesn't the court also make its sentencing decisions in closed chambers? And yes, algorithms may be prone to error and bias – but doesn't this apply even more to judges, who are also »only« human?

Where does the need for algorithms come from?

What drives us, then, to »criminal law« in predictive society? A lot is probably due to the complex relationship between »trust and conflict«. It also has to do with how legal systems or algorithms process and reduce social complexities – future uncertainties, in other words.

The social acceptance of predictive society goes hand in hand with the loss and shifting of trust. Trust in others is lost when they are no longer viewed as fellow citizens, politicians (law-makers) or judges (law appliers), but rather as risks. This brings other actors into play (such as private »code makers« and »code appliers«). In addition, mistrust toward law as a means of reducing social complexity is growing – especially when law becomes politicised and is either unable or unwilling to negotiate social conflicts neutrally. The less social conflicts are able to be confined as legal conflicts and thereby neutralised, the greater the trust in the neutrality of code and IT (»In code and technology we trust!«), even if code and IT are actually thoroughly nor-

native. This applies all the more as algorithmic predictions (so we are constantly promised) are even better and more effective than law at providing security in the future.

The fact that the transition to predictive society means an increase in surveillance trends (no predictions without data!) seems to be acceptable to many. What is decisive in this regard is

IN A NUTSHELL

- We are underway toward becoming an »algorithmic predictive society«: artificial intelligence and big data lead to increasing algorithmic predictions of future behaviour so that we can »re«-act to them in the present.
- The more trust in the constitutional state diminishes, the more society relies on the purported efficiency and objectivity of algorithmic predictions to generate future security.
- Justice and police use prediction algorithms for the purpose of predicting crime and the dangerousness of criminals, among other things
- When analysing these algorithmic predictions scientifically, it is important – as it is now in the corona crisis – to reassess the relation between security and freedom anew. What measure of security is a basic requirement for freedom? And when does the former excessively curtail the latter?

that surveillance in the age of surveillance capitalism (Zuboff) becomes ever more »liquefied« (Baumann): surveillance is difficult to grasp, especially in the West, as it is no longer perceived as authoritarian force, but as realization of freedom (the digital traces we voluntarily leave in social networks come to mind). Moreover, for many citizens, whether their security fears are justified or not, it seems acceptable for them to be algorithmically evaluated as long as others are, too. This is in keeping with the naive, but effective motto: »Those who have nothing to hide have nothing to fear from algorithmic surveillance and risk evaluation!«

What remains of criminal law

Not until we comprehend what propels us toward the »criminal law« of predictive society can we arrive at the crux of the matter. What is left of our current understanding of criminal law in predictive society? What is the »criminal law« – which is intentionally put into quotation marks – of predictive society? What axioms does it rest on? And can these axioms be defended? In keeping with the best of Frankfurt traditions,



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we need to review the issue with a cool head without succumbing to techno phobia.

Whom, for example, does a predictive society act upon when it thinks of its members (one should no longer speak of citizens) primarily as a risk – even as potential dangers? And what effect does this have on iron principles of criminal law – such as the presumption of innocence and the in dubio pro reo principle – if the algorithmic probability calculation has precedence over the idea that judges should only convict when no reasonable doubt remains? And would this be such a terrible thing? After all, the idea of »without a reasonable doubt« is not immune to abuse either? And what does this mean with regard to the doctrine of probable cause as the necessary prerequisite for taking up criminal investigations if probable cause can visibly be generated automatically from big data? Moreover, can a democratically constituted predictive society do without the checks and balances of the law (as it is executed by humans)? (The fact that and how the Bundesverfassungsgericht – the Federal Constitutional Court – recently toppled the criminal prohibition against suicide assistance comes to mind.) Finally: can and may predictive society do without the postulate (which is admittedly not constantly realistic) that the one judging must also be able to be the one being judged (something that is difficult with algorithms)?

Do we have a right to violate the law?

But above all there is the question of freedom in the »criminal law« of predictive society. In Minority Report, a crime of passion was intentionally placed at the beginning of the story. The »criminal« (who did not even commit the crime!) was more or less spontaneously inspired to commit the »crime« (which he did not even complete!) when he found his wife in their marital bed with her lover. Crimes planned well in advance no longer exist in Minority Report. »People have gotten the message!« – is how a protagonist describes it.

What sounds like a utopia in which security (there is no more crime) and freedom (everyone enjoys legal certainty) are maximised can quickly turn into a dystopia. This happens when the getting of »the message« turns into the unavoidable internalisation of all algorithmic determinations and power structures they express; and when all criticism of the smart algorithms on the grounds of anticipatory compliance with algorithmic predictions falls silent. This is where the emancipatory and authoritarian potential of predictive society come together. And the question arises: does the autonomy to be able to in fact commit crimes belong to the core of a free democratic basic order? Is there a kind of right

to break the law, for example in order to initiate social change? What first seems outrageous in view of straightforward cases (manslaughter and murder), becomes clear when considering controversial cases (such as abortion, suicide assistance, consensual homosexual intercourse): A »got the message« must not make the criticism of and reflection on certain norms impossible – whether they take the form of legal provisions or algorithmically implemented programmes. This criticism and reflection requires that the individual, as an equal, is able to contribute his or her position to the making and implementation of norms. Even in predictive society, this is the only way to bring freedom and security into legitimate balance.

And now?

Minority Report ends with the Pre-Crime Programme being abandoned overnight, because a hero acting independently reveals its deficits – i.e., that predictions cannot deliver absolute certainties. The discussion of the actual »criminal law« of predictive society cannot be resolved this simply. This is why it is necessary to now place its benefits and risks under the microscope from an empirical, social scientific and normative perspective. Only then can a humane digital society be designed in which only those innovations are incorporated into the administration of criminal justice that are normatively justified and in accordance with our values. ●





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– Anzeige –

When trust no longer plays a role

On the future of freedom in smart orders

By Klaus Günther

What significance does individual freedom still have in times of digitally generated predictions? Is it still important for us at all? Risks are supposedly minimized with the help of artificial intelligence. But at what price?

In the 1990s, there were several films which, as science fiction, anticipated what today at least partially already is or could become reality. In »The Truman Show«, the protagonist has led a seemingly normal and unremarkable life since childhood in the world of a gigantic television studio. The fact that his everyday life takes place as a live show on TV is kept secret from him, albeit unsuccessfully at the end. The film »The Matrix« works explicitly with a simulated world created by means of artificial intelligence, whose inhabitants no longer know the real world at all and to escape from which is a dangerous and almost futile endeavour.

We too are moving around more and more frequently in artificially created worlds, whose construction is steered by algorithms that only a small number of people understand and which can only be controlled by the fewest. As self-learning machines, these algorithms collect and process the data they harvest from users' behavioural statements and generate a profile from them which makes it possible to predict future behaviour and out of which, in turn, the world is assembled in which users move.

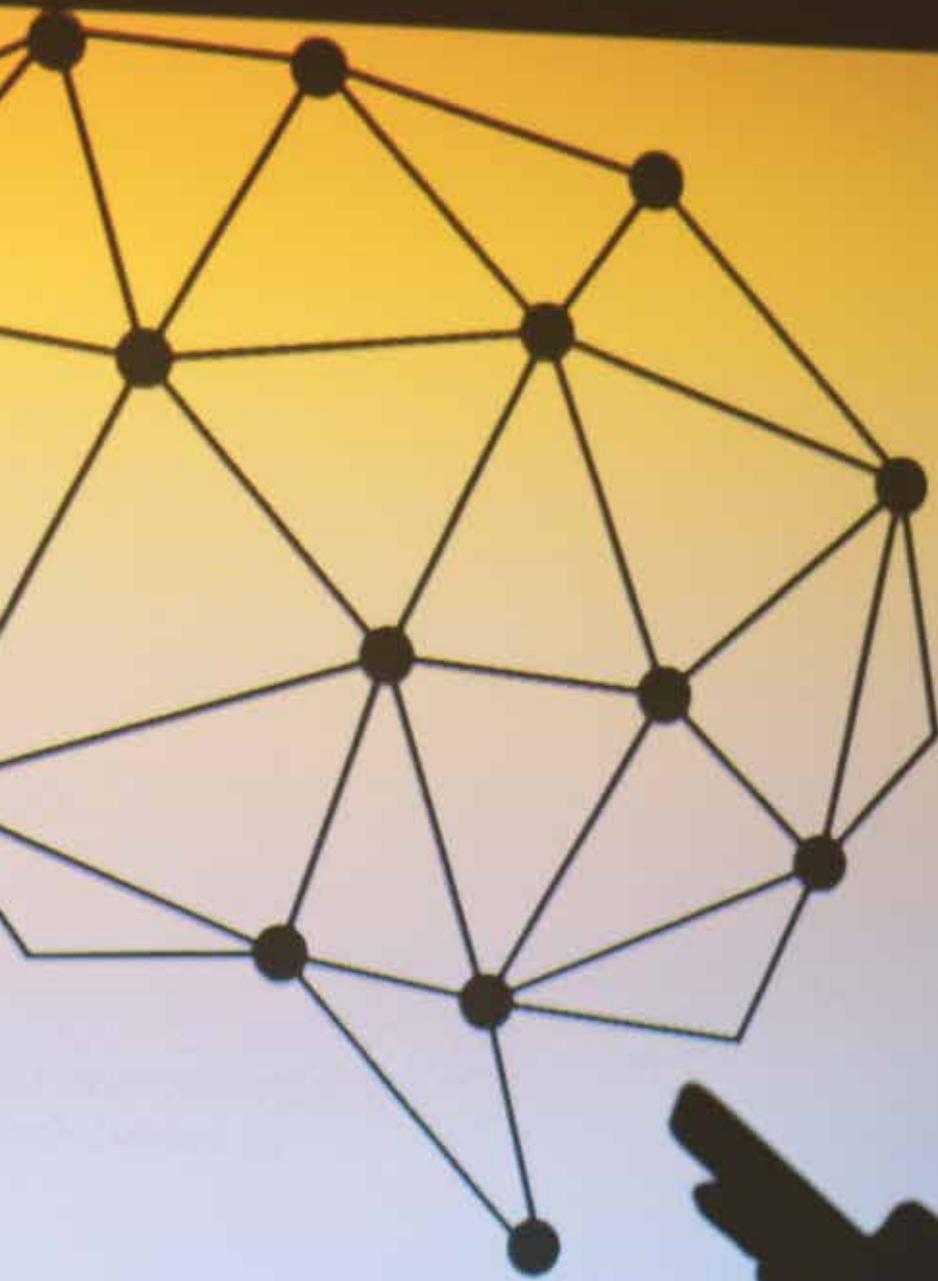
Predictive data as the capital of the 21st century

What many people evidently fail to see entirely is the fact that the predictive data they generate

are used to influence and channel their behaviour and this namely in the interest of corporate entities and governments. Predictive data are, as Shoshana Zuboff vividly described in her book »The Age of Surveillance Capitalism«, the capital of the 21st century. They can be sold or used to produce even more precise behaviour patterns in order to create an even better, customizable product. Viewed from this perspective, the actual value of smartphones or devices such as »Alexa« lies neither in their practical value nor in their exchange value, but instead in their

Cam

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Hybrid Analytics



»Knowledge is power«: Francis Bacon, pictured here in an oil painting by Frans Pourbus (1617), could not foresee to what extent his famous sentence would one day prove true.

added value in terms of the predictive data they produce.

Alongside private companies, however, political stakeholders, governments and above all authoritarian regimes are very interested in using predictive data generated algorithmically to gain or stabilize political control as well as for effectively combating dissent, protest or opposition. As the attempt by »Cambridge Analytica« to influence voters' behaviour in the last presidential elections in the USA showed, democracies are not immune to such temptations either. In some regions of China (e.g. in Rongcheng), experiments are being conducted with techniques such as digital face and voice recognition in order to establish a system that combines surveillance, control and the social classification of citizens (social credits) with incentives and sanctions, the purpose being to optimize their day-to-day »civil« behaviour (and political good conduct) in line with prescribed »core socialist values«.

A new form of power

Both kinds of use of predictive data lead to the strengthening of a type of power that so far has led a rather shadowy existence. A person capable of predicting the future as reliably as possible, who has at least an information headstart with regard to future developments, has always had an advantage. That such knowledge creates power became clear at the latest when we became able to master nature more effectively than in the past through our understanding of

the laws of nature. This awareness prompted Francis Bacon to coin his famous sentence at the beginning of the 17th century: »Knowledge is power«. This applies to a still greater degree for fervently desired, social predictive knowledge, that is, when it is a matter of the future intentions, decisions, courses of action, the future behaviour of others and thus of controlling them. Whoever has such knowledge at their disposal possesses predictive power in the truest sense of the word.

