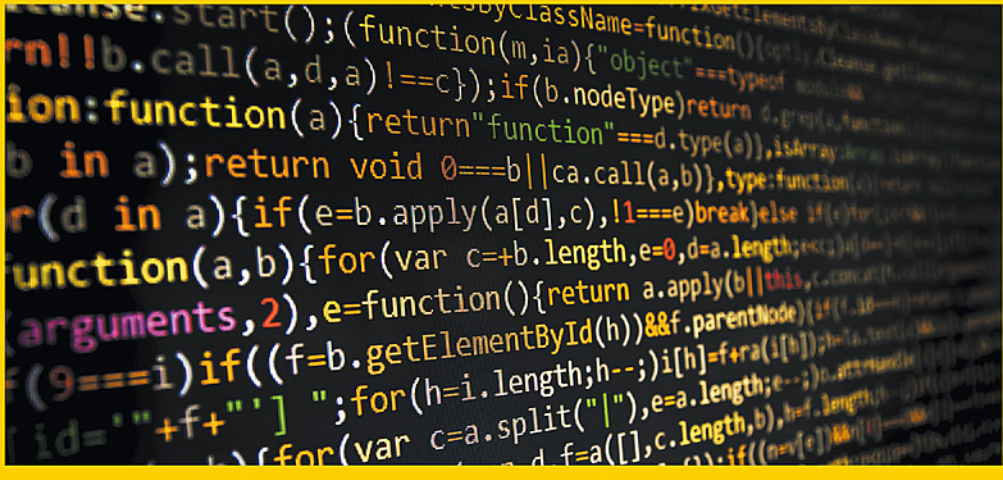
HORST EIDENMÜLLER /
GERHARD WAGNER

Law by Algorithm



Mohr Siebeck

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Preface

This book is about a development which is as fascinating as it is frightening: laws and contracts made – or at least deeply influenced – by computer code. "Law by Algorithm" investigates the impact of digitization, blockchain technology and Artificial Intelligence (AI) on lawmaking, legal scholarship, and legal practice.

About two decades ago, the phrase "Code is Law" was coined to denote the normative autonomy of the Internet/Cyberspace.[1] "Law by Algorithm" goes further. It is not just that certain technologies are beyond the reach of lawmakers and regulators. Human actors use sophisticated new technologies to make and shape laws and contracts. And machines may eventually even replace human lawmakers. Self-driving cars are already on our roads. When will algorithmic judges populate our courts? Would this be an improvement and, if so, for whom?

It is certainly not too early to start thinking about these and related questions. Digitization, blockchain technology and AI applications have been turbocharged in the last two years by the COVID-19 pandemic. Big Tech, i. e. Google, Apple, Facebook, Amazon and Microsoft, is leveraging its power by deploying sophisticated new technologies to shape the legal code of private transactions in its favor. How should societies address this development?

This book explores the multifaceted challenges of "Law by Algorithm". What exactly is happening in terms of technological developments, and what are the law-related developments that we can observe? Which new challenges to legal doctrine and to regulation arise? What use can societies make of AI in lawmaking and the application of laws?

These are the main themes of our inquiry. We analyze conceptual and philosophical questions of "robot law", investigate the (potentially negative) impact of Big Data and AI applications on consumer welfare, examine liability questions related to the rise of autonomous systems and associated conceptual issues, and deal with the impact of AI on corporate governance and corporate law. We also assess the prospect for "driverless arbitrations", smart contracts and digital enforcement, internal complaint handling, Online Dispute Resolution

[1] See Lawrence Lessig, *Code is Law: On Liberty in Cyberspace*, Harvard Magazine 1.1.2000, https://www.harvardmagazine.com/2000/01/code-is-law-html (last visited on September 30, 2021).

(ODR) and the role of the courts in a world shaped by digitization, blockchain technology and AI applications.

The majority of the book's chapters have already appeared elsewhere as articles, and we acknowledge the original publication in the first footnote of each chapter and at the end of the book. The book also contains new contributions, which have not appeared elsewhere before, namely the Introduction (Chapter 1), Chapter 7 on "AI Liability" and Chapter 10 on "Digital Dispute Resolution".