However, other than is the case with predictions based on the laws of nature, social predictive knowledge was for a long time much more uncertain. Indeed, there were already the first successful attempts back in Bacon's day to measure probabilities mathematically and thus also to calculate people's future behaviour, for example, by compiling social statistics and drawing conclusions from them about behaviour patterns (Hacking, *The Emergence of Probability*, 2. A., Cambridge 2006). As Michel Foucault has shown, the developing European state of the modern age used this new type of knowledge for a biopolitical economy of power directed at the productivity and security of the population. It replaced the previous panoptic power of internal and external surveillance directed at the disciplining of the body and the soul (Michel Foucault, *Geschichte der Gouvernementalität I*, Frankfurt am Main 2004). However, this new predictive knowledge relates above all to regularly recurring phenomena in the population (e.g. annual suicide rate, birth and death rates) and less to future individual behaviour. As modern society becomes a risk society due to its dependence on complex technologies and the state becomes an anticipatory prevention state, the need for reliable predictions increases considerably. With big data and AI, social predictive knowledge seems now, however, to be becoming much more robust and can be individualized more precisely. Probability could finally transmute into certainty. In this way, predictive power has the best chances of becoming the biopower of the 21st century.

Freedom and trust in normative orders

If we go along with Foucault's analyses, modern biopolitics operated above all in its liberal manifestations with the freedom of the individual to shape his or her own life in a process of exchange with other free persons. From this external perspective, it was above all a matter of weaving the individual person into a tight net of norms and normalizations through many different and lengthy processes of subjectification in order thus to spawn attitudes and practices which empowered that person to make use of freedom both autonomously as well as to general advan-

tage (Foucault, page 78). This freedom necessitates above all working continuously on oneself so that each person contributes to the security of the population through his or her own individual anticipatory behaviour.

However, freedom is not only the product of the economy of power described by Foucault but rather at the same time the reason for existence for individual and political autonomy and thus of the possibility of release from heteronomy and domination. It presupposes that people develop a reflected relationship to themselves through their experiences with others as well as with outer and inner nature in view of a slightly uncertain future. Only in this way can the self also recognize and criticize the social norms that guarantee its status as a free and equal person, and at the same time that of all others, as well as be held responsible for violating them. By reviewing and correcting our own intentions, wishes and convictions in the light of – often opposing and highly conflicting – experiences with others, with ourselves and with outer nature, that is, through learning processes, the self gains and is given its freedom.

It already becomes clear from this brief outline that such a freedom is – from a social perspective – at the same time full of preconditions and risky. In addition, an indelible remainder of spontaneity is inherent in this freedom, often only awakened by surprising experiences. With this moment of chance, it evades all predictions and calculations again and again. Admittedly, this insight is by no means new, but so far society has confronted this risk with the fragile and not easily producible good known as trust. It seems, however, to be becoming increasingly risky in a globally collaborative, technologically innovative, highly individualized and diverse society to rely on this fragile resource. Freedom itself becomes a risk, relying on the autonomous actions of others could lead to disadvantages for ourselves. The loss of trust is now, however, being accelerated by the fact that with the predictive power perfected through AI and digitalization there seems to be an alternative with which trust can be transposed into certainty about the future actions of others. But then freedom too threatens to disappear – not through oppression or manipulation, but simply because it no longer matters.

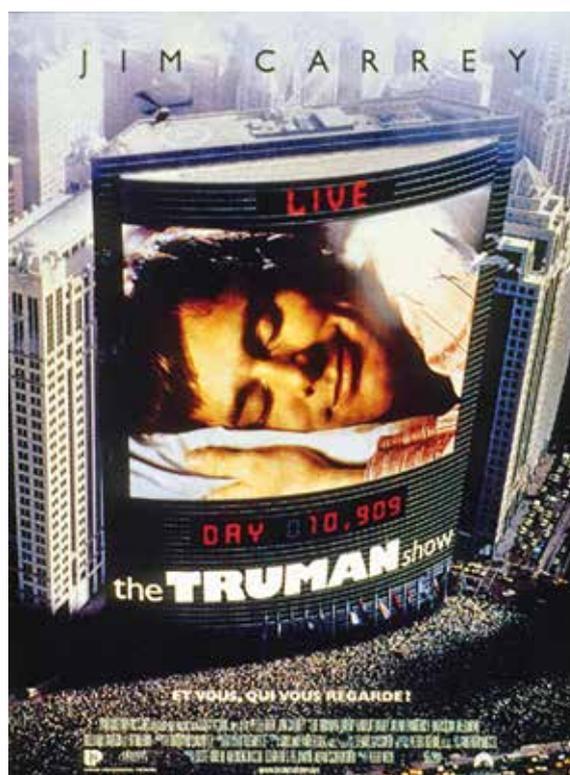
Freedom and security in smart orders

Anyone who orders something online or is underway in social networks can observe – on a small scale in their own actions – how freedom in the sense of autonomous decision-making is becoming increasingly superfluous. On our next visit, we receive offers based on conclusions drawn about our past purchasing decisions or

on messages we have posted. The offer varies, namely in such a way that it still fits into the range of interests constructed on the basis of our personality profile, but at the same time it also has the appeal of the new. Similar can be said of social networks: Our own activities bring us together with other users who perhaps do not share identical, but indeed similar needs, experiences or emotions, which are recognizable not least from the number of likes and followers. Anybody moving around in such digital echo chambers finds himself in a kind of smart world of affirmation, in which the self remains as it is within a certain range of variation. We are spared conflicts with others or can stave them off. We are relieved of the job of making decisions and forming opinions with all its learning processes, which is an indication, according to Gaspard Koenig, of the end of the individual (Koenig, page 135). For the architects of this world of affirmation, for corporate entities as well as for political stakeholders, this minimizes the risk that consumers or voters will suddenly decide differently.

However, this also applies for the normative orders in which we are continuously underway with our words and actions. Although the participants do not always behave everywhere according to their rules, some of which are also institutionalized in the form of legal systems, again and again they do so in such a way that they decide freely and independently to comply with a rule. This is expressed not only through their criticism of rules, e.g. with reference to

Virtual reality in the cinema of the 1990s: Jim Carrey in the role of Truman Burbank, who – without knowing it – is the protagonist in a TV series. Since his birth, the viewers have followed how his life progresses.



Brave new world?
Already today, authoritarian regimes use voice and face recognition to establish a system that allows the monitoring, control and social classification of the entire population.



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other rules, but also by the fact that they have the factual freedom to deviate from the rule in their behaviour – also while accepting negative consequences (Haffke, page 967). No normative order, no legal system is so perfect that it could exclude this factual freedom. This risk too could only be offset by a general, but always fragile trust in the other and, in the case of a violation of the law, in the readiness and ability of the constitutional state to impose sanctions.

Here too arises then the alternative, one which guarantees more security, of simply bypassing the freedom to comply with norms on our own responsibility by making orders smart. Smart orders are characterized by their use of technologies designed to avoid errors. A model for this is the smart city, in which as many complex routines as possible involving the people and things there are coordinated by algorithmically steered processes in such a way that very few malfunctions and errors occur (e.g. in road traffic via externally activatable control modules in self-driving electric vehicles). Regulating these confluent processes is a smart order that directly determines individual behaviour and, so to speak, takes effect via each individual.

The power of conviction of smart orders

If this model is transferred to society as a whole, it becomes clear that the prevention state can

IN A NUTSHELL

- »Knowledge is power«. At the latest since Francis Bacon we know that an information headstart with regard to future developments plays into the hands of those in power.
- The complexity of our modern society increases the need for predictive knowledge. Big data and AI facilitate predictions on a scale never before known.
- The individual freedom establishing itself in a diversified learning process since the Enlightenment accepts risks which are countered with trust.
- In times of AI, this trust threatens to become obsolete: Smart orders are replacing liberal norm-setting processes and leave the individual hardly any choice regarding his or her behaviour.
- The readiness to forego individual freedoms in the interest of more security and prosperity is surprisingly great.

use smart orders to optimize itself to a considerable degree and without being reliant on coercion and direct control. First proposals in this respect have already been put forward under the title of »anticipatory government« (<https://www2.deloitte.com/us/en/insights/industry/public-sector/government-trends/2020/predictive-analytics-in-government.html>). The objective is to identify social problems much sooner than in the past and to predict their danger potential in order then to be able to intervene in good time and successfully before they turn into crises.

The new technical possibilities give the leading principle of any prevention state, »prevention rather than cure«, an almost invincible power of persuasion. It does not take much imagination to envisage how these possibilities will meet with great approval above all in the prevention of dangers to the internal and external security of the population.

It is not by chance that proposals regarding anticipatory government are predominantly put forward by private enterprises, such as international consultants Deloitte. Not only because they hope to acquire a new business model from the conversion of a normative order into a smart one but also because the distinction between sovereign action by the state and the shaping of order by the private sector will mostly become obsolete in favour of the latter: Technical prevention through smart orders demands technical expertise as well as efficient management but not lengthy political processes in the shaping of legislative opinions and policies.

This raises the question of the democratic legitimation of anticipatory government with smart orders. Here too, it seems that processes for shaping public opinion and policies, within which free citizens adopt a critical stance and resolve conflicts according to rules, no longer matter. What is the point of continuing with the political theatre of representation and public debate if AI and big data make it possible to poll individual preferences in a permanent referendum of tracking, e.g. via mobile phone usage and social networks? Would an order that could immediately transform such data into personalized technical prevention measures not be far more democratic? At the end of the day, the question is only how such an order would differ from that of Truman's or The Matrix, with the exception that we would become indifferent to freedom with our eyes wide open. ●



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»I have nothing to hide« – really?

Differentiation versus discrimination by AI, algorithms and digital services

By Indra Spiecker genannt Döhmann

The issue of data security has become increasingly complex in the age of the internet and artificial intelligence. The developments seem to be almost unmanageable in some areas. Cooperation between jurisprudence and information technology is the only thing that can protect the individual and certain social groups from discrimination.

Anyone can know anything about me – I have nothing to hide« – this sentence is often heard in connection with the use of social media or the creation of large databases. Another perspective dawns, however, when people are asked if they would share their payslip, credit card statement or the contents of their medicine cabinet.

At closer examination, most of us have a clear – though quite individual - opinion about what we would like others to know about us. And we also make clear distinctions when it comes to our audience. We will tell a best friend or exercise buddy different things over a beer than we would our boss or insurance agent.

This control over what we reveal to others, and the degree of self-protection it affords came to an end some time ago; our personal data, and what happens with it, is often no longer up to us. Ever since there has been automatic data collection and analysis, since computers collect data, combine it and evaluate it, since algorithms have been employed: we as individuals can no longer even know for sure what happens with our data – not to mention having any influence over it. Our self-protection mechanisms no longer work.

Yielding data to unknown recipients

For one thing, we do not even know who has our data – data analysis can be carried out by various businesses, private individuals, or the government. As a rule, anyone using an app on

their cell phone gives significant amounts of data to the app operator at least, as well as to the telecommunications provider; the app store often has access as well, as does – in the case of android phones – the operator of the operating system or software platform. In addition there are a number of quite controversial legal regulations that allow this data to be passed on to state authorities. Finally, most app providers allow the data collected by the app to be passed on to third parties – often without the explicit consent of the user. It's the same for using internet sites and services: everywhere, data is collected from the user and passed on. As a consequence, enormous amounts of data about the user end up with the providers of digital services across the world.

Nor do we know what is known about us. It is not clear what data from which sources is gathered by whom in what way. Traders of data go all out to provide data on people, their likes and dislikes, their behaviour, their willingness to pay, and their limits.

As the Bundesverfassungsgericht (Federal Constitutional Court) formulated with prescience as early as 1983: if you don't know what others know about you, it makes you insecure in your actions because you can no longer react to the actions of your counterpart. One could also say: a level playing field in communication and in all decision-making and behaviours is disrupted when one side not only knows more, but can also hide what and how much they know.

How we are judged: algorithms in use

This risk to the individual through the analysis of his or her data by automated data processing has been the focus of data protection law from the beginning; in fact, this is its original concern: to protect the individual in his or her self-determination and thereby in the exercising of his or her independence and liberty. Therefore, contrary to what is commonly asserted, data protection law does not have an inherently paternalistic element: it is not about the individual judging what is good for him or her being replaced by the judgment of the lawmaker; rather, it is about putting the individual in the position of being able to form and proclaim his or her own will.

Yet data protection law faces wider challenges today. It has increasingly less to do with the concrete data of an individual which – together with other data on this person – can be compiled to create a comprehensive picture; modern data analysis works with algorithms and for some time now also with the use of machine learning and artificial intelligence in order to dispense with individual data as far as

possible. Instead, the individual is assigned to groups and judged according to the criteria for these groups. On this basis, the prices for products are set variably by target group, decisions on access to continuing education and jobs by social group membership, or disease treatment by profitability criteria. If you think these are the remote scenarios from autocratic systems such as China or Singapore, you are mistaken; examples for these cases can all be found in the EU, and some even in Germany.

Cyber discrimination as mirror of our society

It would be premature to speak of discrimination in all of these cases. The first thing to note is that people are treated differently based on certain advance information to which the decision-maker in each situation attributes a certain importance.

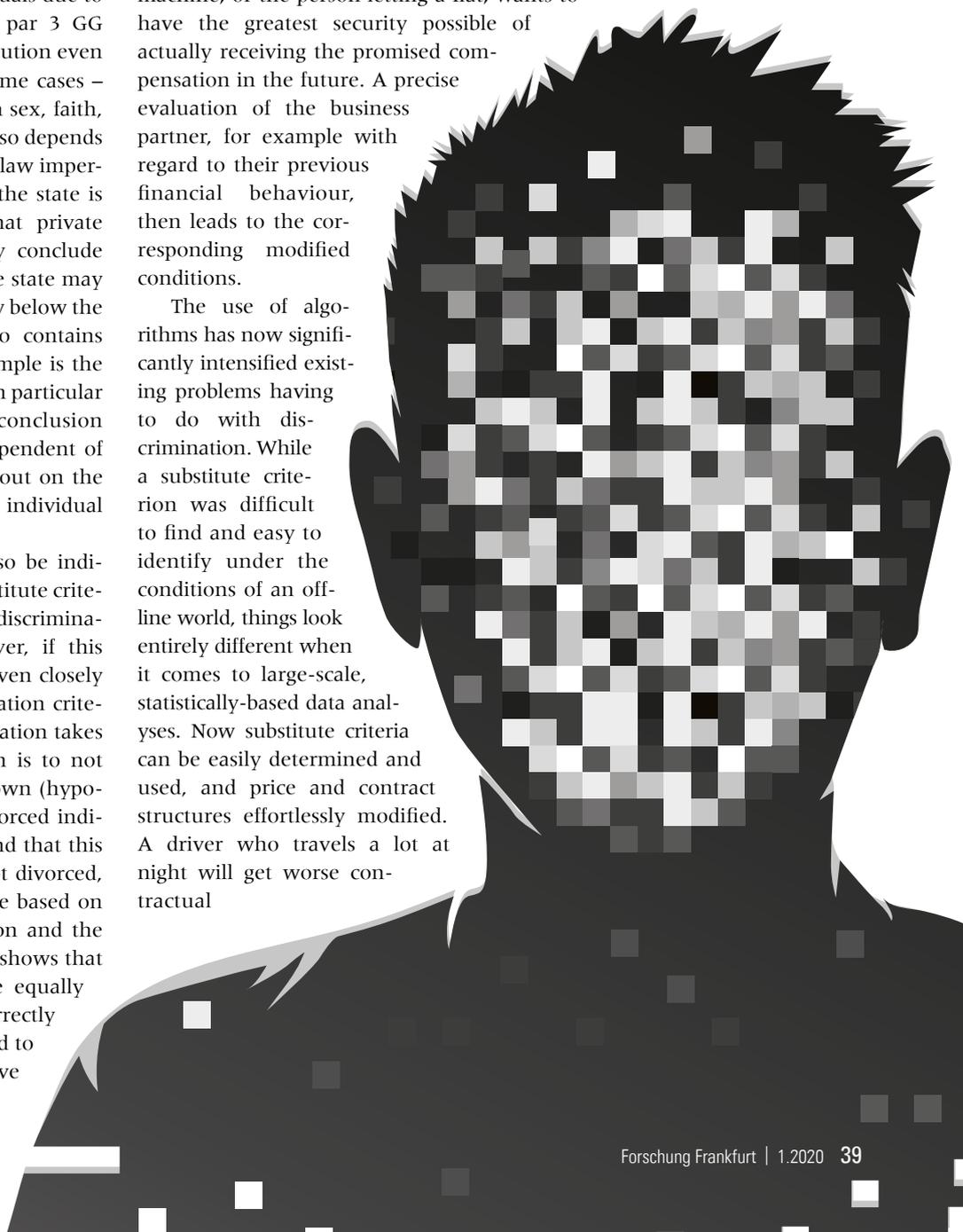
Not every differentiation is automatically discrimination in a legal sense. Discrimination as legal term only encompasses the normatively undesirable discrimination of individuals due to certain characteristics. In article 3, par 3 GG (Grundgesetz, Basic Law), the constitution even determines that differentiation in some cases – for example, differentiation based on sex, faith, race or origin – is discrimination. It also depends on who is differentiating: the rule of law imperative in article 20 par 3 GG means the state is subject to stricter commitments than private individuals. Private individuals may conclude contracts based on sympathy, but the state may not. Meanwhile, however, simple law below the threshold of constitutional law also contains bans against discrimination. An example is the antidiscrimination law AGG, which in particular prohibits the denial of contract conclusion due to certain characteristics – independent of whether these decisions are carried out on the basis of algorithmic evaluations or individual decision parameters.

Discrimination can, however, also be indirect and hidden. In such cases, a substitute criterion is used that does not indicate discrimination, but which is neutral. However, if this substitute criterion is correlated or even closely connected with the actual discrimination criterion the result is the same: discrimination takes place. If, for example, the intention is to not employ divorced people and it is known (hypothetically) that 90 percent of all divorced individuals have longer index fingers, and that this only occurs in 5 percent of those not divorced, discriminating decisions can be made based on this new, apparently neutral criterion and the same goal is achieved. This example shows that the substitute criterion may not be equally meaningful and people may be incorrectly excluded, but those who are prepared to accept these imprecisions will achieve

their goal of excluding the undesired persons just the same.

In the end, discrimination may not only affect the »whether« of a decision, but also the »how«. Higher prices, worse contract conditions and denied access to services can also be the result of discrimination: the user of an Apple will be presented with a higher price than the user of a discount notebook, because a greater ability and readiness to pay are derived from the expensive notebook. Or the hotel guest who comes from a nationally known underprivileged district pays a higher price for hotel rooms than someone from a middle-class district. These differentiations are described as personalised prices or contracts – whether and to what degree they are legally undesirable is a matter of intense controversy. There are obviously good and legitimate reasons for differentiations: the party paying in advance, e.g. the bank in the case of a loan, the seller of an expensive machine, or the person letting a flat, wants to have the greatest security possible of actually receiving the promised compensation in the future. A precise evaluation of the business partner, for example with regard to their previous financial behaviour, then leads to the corresponding modified conditions.

The use of algorithms has now significantly intensified existing problems having to do with discrimination. While a substitute criterion was difficult to find and easy to identify under the conditions of an off-line world, things look entirely different when it comes to large-scale, statistically-based data analyses. Now substitute criteria can be easily determined and used, and price and contract structures effortlessly modified. A driver who travels a lot at night will get worse contractual



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- Nowadays, deciding what we want to reveal about ourselves or not is overridden by digitalisation: We no longer know who has which of our data and what exactly happens with them.
- The analysis of large volumes of data leads to a distinction between social groups. This must not necessarily lead to discrimination, but it can.
- Discrimination against certain groups of people is easier to conceal in the digital world than in the real world. The individual can scarcely defend himself against it.
- In the interest of data privacy, technical solutions must be found that satisfy the legal requirements.
- At the same time, legislation needs further developing so that it is capable of answering the complex questions of the digital age.

conditions on the basis of novel telematics tariffs because a higher accident probability is concluded from this information. For the person affected, algorithmic-based discrimination is a unique challenge, because it is usually even more difficult to prove than discrimination in the real world. How can the average user find out that information is being sent out by his or her own computer, on the basis of which he or she is receiving worse contractual conditions? How can a television viewer learn that his or her preference for certain series correlates with a lower credit rating?

And the use of differentiation algorithms leads to yet another problem. In order for algorithms to perform their calculations they have to have carried out a high number of comparable calculations – especially when they are being

used in the context of artificial intelligence, e.g., machine learning – in order to reliably carry out the intended task. To do so, however, algorithms take up the discriminations that they find in the existing datasets; they may even strengthen them. Algorithms are therefore anything but neutral and objective – they are reflections of their environments. And this is also something that the affected person has no control over.

The powerlessness of the individual

The persons being evaluated is usually unaware of all of these processes. They have no access to the superior knowledge about themselves that a data trader or the operator of known social media sites has collected on them and there is usually no right of disclosure regarding this aggregated data. Nor is it usually possible to deduce the basis on which the decision was made: whether a contract is offered on these or other conditions, or is denied completely, or if the childcare or study slot given to someone else usually allows no conclusions to be drawn about why this is the case. On

the one hand, this opens the floodgates for these mechanisms to be used, and grants significant benefits to those who can use them. At the same time, it sows distrust and miscalculations in those affected, as they will seek and find their own explanations – which, however, may have nothing to do with the real differentiation and the true cause.

The individual is at a systematic disadvantage because he or she cannot decode the relevant technology of the algorithm; and certain calculations, especially those used in artificial intelligence such as machine learning or deep learning do not allow it even when the use of these technologies is known. But those who cannot comprehend what has happened and who do not have the right or the factual means of requesting a justification – these individuals can also not protest that legal violations may have taken place.

Summary and outlook

There have always been differentiations; a differentiation is a component of every decision because a decision always means that at least one alternative has been rejected. Sometimes, however, differentiation is normatively unwelcome – namely, when it constitutes discrimination. Discrimination is to be consistently prevented, regardless of whether it is brought about with or without algorithmic support, or even through algorithmic decisions. This is where legal enforcement and enforcement mechanisms reach their limits, as they are based on individuals' ability to defend themselves and effectively enforce their rights. But this is precisely what is lacking. In the close interdependence of technology and the value system of the law, technical solutions must therefore be developed that fulfil legal requirements. And at the same time, legal requirements must be modified so that they can accept technical solutions. This poses significant challenges for several research approaches at once.

A first approach can for example be found in data protection law which through the concept of »privacy by default« and »privacy by design« demands that even the development and especially the employment of automated data occur in conformity with the law. A comparable concept could also be required for the use of algorithms: those who employ these processes must demonstrate that discrimination is excluded, and they



must do this dynamically, i.e., whether discrimination has become possible or the software has been used in order to discriminate must continually be monitored. Legally, this could be bolstered with instruments such as reversal of the burden of proof and standardised indemnification so that transgressions are no longer worthwhile. The more not only the final user is held responsible, but also the lower levels down to the actual programmers and the companies behind them, the better undesirable side effects can be avoided.

Ultimately, a rethinking on the part of technology, jurisprudence and society is required, and this must happen early on, during education and training. IT developers need an understanding that they have a responsibility not only for a profitable development of technology, but one that is also valuable for society. In society, this demand must be ensured, and this is only possible through knowledge of and appreciation for the concepts that lie behind it. Legally, flanking norms must provide clarity about which differentiations constitute discrimination, and where differentiation is an important competitive instrument for competitive advantage. The state in particular has an obligation to cultivate an actively critical view of its own use of algorithms. ●



About Indra Spiecker

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»THE FLYPAPER PROBLEM«

Data protection in theory and practice: a conversation with Professor Indra Spiecker

The smartphone is our constant companion, making our lives traceable at every step. Do you accept this in your personal life?

There are a few ways to counteract the risks. The first is to occasionally turn the thing off: if I'm not connected to a radio cell, I can't be located. The second is to diversify. For example, I have two mobile phones. I use one to do things that I actually advise against doing. The other one is the mobile phone that I take with me when I am out and about. These strategies are known as diversification and decentralisation: you should not request all services from one provider, don't let everything converge in one cloud, etc. Beyond this, there are providers who do not earn their money primarily with software and data trading, but with good hardware.

We don't want to name any brands here.

We don't have to. Today you can choose between two large providers of operating systems. In doing so, I am also choosing a greater or less secure data protection environment. The same applies to apps and similar services – sometimes it's more secure to access them through a browser than an app.

How can I know if the information from the provider is actually true?

First of all, these are statements made by the manufacturer and as such there is no difference between IT and, for example, the automobile industry. But state inspection authorities and authorisation requirements such as we have in the car industry – TÜV (vehicle inspection certificate) in particular – do not exist for data protection, unfortunately. Something like Stiftung Warentest (German consumer organisation) or other established civic institutions are largely absent. Although it was the Bundestag (German parliament) that founded the Stiftung Datenschutz (Data Protection Foundation), its tasks and development were not further pursued by the representatives - on the contrary. At least on the societal level there is the Chaos Computerclub or civil rights associations that

occasionally review applications and services, etc. On the governmental side, there are the data protection agencies that do the same. Beyond this, a certain control exists more than ever since the GDPR.

Are the controls working?

We frequently observe these mechanisms: when a legal requirement is not only formulated but actually implemented and sanctioned, the legal compliance rate of companies increases. After all, it will be expensive for them if they offer an unlawful product or service. And reputation effects also play a role: when Facebook had to confirm that it was their data that the British company Cambridge Analytica used to influence elections, those who were familiar with the material were not surprised because data trade is and was Facebook's business model. But the public was outraged. Facebook suffers from this to this day; it certainly strengthened other social media.

That was probably because in this case elections were influenced. Otherwise, there seems to be a longstanding consensus that a lot is paid for with personal data.

Yes and no: Of course we are all aware that our data is used. But very few can realistically estimate what conclusions can be drawn from it. It can mean, for example, that prices are calculated differently based on my data, or that my children are denied access to a certain service. If my willingness to pay or my interest in a product is known, then I will be offered different, personalised prices. This raises the question: is this what we want as a society? Can this be reconciled with a free, social and fair market economy?