A recurring theme of our analysis is that although "Law by Algorithm" might massively increase overall societal welfare, it runs the significant risk of benefitting only a few. To make it work for the good of all is a mammoth and complicated task. We are private law scholars who work on the law of contracts and torts, on commercial and corporate law, and on the manifold mechanisms of dispute resolution. While much of the scholarly and policy discourse on regulating Big Tech, AI or blockchain technology focuses on data protection and antitrust, the tools of private law should not be neglected. We hope to demonstrate their potential to deliver the benefits of "Law by Algorithm" for all with this book.

We are indebted to friends and colleagues who commented extensively on drafts of the papers which made it into this volume. Horst Eidenmüller co-authored a paper with John Armour and another one with Faidon Varesis. We are grateful for their permission to use these articles in this volume. The editing process was conducted by research assistants at Gerhard Wagner's Chair in Berlin. We thank them for their diligent work. We are especially indebted to Peter McColgan who supervised the editing process and also made many valuable comments and suggestions on the book's chapters. Leonie Steffen did superb work in the proofreading stages and created the Index. Special thanks go to Conor McLaughlin who reviewed most chapters and made many valuable suggestions. Finally, Horst Eidenmüller is grateful for a Fellowship of the Bavarian Research Institute for Digital Transformation (bidt) which allowed him to focus on this project in 2021.

This is a work of humans not machines. Hence, it surely contains many errors and shortcomings. We look forward to engaging with your comments and criticisms.

Oxford and Berlin,
October 2021

Horst Eidenmüller and Gerhard Wagner

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Chapter 1

Law by Algorithm*

This book ("Law by Algorithm") is about a fundamental change in the fabric of our societies, namely, the influence of digitization, blockchain technology and Artificial Intelligence (AI) on lawmaking, legal scholarship, and legal practice.

Throughout history, laws were made exclusively by humans and for humans. In democracies, members of parliaments debate new rules and regulations and eventually enact new laws. In totalitarian states, dictators or the members of the ruling caste do likewise. Human-made laws regulate human affairs and enable human activities, both in the private sphere and in business. Human judges interpret these laws, fill gaps or develop new rules. Law firms consisting of human attorneys assist clients in enforcing their rights and courts in developing the law. There is no question that legal systems around the world are anthropocentric.

This is not surprising. After all, we live in human societies, and laws structure our interactions in these societies. True, laws also structure human relations with machines, i. e. property. However, that confirms rather than refutes the human-centeredness of our legal systems.

At the same time, this human-centeredness creates well-known problems. One of them is, of course, climate change. For centuries, the focus of human laws has been on the welfare of other living humans. Effects on animals, the inanimate environment and on future generations have largely been ignored.

A very different problem relates to the process of human lawmaking and legal practice. Humans do not operate as flawlessly as well-oiled machines. We suffer from systematic irrationalities and biases in our decision-making.[1] Judges, too, are not immune to these shortcomings.[2] Further, human lawmaking or judging can be slow, cumbersome and costly. Can technology bring about improvements?

The answer to this question is a clear "Yes". Legal systems as we know them are changing under the influence of new technologies, at an accelerating pace, and for the better.

---

* Prepared for this volume by Horst Eidenmüller and Gerhard Wagner.

[1] For a comprehensive account *see*, *for example*, Daniel Kahneman, Thinking, Fast and Slow (2012).

[2] *See*, *for example*, Eyal Peer & Eyal Gamliel, *Heuristics and Biases in Judicial Decisions*, 49 Court Review 114 (2013); Lee Epstein & Stefanie A. Lindquist (eds.), The Oxford Handbook of U. S. Judicial Behavior (2017).

Digitization, i. e. the process of converting information into a digital (computer-readable) format, is not a new phenomenon. However, digitization has been turbocharged in the last two years by the COVID-19 pandemic. The pandemic has shown all of us the potential (as well as the limitations and drawbacks) of "doing things online", including in legal matters – from filing an application for a vaccination appointment to shopping on the Internet for daily supplies or even attending a virtual court hearing.