And this risk emanates from Facebook, Google and WhatsApp?

You have named three main actors – there are others of course, such as TikTok from China. Data is also used internally, by the way, to improve a company's

competitive position. It's known that Google, for example, uses data from search machine requests or route planners for the development of self-driving cars. Google therefore does not have to go to the trouble of purchasing a lot of training data to be used by their artificial intelligence, but can obtain it on its own – and deny it to others. Who has access to what data will therefore have a lasting effect on research and development. Added to this is a growing number of centrally organised services platform structures. Data from mobile phone use, email contacts and browser use set off a data flow that taps data and passes it on like a spider in a web.

Is there a way for us to protect ourselves? We're all already caught in the spider's web.

The power of the masses is always helpful. If a lot of people change their behaviour, markets change because supply adjusts to demand. Every user who asks if a product is data protected in a store has an effect – the user who, when buying a television, doesn't just say: »It's web-enabled, great!« but also asks: »Who is informed about what my family uploads from the internet to the television?«

When I look around, I get the impression that people don't really place a lot of value on that.

Many people think: If everyone uses it, it can't be that bad. This is the famous flypaper problem: The flies flying around it are warned by the others: don't land on it! But they reply: There are so many others already sitting there, it must be safe because so many can't be wrong. But in fact, they can. Swarm intelligence is not always best.

WhatsApp for example: as a mother you can't get around it because so many parent groups communicate with WhatsApp.

This is particularly regrettable, because there are alternatives that are secure with regard to data protection and IT.

My personal approach is to assume the costs for the more secure messenger app. At least this works for smaller and newer groups, for example when the class chat for an exercise class or company group is being set up.

Do you use a different browser than other people?

I use Firefox and always use the private browsing mode. I use Startpage as search engine. It accesses Google, but works without personalisation or tracking.

How do you learn about data protection secure services?

I also view my environment through these glasses of course – newsletters etc. keep me up to date. And my student assistants are constantly researching new services. I then share the results at the beginning of my lecture on data protection, among other things.

Do you have any more tips for our readers?

In view of the flood of video conferencing formats, I campaign for small, secure providers like BigBlueButton or WebEx from Telekom. Telekom presents itself as data protection friendly, and moreover, I can lodge a complaint with German courts and enforce in Germany if promises are not kept. This is not the case with other formats located abroad, with no assets in Germany and servers located in Asia or overseas, which brings us back to the matter of effective legal prosecution. Above all, one would like to see investments in Germany and throughout Europe and, in times of corona, to see capacities being increased in data protection-friendly services and goods. Goethe University recognised the basic problem some time ago and barred the usual voice-over-IP and video conferencing systems such as Skype due to the legal problems (including copyright law) and switched to Vidyo by the Deutschen Forschungsnetzwerk (German Research Network) – but we now use different tools because things were not ramped up quickly enough here. So it's no sur-

prise that the market power of the international players is growing, leading to European legal concepts falling down as well.

Isn't it far too late? Young people in particular don't seem to have much of a problem with not knowing what happens with their data.

Educational politics are the key: we need early, integrative media instruction as soon as children start using these media. I can't sit first-grade children down at computers and instruct them: "google this!" In the corona crisis we have arrived in the digital age with a vengeance, but what is being used in the schools? Primarily products from American market leaders! Why do we use video tools whose servers we know are located abroad and whose contents are accessed there? We're allowing the generation of ten to twenty year-olds to grow up with the impression that there are no alternatives. But under no circumstances is it acceptable that teachers distribute schoolwork through Facebook or start a WhatsApp group. Fortunately, this has now been decided by the courts.

What do you think of the corona tracking app?

I think – under the current circumstances – it's a very good supplemental tool for managing the pandemic. The substantial reservations about data and IT security issues were taken seriously and it is being operated very transparently. People experience that decisions are not being made over their heads, that they actually do have a choice, and that data use is being tightly restricted by a precise technical solution. This is all very pleasing. What remains unclear, however, is how we can ensure that use is voluntary and that social pressure is not exerted, for example by employers or restaurants or event organisers demanding the use of the app, or the courts possibly construing complicity if someone doesn't use the app. This should not even be considered, as it undermines the voluntary nature.

Have you downloaded the app?

Yes, on my »second mobile phone«, but I am sceptical as to whether policy makers have understood how important it is to really keep the app restricted. Law enforcement authorities and other interested parties are already voicing desires. If these are given into, the trust that has just been won will be gone immediately. And even worse: citizens will lose their ability to believe in the state's self-limitation.

Dr. Anke Sauter conducted the interview.

STOP

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Copyright law in dispute

Digital access culture vs. analogue culture of exclusivity

by Alexander Peukert

Through digitalization, the social importance of copyright law has grown considerably. Moreover, the culture of exclusivity established by copyright law conflicts fundamentally with the culture of access prevalent on the internet. An example for this is the dispute over the EU's latest copyright directive. Does it ring in the end of the internet as we know it, or does it »only« see to fair remuneration for those working in the creative economy?

On the evening of 5 March 2019, hundreds of demonstrators, mostly between 20 and 40 years of age, marched through Frankfurt city centre. »We are many! We are loud! You are stealing our freedom!« resounded through the streets. Posters read: »Save the Internet« and again and again: »No to Article 13«.

It rarely happens that a single article of an EU directive that has not yet even come into force triggers spontaneous demonstrations – organized online – in several German cities. With Article 13 of the draft (at that time) for a Directive on Copyright in the Digital Single Market, the said field of law has achieved dubious prominence. While in the analogue age only a few legal experts as well as originators and companies in the cultural sector dealt with copyright law more closely, today it is a regular topic in the daily news and political debate.

Reasons for the growing significance of copyright law

The reasons for this growing significance and the conflict-laden nature of copyright law are of a technical, economic, social and not least legal character. The prolific availability of computers and growing storage capacities make it possible to digitalize more and more text, sound and image data. Via the internet, any of this content

can, in principle, be made accessible and retrieved by anyone from anywhere at any time. The architecture of the internet does not provide for a central instance that would control this mass communication and no such instance yet exists. Search engines and platforms for user-generated content, such as YouTube, Facebook and Wikipedia, aggregate, select and present the net's wealth of information without demanding that users pay for it. Insofar as their activities are not based on donations – such as is the case, for example, with Wikipedia – they systematically sell advertising space by evaluating users' personal data and finance themselves in this way.

As appealing as this access culture may be from the standpoint of internet users, who are graduating from passive consumers to active producers, and of major service providers, it seemed in the past and continues to seem threatening from the standpoint of professional creators and traditional exploiters, e.g. publishing houses and music labels. This is because their existence was based until now on the sale of copyright-protected content. Some sectors have still not succeeded even today in shifting their analogue business model into the internet age. While scientific publishing companies adhered stubbornly to their subscription system and have meanwhile become powerful database providers, and the music and film industry can look ahead to a rosy future in licensed streaming services such as Spotify and Netflix, in particular press publishers continue to lament readers' ruinous free-of-charge mentality and at the

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- Through digitalization, the social importance of copyright law has grown considerably.
- The culture of exclusivity established by copyright law conflicts fundamentally with the culture of access prevalent on the internet.
- Already in the early days of the internet, international treaties were concluded at the instigation of the USA, the then EC and Japan to extend copyright protection on the »information highway«.
- In the dispute over the EU's latest copyright directive, the question is: Does it ring in the end of the internet as we know it? Or does it »only« see to fair remuneration for those working in the creative economy?

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same time a parasitic exploitation by services such as Google News.

A short history of digital copyright law

Copyright law can, however, scarcely be held responsible for these economic upheavals because the internet has never been a copyright-free space. Even back in the 1980s, when the first universities in West Germany were connected to the internet, digital copies were subject to permission as a matter of principle. In 1996 already, that is, at a time when the internet had not yet reached the broad masses – two international treaties were concluded by the World Intellectual Property Organization (WIPO) in Geneva at the instigation of the USA, the then EC and Japan, the purpose of which was to extend the culture of exclusivity in copyright law to what was at that time called the global »information highway«. In 1994, Stanford law professor Paul Goldstein described the goal of this regulation with the metaphor of the »celestial jukebox« (Goldstein, 1994): All content should be accessible to everyone from anywhere at any time – but only in return for payment. To let this vision become reality, the WIPO treaties of 1996 extended copyright law to every copy – however temporary – in the memory of a computer, subjected every upload to the exclusive right of making available and prohibited the circumvention of digital rights management systems. It is these legal infrastructures on which paid subscriptions are based – from Elsevier's ScienceDirect to Netflix and WELTplus. Copyright law therefore did not lag behind but instead in many areas even forged ahead of

technical and economic development (Peukert, 2014).

From this time on, problems persisted more than anything in the enforcement of applicable law. Regardless of how complete it is, there is little that statutory law can do against organized crime and decentralized, anonymous file-sharing networks, such as BitTorrent. Yet here too measures were stepped up. The operators of the piracy website kino.to, which was financed from advertising, were sentenced to several years in prison. Access providers are obliged to block internet pages whose content systematically infringes copyright. And owners of WiFi connections are liable for anonymous file sharing using their IP address, unless they name the member of their family or household actually responsible.

A special aspect: The liability of host providers such as YouTube

By contrast, highly contentious and ultimately today still unresolved is the question of the liability of platform operators for user-generated content, first and foremost YouTube, which Google already took over in 2005, its founding year. As with Facebook, its user numbers meanwhile exceed the billion mark. According to company figures, 400 hours of video material are made accessible via the platform every minute. The age group of 18 to 49 year-olds, which is particularly important for advertising, uses the service to a large and continuously growing extent for entertainment and information as well as for educational purposes (Hasebrink et al., 2017, page 106 f.).

This brings us back to the demonstration in Frankfurt on 5 March 2019, since the demonstrators were above all concerned about the future of YouTube. They were afraid that Draft Article 13 of the Copyright Directive would lead to extensive »upload filters« and thus to »censorship«. They saw a threat in the strengthening of copyright law to the open internet where »you« too can also become a public creative individual.

As pointed and overblown these concerns were, they nonetheless have a core of truth, since Article 17 of the EU Directive, which in the end indeed came into force, aims at tightening the liability of online service providers »for the sharing of online content«. To date, such intermediaries that host content have only been regarded as »interferers«. This is because they do not themselves make content accessible but instead merely make a platform available for third-party content. However, as this per se lawful service significantly increases the risk of copyright infringements, it has been officially accepted for over 20 years that unauthorized content, having



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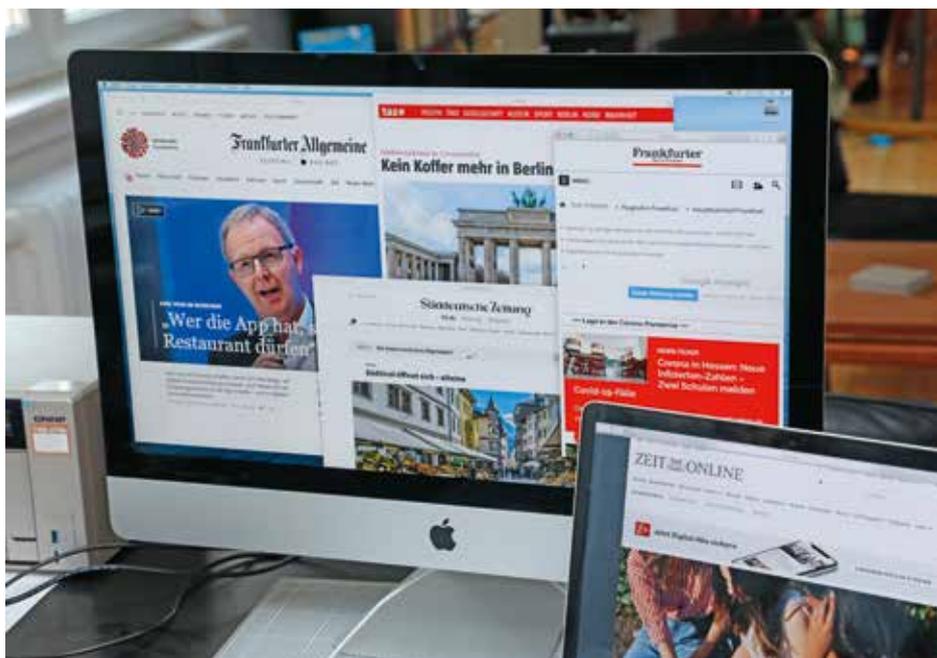
been reported accordingly, must be deleted (notice and takedown). About ten years ago, case law additionally obligated host providers to suppress content permanently once it has been deleted. Filter technologies are already used for such a staydown, which prevent content already deleted from being unlocked again.

YouTube has successfully endeavoured to make a virtue out of this liability. Namely, rights holders were given the opportunity to monetize infringing content – that is, to participate in the advertising revenue surrounding the content – instead of always just having it deleted. However, among others for GEMA, a music rights management organization headquartered in Berlin, this was not enough. On the basis of the argument that YouTube selects and presents illegal content with the intention of making a profit and should therefore not be regarded as merely enabling third-party infringements but itself as the perpetrator of such copyright infringements, it demanded damages equivalent to a licence fee, such as Spotify has to pay. The lawsuit, which has been pending for a decade, has not yet been finally adjudicated. Several cases currently lie before the European Court of Justice in which the copyright liability of various host providers, including YouTube, is to be decided.