Roughly ten years before the pandemic, two other technological developments had started to influence commerce and the legal system, namely blockchain technology and advances in AI. A blockchain is a growing list of records ("blocks"), which are linked together using cryptography.[3] Many will associate blockchain technology primarily or even exclusively with the digital currency Bitcoin. A few months ago, for example, the carmaker Tesla announced that it will accept payments in Bitcoin for its cars in certain circumstances.[4] But blockchain applications go much beyond digital currencies. South Korea (and other countries) uses the same technology for its digital vaccine-passport, for example.[5]

Whereas the blockchain is used to automatically execute decisions, AI applications help us make better decisions. The greatest advances in this respect have been associated with a specific form of AI, namely Machine Learning (ML). ML is able "… to adapt to new circumstances and to detect and extrapolate patterns".[6] For example, AI applications based on ML allow us to predict the outcome of legal cases with great accuracy[7] or assist (human) judges in making better decisions, for example regarding the question of whether to grant bail in criminal law.[8] The list of law-related ML applications is already very long, and the numbers are growing rapidly – in all areas of the law.

The impact of new technologies such as digitization, AI, and blockchain on lawmaking, legal scholarship, and legal practice obviously raises a host of important questions.

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[3] *See*, *for example*, Primavera De Filippi & Aaron Wright, Blockchain and the Law: The Rules of Code 1–9 (2018).

[4] *See* Reuters, *Musk says Tesla will accept bitcoins when miners use more clean energy*, June 13, 2021, https://www.reuters.com/technology/musk-says-tesla-will-accept-bitcoins-when-miners-use-reasonable-clean-energy-2021-06-13/ (last visited on June 28, 2021).

[5] *See* Sangmi Cha, *South Korea to issue blockchain-protected digital 'vaccine-passports'*, Reuters, April 1, 2021, https://www.reuters.com/article/us-health-coronavirus-southkorea-idUSKBN2BO43W (last visited on June 25, 2021).

[6] Stuart Russell & Peter Norvig, Artificial Intelligence: A Modern Approach 2 (3rd ed. 2016).

[7] *See*, *for example*, "ArbiLex", https://www.arbilex.co/welcome (last visited on June 25, 2021). On algorithmic predictions *see generally* Ajay Agrawal, Joshua Gans & Avi Goldfarb, Prediction Machines (2018).

[8] *See* Jon Kleinberg et al., *Human Decisions and Machine Predictions*, available at https://cs.stanford.edu/people/jure/pubs/bail-qje17.pdf (last visited on June 25, 2021).

Firstly, what exactly is happening in terms of technological developments, and what are the law-related developments that we can observe? Understanding these developments as comprehensively and precisely as possible on an empirical level is paramount to solidly grounding whatever normative inquiry of the relevant issues one pursues.

Secondly, which new challenges to legal doctrine arise? For example, already in 2017, the European Parliament passed a resolution calling on the European Commission to consider "... creating a specific legal status for robots in the long run, so that at least the most sophisticated autonomous robots could be established as having the status of electronic persons ..."[9]

Thirdly, which new regulatory challenges arise? In particular, is there a need to provide for mandatory safeguards to protect less sophisticated parties, especially consumers, from being exploited by powerful corporations?[10] Is there a risk of new forms of discrimination to the detriment of certain minority groups by "smart algorithms"?[11]

And fourthly, what use can societies make of AI in lawmaking and the application of laws? What is the potential of "eGovernment"?[12] Are "Online Courts" on the horizon anytime soon?[13]

In this book, we engage with these questions. The majority of the book's chapters have already appeared elsewhere as articles, and we acknowledge the original publication in the first footnote of each chapter and at the end of the book. For publication in this book, these articles have been updated in respect of the sources cited. However, no substantive changes have been made. The book also contains two new contributions, which have not appeared elsewhere before, namely Chapter 7 on "AI Liability" and Chapter 10 on "Digital Dispute Resolution".