Article 17 of the Directive on Copyright in the Digital Single Market

In parallel to this, in 2016 the European Commission published the draft for the directive on copyright in the digital single market finally adopted in 2019. However, it gave YouTube and other comparable services only very vague guidelines. The impetus for tightening up the corresponding provision in the interest of better and fairer remuneration for people in the creative economy came rather from the Member States and the European Parliament. Here, the culture of exclusivity in copyright law clashed at a neuralgic point with the net's technical and social culture of access. Established media and their representatives found themselves in head-on confrontation with the major online intermediaries and their users.

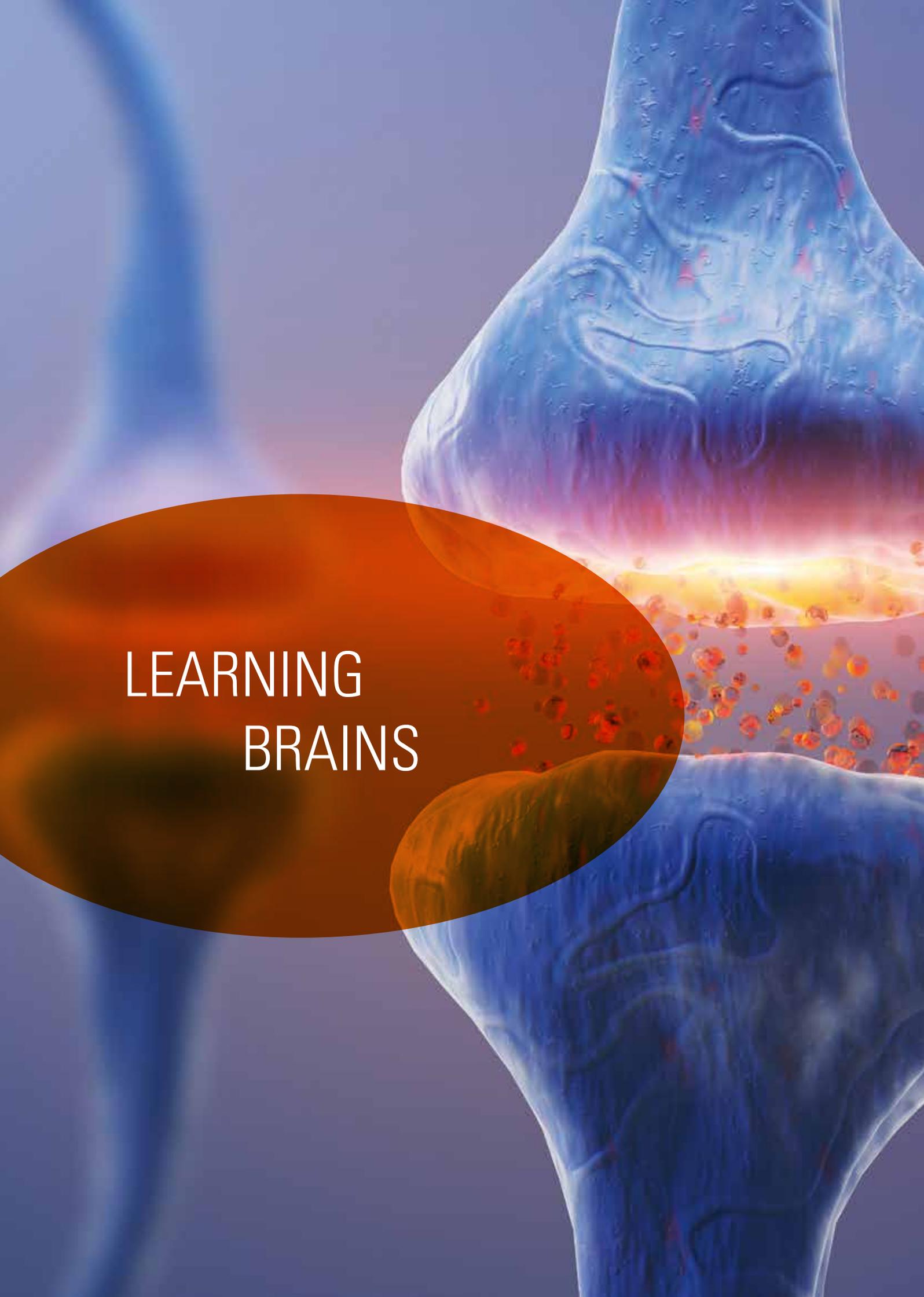
Who has left the field victorious in this confrontation has yet to be seen. The corresponding Article 17 of the EU Directive comprises no less than ten paragraphs and almost exactly as many characters as this paper. Copyright owners can credit themselves with the fact that from now on operators of sharing platforms will be liable for damages alongside the uploaders as perpetrators of copyright-infringing content. As a consequence, their legal position shifts in the direction of closed media platforms licensed through and through, such as Spotify and Netflix, which end customers can only consume with-



out adding content. In the meantime, the proponents of the access culture have been able to prevent, at least temporarily, the openness of services that share UGC (user-generated content) from becoming an incalculable liability risk even for huge multinationals such as Alphabet/YouTube. This is because if they (1) undertake »every effort« to obtain permission from the rights holder, (2) use upload filter systems to identify content already reported by rights holders and (3) immediately delete and permanently block any remaining illegal content, they escape further liability.

The deadline for implementing this highly complex provision expires in June 2021. It can be expected from the debates now commencing in political Berlin that copyright law will soon pop up again in the daily news. Whether the numerous legal issues centring around Article 17 will have been clarified by the highest court in the land by the time I retire 20 years from now is rather doubtful. Digital copyright law remains an exciting evergreen! ●

Ruinous free-of-charge mentality? Press publishers still have difficulty shifting their analogue business model into the internet age. Despite a much-used web presence, they are still dependent on income from the sale of printed newspapers.

The image features a stylized, glowing blue brain with intricate neural pathways. A central horizontal band is highlighted with a bright yellow and orange glow, from which numerous small, glowing orange and red spheres, resembling neurons or data points, are scattered. A large, semi-transparent orange circle is overlaid on the left side of the brain, containing the text 'LEARNING BRAINS' in white, bold, sans-serif capital letters.

LEARNING
BRAINS

A question of striking the right balance

How do digital media influence how we think and act?

By Yee Lee Shing, Isabelle Ehrlich and Christian Fiebach

What influence do digital technologies have on human perception, thinking and action? Do computer games harm the development of young brains? And is there really such a thing as »digital dementia«, an increasing forgetfulness caused by the use of modern technologies? For some of these questions, answers are available that are empirically corroborated.

The digital revolution has changed our life fundamentally over the past years, and this trend will continue in future. Teenagers in the USA spend an average of between six and nine hours of their free time each day with digital media. Even if these figures would so far seem to be lower for Germany, with an average of around three hours per day – according to a recent report by the Federal Centre for Health Education – 12-16 year-olds in Germany also spend a great deal of time online. 22.4 percent of the young participants in the survey rated their own use of media as problematic.

In view of these figures, the following question arises for psychology: How do digital technologies influence human perception, thinking and action? In order to answer this question, it is critical to understand how the use of digital technologies affect human cognition and the human brain – positively as well as negatively. The focus here lies especially on some recent key findings in the fields of cognitive psychology, cognitive neuroscience and developmental psychology that are concerned with the impacts of computer games and media use on cognitive performance and cognitive development. To conclude, this will be contemplated in the light of current developments in the area of artificial intelligence.

Concerns about the brain's »maladaptation«

Our brain is a miracle of nature. It is capable of learning and adapting to constantly changing demands and circumstances. Neural plasticity, that is, the ability of our nervous system to continuously change its function and structure, allows us on the one hand to develop and modify all kinds of skills through training, but also to compensate them. On the other hand, the absence of sensory experiences and even excessive one-sided training can also entail adverse changes in plasticity that lead to our abilities shrinking or even being lost altogether. It is precisely this concern that is increasingly a topic of discussion in the age of smartphones and the internet.

Research is paying special attention to the effects of excessive gaming. Since the Columbine High School massacre in Colorado, USA, 20 years ago, several studies have explored the influence of computer games on aggressive behaviour as well as on cognitive skills. The results are, however, contradictory. Meta-analyses have revealed that the effects of computer games containing violence on aggressive behaviour are generally to be regarded as minimal (Anderson et al., 2010). Gaming therefore does not seem to mould the human brain in a way that would generally drive us to violent acts. It is more the

Our brain, a miracle of nature: It is capable of adapting to constantly changing circumstances. Synapses that connect the neurons play an important role here.



Computer games have a great power of attraction for adolescents. Other possibilities for leisure activities are often neglected as a result.

IN A NUTSHELL

- The human brain adapts constantly to changing demands from its environment. Missing or one-sided stimuli can trigger disadvantageous changes to its plasticity. This concern is increasingly a topic of discussion in the age of smartphones and the internet.
- What cannot be proven is a strong correlation between computer games and a disposition towards aggressive behaviour. Nonetheless, computer games leave behind traces in the brain; the effects depend on a large number of factors.
- Studies show that moderate screen time among children and adolescents does not have a negative impact. Important, however, are their living conditions: Children from difficult backgrounds tend to experience social disadvantage online too. This is referred to as social media spillover.
- People who use their smartphones frequently often display a poorer cognitive performance. The relationship between cause and effect is still unclear.
- As far as artificial intelligence is concerned, psychology is still in its infancy. To meet this challenge, enhanced collaboration between computer science, technology providers and psychology is needed.

case that there are indications of complex interdependencies that are so far not fully understood.

More attention, but also greater potential for addiction

There is no mistaking that gaming has an impact on our brain. For example, a widely acclaimed study showed that playing »Super Mario 64« on a regular basis leads to an increase in the volume of brain regions associated with spatial coordination (Kühn et al., 2014). Moreover, similar structural changes could be observed in areas involved in processing rewards. This result is in line with a number of studies which corroborate that playing action games on a regular basis can bring small but noticeable improvements in attention performance (Bavelier & Green, 2019). At the same time, the morphological changes in the reward system resemble changes that can also be observed in substance addiction. Computer games are designed in such a way that they facilitate frequent and slightly rewarding experiences. Via this mechanism, frequent gaming could lead to dependency – the vastly increasing numbers of internet

and gaming addicts substantiate this correlation and are worth monitoring.

Harm or benefit – a question of many factors

Yet even if gaming does not become pathological, the tremendous appeal that emanates from these games may have negative consequences: If a large part of children's free time is spent playing computer games, their reading and writing skills may suffer and conflicts at school might increase, as has been shown (Weis, Gerankosky, 2010). At the same time, education and health care are increasingly capitalizing on the motivational potential of computer games. Consider serious gaming, which is the use of specially developed PC games to improve, for example, motor skills, multitasking or health (Gentry et al., 2019). However, this type of intervention is still in its infancy and its actual value has yet to be empirically tested. Overall, it can be stated that gaming leaves traces in our brain's plasticity. Whether these are harmful or beneficial, like any form of experience, seems to be a question of striking the right balance and of the interaction of personal and external factors.

The complex connection between media use and child development

The often cited »displacement hypothesis« assumes a correlation between media use and development, and postulates that the harms caused by technology are directly proportional to the extent of this use. However, this hypothesis has not been well supported by empirical evidence. For example, a large-scale survey with 120,000 adolescents revealed that the relationship between screen time or time spent online and mental well-being is best illustrated by a

quadratic function (Przybylski & Weinstein, 2017). According to this, positive effects can be expected in the case of media use lasting one to three hours per day. After that, a »turning point« is reached, beyond which greater media use is associated with negative effects on mental health. However, the actual effects also depend, for example, on the type of activity and the weekday. For example, video games have a later turning point than smartphones, and the turning point occurs later on weekends than on weekdays. These results support what is known as the »digital Goldilocks« hypothesis, which postulates that moderate screen time as such is not harmful (Przybylski & Weinstein, 2017), since it can also have positive effects, for example, by integrating the user in social media. It is also worth noting that the negative correlation between screen time and well-being is weak (Orben & Przybylski, 2019) and can be overshadowed by other influencing factors.

Something that is important to point out in these studies is the fact that people have different online experiences – which in turn also often reflect differences in their living conditions (e.g. relating to socio-economic background). Studies by American psychologist Candice Odgers show that adolescents who have to deal with more adversities in real life are more likely to experience negative effects from the use of smartphones and other digital devices – an observation she calls »social media spillover«. For example, adolescents who have already been victims in real life are more likely to be exposed to online bullying. Teenagers from poorer households receive less parental supervision when using the internet. In this way, a kind of digital divide emerges, such that online experiences increase the risks for precisely those young people who are already more vulnerable in analogue life.

Digital technologies and their influence on cognitive performance

The use of tools to improve our quality of life is one of humankind's main cultural achievements. Digital technology is such a tool and one that has grown far beyond the power of our imagination. It penetrates our professional and private life so deeply that the boundaries between the digital and the analogue are becoming increasingly blurred. There is growing concern that our digitally expanded environment is overloaded with information to an extent where the disadvantages resulting from it for human perception far exceed the advantages of digital media. This is in line with the fact that doing several things at once (»multitasking«) is cognitively very challenging, regardless of whether it is a matter of digital technologies or not. But is it pos-

sible to corroborate empirically the notion that digital technology has negative effects on perception in the long term?

A pioneering study in this area (Ophir, Nass, Wagner, 2009) showed that people who frequently use several media in parallel (heavy media multitaskers) are more easily distracted by unimportant input from their surroundings than light media multitaskers. Although findings of follow-up studies are heterogenous, an emerging pattern indicates that persons with »heavy media multitasking« display poorer cognitive performance. However, an important unanswered question in this context is that of causality: Does media multitasking really cause the poorer cognitive performance observed, or do individuals with behavioural tendencies that already exist, such as impulsiveness, exhibit more problematic behaviour regarding media use? Understanding these causal connections will thus be a deciding factor in the development of appropriate interventions, for example, in order to decide whether media use should be reduced or an increased awareness of the risk established as a preventive measure.

Google as »outsourced memory«

The possibility to use computers and smartphones as external memory aids also has a major impact on how our brain stores information. The example of the »Google effect« illustrates this point aptly: Information is more quickly forgotten when we are sure it can be accessed at any time on the internet. A similar finding is the »photo-taking-impairment-effect«, according to which taking a photograph of an event in comparison to its passive observation reduces our recollection of it.

Computer games have a considerable power of attraction for adolescents. Other possibilities for recreational activities are often neglected as a result.



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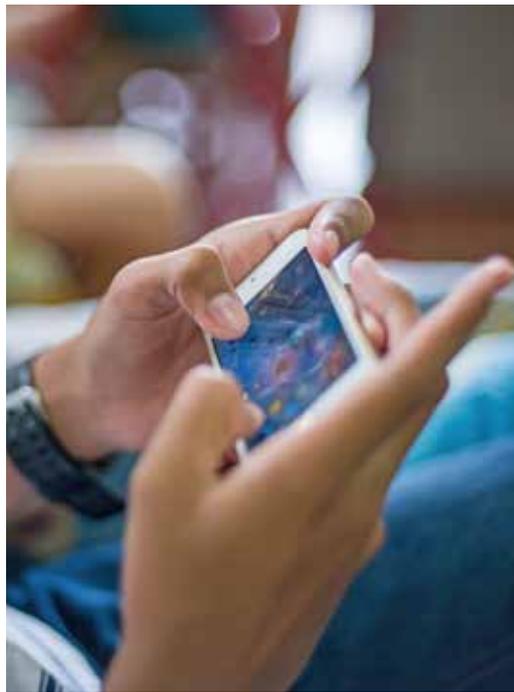
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»Heavy media multitaskers« like to use several media in parallel. But what effects does this have on their cognitive performance?

On the other hand, positive outcomes from computer use are reported in literature too: If the computer is used as a strategic aid, this can release resources for other cognitive tasks and improve memory performance, as has been shown in earlier studies in conjunction with non-digital memory aids. Thus, the effects of digital technologies on human cognitive performance likely reflect basic principles of the human brain in interaction with its surroundings. To understand the effects of digital technologies on how we think and act, it is essential that we examine closely the basic cognitive processes of the human brain.

Artificial intelligence as opportunity and challenge

The recent development of what is known as artificial intelligence (AI) represents a particular challenge. Many processes in human decision-making – from everyday consumer decisions to investment decisions in the financial sector and medical diagnostics – are supported more and more by machine learning and predictive algorithms. Consequently, the risks of modern AI applications are coming increasingly to the forefront of social discussion. However, in view of the cognitive and neuroscientific evidence discussed to date, we do not automatically expect negative effects at the interface between human cognition and machine »intelligence«; here too, type and scale of use, mediated via the mechanisms of perception, cognition and neural plasticity, will

have a differentiated impact on human thinking, acting and decision-making.

However, from a psychological perspective individual expertise in the handling of AI algorithms seems to be of critical importance. Popular examples over the last years show that even developers do not understand all the aspects of decision-making in AI systems. Understanding this »black box« and the possible intentions of its developers will be a major challenge. Will it be possible, for example, to protect adolescents from the marketing interests of commercial enterprises by means of »child-friendly« algorithms? How must educational curricula be adapted in order to allow future generations an understanding of the basic principles of AI algorithms, which they will need both in their careers as well as their private lives? Will it be possible to maintain the ability and willingness to engage intensively and critically with texts and other sources of information in the face of increasingly powerful and easy-to-use search algorithms? To meet these challenges, strengthening collaboration between computer science, technology companies and psychology is essential. In view of the particular need to protect children and adolescents, we consider that knowledge from developmental and educational psychology are especially required here, in addition to cognitive psychology.

If these objectives could be achieved, important applications developed from a psychological perspective could contribute to improving mental well-being. For example, screening algorithms are a possibility here, which on the basis of behaviour, facial expressions or voice can support the early detection of mental problems, as well as internet-based psychotherapeutic prevention and intervention measures (keyword: E-mental health). Socially disadvantaged groups could especially profit from this. Finally, it is also important when designing such digital applications to introduce sound psychological knowledge regarding, for example, vulnerability vs. protective factors in relation to children and adolescents. ●



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A »flight recorder« for better learning

»Learning analytics«: Making digital data usable
for greater educational success

By Anja Störiko





So far, personal feedback in the case of lectures with hundreds of students still seems utopic – even after the digitalization boom in times of the coronavirus. Tools from the research field of »learning analytics« could in future give students feedback and at the same time provide their supervisors with clues about where help is still needed.

For large courses such as the »Introduction to Computer Science« with 600 students, Professor Hendrik Drachsler from the »Educational Technologies« research unit sees digital room for improvement: »With one professor and eight tutors, the supervision ratio doesn't allow any personal feedback to students – we can improve this situation by means of technology.«

For digital feedback on the learning process, his »Learning Analytics« (LA) research team uses the process data which students leave behind each time they access a computer system. These log files are like footprints in the background which contain important and evaluable information. These also include – alongside activity, date and time – details of contents, which can be analysed by means of suitable software. A comparable example for such data analysis is the flight recorder which, when analysed after an accident, allows conclusions to be drawn about what happened in the cockpit.

Direct mapping of learning behaviour

»To date, questionnaires, interviews or specific tests to measure knowledge acquisition have been used to describe and understand learning processes – or subjective observers are deployed who log the learning situation of small groups and their actions,« says Drachsler. »Today, we can use process data from learning activities and exercises directly to evaluate the learning process and offer help.« This, in his view, allows more direct, more extensive and thus more conclusive analyses of learning behaviour. With the help of artificial intelligence, it is possible to identify and use behavioural patterns in order, for example, to test learning theories in terms of their practical feasibility.

If students are logged onto a platform and using it interactively, LA tools can evaluate their activity and provide corresponding feedback. »moodle«, for example, is a platform often used

in teaching. With each action – downloads, posts, questions or messages – school pupils or students leave behind their log data and with them evaluable information. »We're allowed to use these data, provided they are anonymous,« says Drachsler, explaining the background regarding data privacy. However, it often makes sense to ask for consent in order to facilitate a personal analysis as well and in this way be able to offer personalized assistance.

A survey conducted at Goethe University revealed that most students welcome appropriate feedback. It is precisely this personal feedback, which is often impossible due to high numbers of students, that many of them miss. »According to Germany's National Report on Education, 28 percent of students discontinue their bachelor's degree, among others because they feel inadequately supervised. With the aid of technology, we could help to offer prompt and personalized feedback here, with detailed individual solutions for each user,« explains Drachsler.

Only customized tools generate reliable statements

Data analysis which is as conclusive as possible necessitates complex, content-related, quantitative and qualitative evaluation. This means that each LA tool must be adapted to the context and cannot be »off the peg«. Drachsler's working group is planning a first research project in this direction: In the coming years, the DIFA lecture (Digital Formative Assessment) is to be supported by an LA system which,

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- Until now, lecturers have handed out material in tutorials, discussed it with the students and held a written exam at the end. They mostly remain unaware of what happens in between.
- From the data provided by the digital media increasingly in use, we can now deduce how the material is picked up and used for specific tasks. Via a tool, teaching staff can see how the group is working together, who replies to whom and which participants are less involved. Students then receive corresponding feedback.
- Especially for large-scale teaching formats with a large number of participants, learning analytics offers a completely new opportunity for individual feedback.

on the basis of process data, allows conclusions to be drawn about different prerequisites for learning, such as commitment, self-control and the ability to understand complex documents. Ideally, students (but lecturers too) will then be given an overview of the extent to which they have developed skills in these areas and who still needs help, why and where.

Learning activities play an important role in this context, that is, who is proactive and how often, for example, who uploads documents or posts messages in the forum. Keywords can help to identify and evaluate content as well. Language-processing systems already exist in English, for example for analysing essays, explains computer scientist Drachsler. They can, he says, even recognize and rate word usage and semantics (meaning).

The working group wants to make such applications publicly available as Open Source and Open Educational Resource. However, much of what is today found in the digital marketplace is already firmly in the hands of major US corporations such as Google, Apple, Amazon and Microsoft, which dominate the whole sector – such as in »the area of language recognition tools. »In this way, a lot of data from education migrates to private companies,« warns Drachsler and calls for controlled, EU-owned servers and the necessary funds for setting up independent European systems and platforms.

Learning of the future as feedback culture

Learning in ten or twenty years will require a change in thinking, of that Drachsler is

convinced: »We must progress from an assessment culture, that is, thinking only of high performance, to a feedback culture.« This would make it possible to intervene much earlier and avoid frustration and directionless cramming. In his view, universities are predestined to take the lead here. In schools, by contrast, LA applications are problematic due to the sensitive nature of minors' data; but the different structures in the federalist education system in Germany also impede the use of such methods.

The Agora model school in the Netherlands provides a glimpse into the future. There, the students work in a very free manner on »challenges« with all manner of materials, often digital, as well as with role play and the internet. Learning progress is mapped individually in the process. »Learning analytics helps here in the acquisition of skills by each individual child,« explains Drachsler. At the same time, he warns: »Inequality of opportunity in the educational system must not be allowed to worsen as a result of different access to digital media.«

Drachsler reports that the new methods make teaching more attractive as well as motivating and fascinating the school students. Raising efficiency is also possible: For example, teachers today spend up to half their time on correcting tests – digital technology can accelerate this. »But it's no use simply making the biology textbook available as a PDF on a tablet – we need new didactic concepts in order to deploy new media expediently in teaching and, for example, facilitate new scenarios for joint learning.«



About Hendrik Drachsler

Hendrik Drachsler is both professor at Goethe University and Head of the Educational Technologies and Learning Analytics Unit at the Leibniz Institute for Research and Information in Education (DIPF). He is an elected member of the executive committee of the Society of Learning Analytics Research (SoLAR) and of the European Association of Technology-Enhanced Learning (EATEL). Drachsler has been scientific coordinator of various national and EU projects, regularly heads international scientific conferences and is co-editor of the IEEE Transactions on Learning Technologies (TLT) and of the Journal of Computer Assisted Learning (JCAL). He has written a number of often cited articles on technology-enhanced learning.

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Practising presenting with the help of AI

Here, the next generation of learning technology is already in the starting blocks. Current research work by Drachsler's group shows that by using various data sources and systems, such as sensors, cameras and microphones, completely new types of learning systems can evolve. For example, the research group has developed a first presentation trainer based on an Xbox camera: It shows whether the presenter fiddles with his or her hands too much, is not active enough, needs to speak louder or more softly and a lot more besides. »Presenting is one of the skills of the 21st century, one of the most important abilities of our times that must be practised,« stresses Drachsler. With LA tools such as the presentation trainer, these skills can be practised individually and without stress or time pressure before facing a larger audience.

New learning systems are finding their way into the natural sciences, medicine and sport as well. As examples, Drachsler names training systems for cardiac massage and a salsa trainer that allows the user to practise the basic steps and the rhythm – with suitable feedback. Virtual representations (augmented reality) make

learning easier. For example, a chemistry application brings the »dry« periodic table of the elements to life: It makes it possible to build molecules so that, for example, »visible« water is created from water and oxygen. Such effects support learning, since perception via several senses makes learning experiences more sustainable.

Over the last three years, collaboration between the Leibniz Institute for Research and Information in Education (DIPF) and Goethe University has been enhanced by the DELTA project (Towards Digital Education with modern Learning Technologies and Assessment approaches). It aims to provide a stimulus for establishing a nationwide and international centre of advanced educational technology in Frankfurt. To this purpose, students and teaching staff were asked about the success factors for digitalization, and from these the most important and achievable elements were deduced. For example, students expect more flexible and individualized studies as well as more support for independent learning – exactly what Drachsler targets in his research projects. The working group wants to draw recommenda-

Transparent students? Much of what is found in the digital marketplace is already firmly in the hands of major US corporations.

tions for the DELTA project before the end of the year.