The ordering of the chapters is as follows: In Chapters 2 and 3 ("The Rise of Robots and the Laws of Humans", "Machine Performance and Human Failure: How Shall We Regulate Autonomous Machines?"), we analyze conceptual and philosophical questions of "robot law". In Chapter 4 ("Down by Algorithms? Siphoning Rents, Exploiting Biases, and Shaping Preferences: Regulating the Dark Side of Personalized Transactions") we investigate the (potentially negative) impact of Big Data and AI applications on consumer welfare. Chapters 5, 6 and 7 ("Robot Liability", "Robot, Inc.: Personhood for Autonomous Systems?", "AI Liability") examine liability questions related to the rise of autonomous systems and associated conceptual issues. Chapter 8 ("Self-

[9] *See* European Parliament resolution of 16 February 2017 with recommendations to the Commission on Civil Law Rules on Robotics (2015/2103(INL)), at no. 59 f), OJ C 252/239.

[10] *See* Shoshana Zuboff, The Age of Surveillance Capitalism (2019).

[11] *See* Cathy O'Neil, Weapons of Math Destruction (2016).

[12] The European Commission, for one, is taking actions to develop cross-border digital public services, *see* European Commission, eGovernment and digital public services, https://digital-strategy.ec.europa.eu/en/policies/egovernment (last visited on June 26, 2021).

[13] *See* Richard Susskind, Online Courts and the Future of Justice (2019).

Driving Corporations?") deals with the impact of AI on Corporate Governance issues and Corporate Law. The final two chapters focus on dispute resolution. Chapter 9 ("What is an Arbitration? Artificial Intelligence and the Vanishing Human Arbitrator") assesses the prospects for "driverless arbitrations", and Chapter 10 ("Digital Dispute Resolution") deals with smart contracts and digital enforcement, internal complaint handling, Online Dispute Resolution (ODR), and the role of the courts in a world shaped by digitization, blockchain technology and AI applications.

Given that the majority of the chapters have appeared as individual articles, it is inevitable that certain issues and themes are treated in more than one chapter. We view this as a benefit, as the reader can see how our thinking on certain issues has evolved. It also reveals different insights to be gained from different perspectives on the same or similar issues. Another beneficial feature of our approach is related to the fact that the articles have different authors, and only a few are co-authored by the authors of this book. As a consequence, certain issues are treated differently in the individual chapters, for example the usefulness or even necessity of an economic analysis when thinking about "robot liability". This should enrich the book and make for a livelier reading, we hope.

If there is one recurring theme in all chapters it is how "Law by Algorithm" helps to massively increase the welfare in our societies and, at the same time, creates the significant risk that this increased welfare benefits only a few of its members.

On the one hand, the benefits digitization, blockchain, and AI bring to our legal systems are huge. We will be able to conclude smarter contracts, which better satisfy our needs, interact with one another and public institutions much more efficiently, and benefit from much improved dispute resolution services. Laws can be "personalized" in the sense that private and public rules are calibrated to the needs and preferences of individual members of society.[14]

On the other hand, it also seems clear that not all parties will benefit from this development to the same degree. We do not believe that futuristic visions of a world populated by robots with legal personality will become a reality anytime soon. But we do believe that sophisticated private actors will increasingly use the new technological tools to enrich themselves, at the expense of less sophisticated market participants, especially consumers. In fact, this is already happening right now, and the velocity and impact of the development is staggering.

The greatest beneficiary of digitization, blockchain technology and smart AI applications is Big Tech, i. e. Google, Apple, Facebook, Amazon and Microsoft. Facebook is or has been the subject of investigations by antitrust agencies in Europe and the United States.[15] The company is widely criticized for its business

[14] *See* Omri Ben-Shahar & Ariel Porat, Personalized Law: Different Rules for Different People (2021).

[15] For Germany *see*, *for example*, Bundeskartellamt (Federal Monopolies Commission),

model of aggressively collecting and analyzing the personal data of its users for profit, and for the commercial gain of its business partners.[16] Another tech power player is Amazon: shaping consumers' preferences, exploiting their biases, engaging in first-degree price discrimination, and handling any disputes by an effective but biased internal complaint handling algorithm (see Chapters 4 and 10 in this volume). The European Commission has initiated antitrust proceedings against Amazon for abuse of a dominant position.[17] In the United States, Amazon now faces the first serious antitrust action for allegedly breaking the law by unfairly crushing competition.[18] And there is more to come: A law review article written by the FTC's newly elected chairperson reads like a playbook on how to restrict Amazon's monopoly power – perhaps by employing elements of public utility regulation.[19]