Ray of hope in mass intramural operations?

In keeping with this, Goethe University has set up a Digitalization Task Force, to which Drachsler also belongs. The university had already recognized before the Covid-19 pandemic that the increasing numbers of students, the strained supervision ratio and growing heterogeneity necessitate the use of digital structures. For example, the university's executive board announced in one of its publications last year: »Lecture theatres and individual offices will in future – at least partially – become collaboration spaces and experience centres.« It is therefore necessary, according to Drachsler, to support digital courses as well as examination and learning systems.

So that sufficient attention is also paid to data security, Drachsler's working group has coined the term »Trusted Learning Analytics«. »Trusted – that is, secure and reliable – means that we consistently bear in mind data privacy and ethical practices,« says Drachsler. Together with TU Darmstadt, the working group has compiled a code of conduct for universities. »It's very important for us that we don't play big brother here but instead support students.« Against the backdrop of more and more degree programmes and a rising percentage of students



The author

Anja Störiko, 55, earned her doctoral degree in microbiology and has been working as a freelance journalist, authoress and editor for the »BIOspektrum« journal for many years. In an interview with Henning Drachsler, she recalls how, as a school student, she laboriously »hammered« Latin vocabulary into her head with the typewriter. She hopes that future generations of school students will be able to immerse themselves virtually and more easily in the world of the Romans or other fields of knowledge.

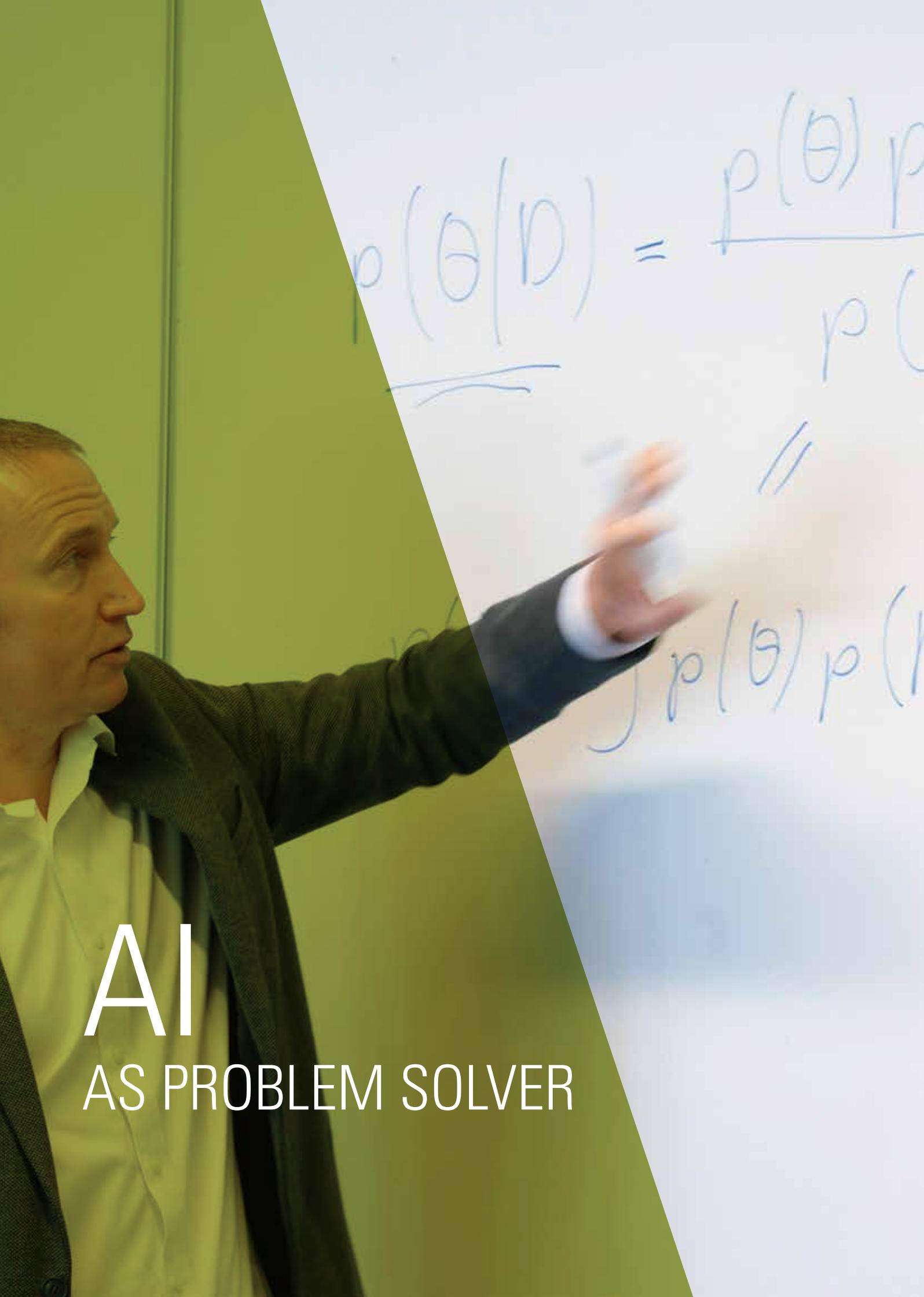
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who discontinue their studies, Drachsler feels that putting various LA tools into practice step by step and flanked by research makes sense and is necessary.

Examples from the Netherlands and the USA

A system already used at the University of Delft is the Learner Tracker. It supports self-regulated learning by visualizing students' time management and comparing it with previous cohorts. The Group Activity Widget (which is also Dutch) supports study groups by imaging initiative, productivity, presence, connectivity and reaction. »As we know, commitment is often unevenly distributed in group work – this can be demonstrably prevented with such systems; work is distributed more evenly and there are less conflicts,« says Drachsler, describing the system. The Student Explorer in use at the University of Michigan, USA, also identifies students with additional learning requirements in order to introduce support measures at an early stage.

Drachsler sees the possibilities and limits of digital media in his own three children: »Technology is, of course, enticing. That's why we limit screen time at home, for example.« And naturally parents need to talk about the risks – social media, stalking, bullying – and present alternatives in the shape of music, sports, reading, other recreational activities. »But it fascinates me how quickly children learn English today thanks to modern media or platforms for learning vocabulary or have fun acquiring skills at a high standard, for example, video production or the coordination of joint projects online.« These digital natives are conquering multimedia learning by themselves. LA research will fall on fertile ground here. ●



AI

AS PROBLEM SOLVER

A close-up photograph of medical equipment, likely an EEG or similar diagnostic device. The image shows a white cylindrical component at the top with several black cables connected to it. To the right, there are several vertical cables in various colors (red, green, blue, black) with different connectors. The background is a plain, light-colored wall. The overall scene is clinical and technical.

Epilepsy research: will the digital doctor soon be assisting?

Neurologists want to use large datasets
for early detection

By Anne Hardy

The healthcare industry sees great potential in consolidating medical data on one and the same person which is currently distributed across various practices and hospitals. This would not only save costs on repeating procedures; physicians also hope that artificial intelligence will help them identify new connections and thereby treat diseases earlier, or even prevent them.

It is somewhat reminiscent of »Brave New World«: in front of a wall full of monitors in the monitoring room of Ward 95-5 of the Epilepsy Centre at the Frankfurt University Hospital sit two medical-technical assistants and from here observe the patients in the hospital rooms. They simultaneously monitor their brain activities on the EEG (electroencephalogram). As soon as an epileptic attack occurs, Professor Felix Rosenow's team can find out what type of epilepsy it is, localize the seizure onset in the brain, and treat it with either medicine or an operation.

The people admitted to this ward usually have a waiting period of three months behind them. In Hessen, there are only two specialized epilepsy centres. At 13th place, the number of neurological practices in proportion to the population is ranked quite low in national comparison. It often takes years for epilepsy patients to get the right diagnosis. »The attacks could be controlled much more quickly for two thirds of the patients if they got the right therapy early on,« says Rosenow with regret.

Obstacles to telemedicine

In 2015, the Epilepsy Centre Rhine-Main was established in the Department of Neurology. Sections of EEG recordings from all over Hessen arrive here along with the question: does this patient suffer from epilepsy? Frequently, this cannot be answered on the basis of the data sent. Rosenow illustrates the complexity of an EEG by clicking on various curves recorded parallel to each other on a monitor. They represent the recordings of the electrical brain activity through 21 electrodes attached to the scalp according to a specific special configuration.

If the expert has the complete dataset, he can compare the recordings from individual electrodes over various brain regions with one another, create an image from the average of all electrodes, or filter out certain activities. »For an epilepsy diagnosis we require an average of eight to twelve montages,« Rosenow explains, while looking for noticeable high amplitude sharply contoured »spikes« in the ongoing brain activity.

Currently, there are difficulties in transmitting a complete EEG electronically. Although the data has not been recorded by pen for over 25 years, to this day there are no universally accepted international standards for electronic data storage and transmission of electrophysiological data. »Since the manufacturers do not make the source codes for their software public, I can't convert the data from a colleague who uses a different machine,« says Rosenow. This significantly complicates the exchange of data per telemedicine.

Negotiations on EEG standards

The International Federation for Clinical Neurophysiology is working on uniform EEG standards together with the DICOM, an international organisation for saving data in medicine. They have already created standards for numerous image-creating procedures such as X-ray, MRI and computer tomography. EEG standards from the DICOM organisation should now be published this year. »These are large files that state which channels, data sources and types of electrodes are used, and how the data should be stored,« explains Rosenow, who is a member of the respective DICOM working group #32.

This represents significant progress for the telemedicine project on epilepsy, which Rosenow began in 2017 using state funds. Currently, hospitals in Eschwege, Kassel and Bad Homburg, as well as the children's hospitals in Limburg are connected. At the end of the pilot phase, ten Hessian hospitals and ten practices should have the capability to send EEGs to the Epilepsy Centre and, as in a medical council, ask the experts questions. This is particularly important for the children's hospitals, since many forms of epilepsy appear during childhood and very few hospitals still have neuro-paediatricians with expertise in EEG evaluation.

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Enhancing valuable data for the neurosciences

It is also important to standardise data so that the currently existing large data volumes can be used more intensively. The Federal Ministry of Education and Research, and the German Research Foundation want to enhance this potential in the context of the National Research Data Infrastructure (NFDI). »When we talk about data as the raw material of the future,

then the NFDI is a refinery in which data is processed and made available – and thus usable – to everyone,« says Federal Research Minister Anja Karliczek.

The German Society for Clinical Neurophysiology and Functional Imaging (DGKN), of which Rosenow is Vice President, has applied for a consortium in the NFDI. »Our goal is to consolidate the datasets that are stored throughout Germany in doctor's offices and hospitals and make them usable,« Rosenow explains. The server on the epilepsy ward currently has storage space for approximately 100 terabytes. This is equal to the capacity of about 100 external hard drives.

Rosenow enumerates the advantages for epilepsy research that come from the analysis of large, anonymized data volumes: »At this time we are studying how certain forms of epilepsy are distinguishable through the basic rhythm of the brain waves. We can determine whether the signals have a looser or tighter connection in various brain regions. In this way we can locate epilepsy sources,« Rosenow explains.

Recognising new connections with artificial intelligence

Far beyond brain research, the initiative Medical Informatics in Research and Medicine – MIRACUM for short – seeks to consolidate all the medical data on patients that has been collected by different doctors and hospitals. For this comprehensive task, which is being funded by the Federal Ministry for Education and Research with 3.8 million euros, five consortia joined forces in 2017. Goethe University and its hospital are among them. A file of patients is planned, through which any doctor providing treatment can access all of the medical data that was ever collected on this person. »Today, the best case is if this data has been gathered by the family doctor, although he or she is not a specialist in its analysis,« comments the neurologist.

»If for example someone came to the hospital with memory loss, we could use the available datasets to find out which constellation of findings lead us to the possible diagnoses of alcoholism, depression, vascular dementia or Alzheimer's,« Rosenow says. With the aid of artificial intelligence (AI) he hopes to see new connections and be able to make diagnoses at an earlier stage of the disease, when treatment may be more successful.

On the basis of test results and images of the vascular system, for example, an algorithm could predict the risk for cardiovascular diseases. »Patient X has narrowed brain arteries and elevated blood fat values. The risk of a heart attack in the next three years is 80 percent. If he takes blood fat-reducing medicine it might take

IN A NUTSHELL

- Currently, DICOM standards for recording and storing EEG data for epilepsy are being developed. The goal is an optimisation of telemedical communication.
- Doctors hope that the consolidation of health data and their analysis by learning AI systems will enable early diagnoses and individualised treatments.
- In tests with animals, AI systems can identify developing epilepsy in the EEG, even before the first seizure takes place.



half a year longer. And if he gives up smoking, he'll have a couple more healthy years.« The doctor hopes that individual therapeutic recommendations can also be derived this way. Perhaps one patient will benefit from cholesterol-reducing medicines, while others would do better to focus on their high blood pressure.

Early diagnosis, specific therapies

In the future, AI systems should also help to diagnose neurological diseases earlier. Patients with muscle tremors and movement disorders may suffer from either Parkinson's or multisystem atrophy, a progressive neurodegenerative disease whose symptoms are initially indistinguishable from Parkinson's. Neither the clinician nor the neuroradiologist can distinguish between these two diseases in their early stages. But perhaps it will be possible in the future to send image data sets to an AI platform that can discover hidden patterns. In this way, the patient could receive disease-specific therapy earlier.

The West German Teleradiology Network has proactively founded an AI platform on which various operators have made their algorithms available. The application possibilities go far beyond neurology. Even now, intelligent systems are finding application in forensic medicine for determining the age of underage criminals without IDs. The system is able to determine the age of the bones in an X-ray.

Artificial intelligence predicts epileptic attacks

It is the dream of every doctor to treat diseases before they exhibit severe symptoms or to prevent their occurrence altogether. »With epilepsy, the

risk factors are often already present during childhood,« Rosenow explains. The risk increases if a febrile seizure lasts longer than 15 minutes, or if only one body half is involved. But many years may pass before the first spontaneous seizure occurs. »If we could predict epileptic attacks with a high degree of certainty, we could ideally prevent them with the right treatment,« says the neurologist.

Together with the physicist Professor Jochen Triesch from the Frankfurt Institute for Advanced Studies (FIAS), Rosenow recently demonstrated that this works in principle. In an animal model, the researchers stimulated certain areas of the hippocampus. Following this procedure, the animals developed temporal lobe epilepsy within about 21 days. In Rosenow's working group, EEGs of the test animals were recorded before and after stimulation.

An epileptologist studying these two datasets would hardly notice a difference. The physicists in Jochen Triesch's team then programmed a computer to recognise characteristic patterns or connections in the datasets with the help of deep learning algorithms – completely independent of any human input. The algorithm was then trained with the data of six rats. With a seventh rat, it was able to determine with 97 percent certainty if the animal was healthy or about to develop epilepsy.

Pairing specialised intelligence and common sense

»What's exciting about this approach is that we can then ask the system which characteristics it noticed. This could bring something new to the

In the monitoring room of the video EEG monitoring ward, MTA-Fs and doctors have all 8 patients constantly in view and can be on the spot immediately. The large amount of EEG and video data that is recorded here make it possible to localize the seizure's origin in the brain and can later be analysed by artificial intelligence.



Image-creating methods such as magnetic resonance imaging (MRI) provide important data which, thanks to artificial intelligence, can be processed in order to make an early diagnosis of specific diseases possible.

surface,« says Triesch. There have been no surprises with regard to epilepsy so far, but in a joint project with Professor Elke Hattingen in neuroradiology, this kind of system recognised a relevant structure for a brain tumour that radiologists had not previously observed. These kinds of discoveries stimulate research.

And if the AI system makes a mistake? Can Triesch check the information given by his deep learning algorithm? »In a way, the AI system resembles a human expert who makes decisions based on experience. When it comes to deep learning systems, we know in principle how they work. But even though we are currently putting intensive effort into understanding their decisions, it will probably not be possible to do so

a way that is completely satisfying,« the physicist admits.

The risk of errors in decisions and diagnoses can be minimised, however, if the system is used correctly. He recently showed a shoe to an app for identifying mushrooms, and it gave him the name of a mushroom. »This happens because these system have a very limited type of intelligence and no common sense. For this reason, a human expert will always have to be involved for the foreseeable future,« says Triesch.

Using mobile phones to diagnose epilepsy

Triesch and Rosenow cannot yet say when the epilepsy risk for humans can be also read from EEG data before the first seizure. »We want to examine more clinical data with artificial intelligence in order to collect additional characteristics that make the prediction more certain. To turn this dream into reality, we will then have to prove the connection in clinical studies. That will take at least another 10 years,« Rosenow estimates. It also has to be kept in mind that there is currently no treatment that can be used to prevent epilepsy. This means that high-risk patients will need to carefully consider whether they want to have this information in advance.

The doctors at the epilepsy centre are currently still struggling to prevent unnecessary suffering through early diagnosis and appropriate treatment. The telemedicine project should make a significant contribution toward this goal. But family members can help by filming the seizure with their mobile phones. »A doctor seldom sees a patient during a seizure. A video would be very helpful,« says Rosenow. It may possibly also spare afflicted individuals a longer stay at the at the video EEG monitoring unit at his ward. ●



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A new type of writer

The first book by AI author »B. Writer«

By Jan Schwenkenbecher

Together with his team, Frankfurt computer linguist Christian Chiarcos has developed a software. This software has written the first machine-generated science book.

At first glance, the book »Lithium-Ion Batteries« seems to be a completely normal book: It was penned by »Writer, B.« and appeared in the spring of 2019. It was published by scientific publishers Springer Nature. It has a title, a subtitle, four chapters and a large number of subchapters. There is a preface, a bibliography and the fact that the headings sound a little awkward does not necessarily confuse the reader – after all, it's a textbook. Springer Nature found the book's publication worthy of a press release nonetheless, and this has less to do with the content than with »Writer, B.«, the author.

The »B« stands for Beta and Beta Writer is not the name of a battery researcher given that name at birth by slightly eccentric parents. Beta Writer is not a chemist nor a researcher, Beta Writer is not even a human being. The explanation can be found on page 4 of the book: »This book was machine-generated.« The book »Lithium-Ion Batteries« is the first book composed by artificial intelligence that Springer Nature has published. Beta Writer is the software that wrote it. And in this sense Beta Writer also has parents: A research team led by Christian Chiarcos, professor for applied computer linguistics and head of the Applied Computer Linguistics (ACoLi) working group at Goethe University,

and Niko Schenk, a doctoral researcher in his group. Chiarcos will say later of Beta Writer: »Beta Writer is the name of an algorithm that we've developed here on the basis of our own already existing work and that of the community in order to generate books. The plan was to use it to produce the first machine-generated science book. And we've done just that.«

Selecting sources

Chiarcos is also the right person to ask exactly how Beta Writer wrote the book. He can be found at the Institute of Computer Science in the Frankfurt suburb of Bockenheim – woolly jumper, jeans, spectacles, brown hair that blends into one with a full brown beard – first of all he gets himself a big cup of coffee from the machine then sits down on one of the four low armchairs. There is a shelf full of books along one wall, along another two whiteboards on which countless formulae are scribbled, a pile of documents on the desk. Chiarcos picks up a pen and draws diagrams in the air when explaining the four steps he and his colleagues took along the route to their AI book.

»The first step is pre-processing, where you start by building up a collection of possible sources,« he says, explaining the basis on which the programme composed the book's content. This can be PDFs or Word or XML documents. »We then filtered these sources according to specific keywords given to us by experts in the field in question,« says Chiarcos. »In this way we chose the scientific publications most suitable

Machines have what it takes to be book authors and can create a literature overview in science books.



Lithium-ion batteries are the subject of »B. Writer's« book.

ble for the book.« The researchers extracted the text from these documents, which was not so easy as there were all sorts of chemical formulae between the words and the punctuation marks. However, they mastered this challenge and at the end were left with a collection of 1,086 publications, all written in English and from Springer Nature's library.

»B. Writer« is the author

In the second step, the researchers used different methods to create a structure for the new book from this collection of texts: Structure generation. Computer linguist Chiarcos explains:

About Christian Chiarcos

Christian Chiarcos, born in 1977, computer scientist and linguist, earned his doctoral degree in 2010 at the University of Potsdam with a thesis on computer linguistics. In 2012, he organized the first workshop on »Linked Data in Linguistics« in Frankfurt. He was then a visiting researcher at the Information Sciences Institute of the University of Southern California in the USA. In 2013, he was appointed as Junior Professor for Applied Computer Linguistics at the Faculty of Computer Science and Mathematics of Goethe University. In parallel to his junior professorship, since 2015 he has headed the »Linked Open Dictionaries« Early Career Research Group, which is funded by the Federal Ministry of Education and Research.

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»For all the documents, we identified their relative similarity to each other.« Whereby similarity referred to how each respective text resembled itself. »The most similar ones are clustered together until you have a tree structure.« Things with little similarity drop out, the user can specify how many chapters, sections and subsections he wants in the end and also how much text is available for Beta Writer in each subsection in order to put together the respective publication.

»The actual text generation, the third step, then comprises identifying the most important statements within a text,« explains Chiarcos. To do this, he tested various approaches with his colleagues: A classic, graph-based technique, a modern neural model – at the end they used the different methods in parallel. They tested various quantifiers in a number of runs and looked at which result the experts in the subject preferred. These authorities were chemistry and battery experts at Springer Nature. Several times over, Chiarcos and his colleagues presented different variants of interim results of what Beta Writer had so far put together to the experts. The experts rated content and style – whereby they, as can easily be seen when reading the book – placed more weight on technical accuracy than on elegant language.

Sentences are reworded

On the basis of this feedback, Chiarcos and his team then also weighted their methods quite differently depending on where they were applied in the book: The introductory texts of each chapter, which Beta Writer compiled from all the publications contained in it, have a specific weighting. The subsections, in which a single publication is summarized respectively, have a different one. The researchers weighted their methods differently once again for the chapters »Summary« and »Applied Research«.

The text is compiled as follows: »We take a complete sentence,« says Christian Chiarcos, »we perhaps eliminate parts of it, we substitute other parts, we rearrange it on the basis of syntactic analysis.« If the resulting sentence is sufficiently different from the original one, it is not marked as a citation. The authors of the original sentences do not need to worry about plagiarism anyway. Even if the new sentence is not cited verbatim in the book, the corresponding footnote with the source is always indicated after it.

Critical comments too

Finally, the last step for Chiarcos and his team was post-processing. They collated all the references in the bibliography, inserted the chemical formulae again, which had previously been sub-



stituted with wildcards in order to work on the text, converted the document into a format readable for the scientific publishers, Springer Nature, and presented it to them.

And those responsible there seem to be giving Beta Writer's debut novel the best reviews. Alongside Christian Chiarcos and his colleague Niko Schenk, Henning Schoenenberger, Director Product Data & Metadata Management at Springer Nature, wrote part of the book's introduction and was not sparing with praise and pathos: »This book on lithium-ion batteries has the potential to ring in a new era of scientific publishing,« says Schoenenberger. The future will show whether that will actually happen. Now, after about a year, the book has been cited 14 times and downloaded 357,000 times. But it is free of charge.

The download figures should not, however, belie the fact that the project was also criticized. »The feedback we received was indeed mostly positive,« says Chiarcos. But there were also some very critical comments regarding the question of social and political responsibility. »People stressed the responsibility of science and asked whether the system didn't produce a distorted picture of a subject area, a bias. «

A finer language, more attractive headlines

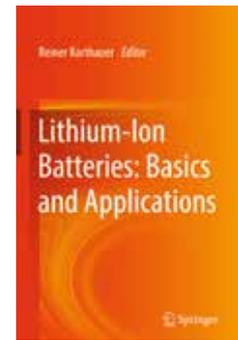
Indeed, the publications included are selected on the basis of their similarity to each other. Now if these original data already distort reality because, for example, someone has provided extensive funding for a specific research topic or a specific research group and a particularly large number of publications are now available in this subdomain – then the system reproduces this distortion and amplifies the bias. »Although our system does not produce such a distortion,« says Chiarcos, »there is no way to compensate for it automatically. This can only be done by an expert in the field in question getting down to work and reviewing the literature manually.«

Besides that, there are numerous other aspects that Christian Chiarcos would like to optimize together with his colleagues. A finer language. More attractive headlines. Greater coherence. Moreover, there are other research fields in science apart from lithium-ion batteries where Beta Writer could also compile the one or the other anthology.

The book now published has answered the question whether artificial intelligence can write scientific books. It can. The follow-up question is now: In which role will Beta Writer – or similar algorithms – find its place in the libraries of scientific publishers? Will there be a review now and again? Or will all the non-fiction authors in the country soon be out of work?

The real strength of Beta Writer does not lie in the fact that it has written a scientific book. It is the fact that it wrote a scientific book about a random research topic and the users – in this case Christian Chiarcos and his colleagues – could tell the programme how many chapters they would like and how long they should be. Perhaps Beta Writer's main work could thus become something completely different to writing books. After all, it is a software that can automatically create a highly individual literature overview. This is what researchers need, for example, when tackling a new topic, but it is also what doctoral researchers need when writing their thesis.

»That is indeed what I consider to be the most probable application for this technology in the long run,« says Christian Chiarcos too. He believes that people will not use the software as a tool for generating texts »but rather as a tool to help them write books more effectively.« ●



»B. Writer«
Reiner Korthauer, Hg.
**Lithium-Ion Batteries:
Basics and Applications**

The first book by AI author
»B. Writer«.
Free download under
<https://tinyurl.com/BWriterBattery>



In response to current events,
another book by »B. Writer«,
a literature overview on
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