On the legislative front, the United States Congress is about to discuss and possibly enact a package of five legislative acts aimed not only to restore competition in the digital marketplace, but also to "rein in" the largest tech platforms.[20] The proposed "American Innovation and Choice Online Act" is designed to prohibit and sanction discrimination on online platforms, while the so-called "ACCESS Act" calls for interoperability and data portability. On the other side of the Atlantic, the European Union has already passed a legislative instrument which regulates the conduct of online platforms vis-à-vis commercial customers, i. e. the P2B Regulation 2019/1150.[21] In essence, its purpose is to ensure non-dis-

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Resolution of February 6, 2019, Case B6–22/16; Oberlandesgericht (Higher Regional Court) Düsseldorf, Decision of August 26, 2019, VI-Kart 1/19 (V), Neue Zeitschrift für Kartellrecht 2019, 495; Bundesgerichtshof (BGH) (Federal Court of Justice) June 23, 2020, KVR 69/19, Neue Zeitschrift für Kartellrecht 2020, 473. As to the U. S. *see* FTC v. Facebook, Inc., No. 1:20-cv-03590-JEB (D. D. C. Jan. 13, 2021), https://www.ftc.gov/system/files/documents/cases/051_2021.01.21_revised_partially_redacted_complaint.pdf (April 22, 2021) (press release available at: https://www.ftc.gov/news-events/press-releases/2020/12/ftc-sues-facebook-illegal-monopolization (last visited on June 30, 2021)).

[16] *See*, *for example*, Bernard E. Harcourt, Exposed: Desire and Disobedience in the Digital Age 3–7, 21–24, 42–46 (2015); Brad Smith & Carol Ann Browne, Tools and Weapons: The Promise and the Peril of the Digital Age 89–107 (2019).

[17] European Commission, Case AT.40562 – Amazon Marketplace; European Commission, Case AT.40703 – Amazon – Buy Box.

[18] *See* Shira Ovide, *The Big Deal in Amazon's antitrust Case*, New York Times, May 25, 2021, available at https://www.nytimes.com/2021/05/25/technology/amazon-antitrust-lawsuit.html (last visited on June 26, 2021).

[19] *See* Lina Khan, *Amazon's Antitrust Paradox*, 126 Yale L. J. 710, 797–802 (2017). *See also* Tim Wu, The Curse of Bigness: Antitrust in the New Gilded Age (2018).

[20] *See* David Cicilline, *House Lawmakers Release Anti-Monopoly Agenda for "A Stronger Online Economy: Opportunity, Innovation, Choice"*, June 11, 2021, available at https://cicilline.house.gov/press-release/house-lawmakers-release-anti-monopoly-agenda-stronger-online-economy-opportunity (last visited on June 30, 2021).

[21] Regulation (EU) 2019/1150 on promoting fairness and transparency for business users of online intermediation services, OJ L 186/57; *see* Martin Eifert et al., *Taming the Giants: The DMA/DSA Package*, 58 Common Mkt. L. Rev. 987 (2021).

crimination, transparency, and fairness in the commercial relationships between platforms and business users. While the P2B Regulation mostly confines itself to disclosure mandates, the recently published proposal of a Digital Markets Act[22] goes much further. If enacted, it would subject the tech giants, the so-called gatekeeper platforms, to rather strict duties of equal treatment, easy access, and fair dealing, together with a prohibition of "self-preferencing".

Despite this flurry of activity, antitrust is a blunt instrument, and it comes very late in the game.[23] Traditional antitrust remedies such as breakup are like a massive operation after the problem has almost gotten out of control. Societies must apply more and different tools on a "micro level" in different areas of the law to make sure that the benefits of new technologies accrue to the many and not just the few. With the proposal of the Digital Markets Act, Europe is moving in this direction, and it seems that the United States is about to follow.

However, the challenges for private law, and the legal system more generally, remain. Statutes like the Digital Markets Act are just one puzzle piece in the appropriate regulatory response to Big Tech. Arguably, the law should protect consumers (and SMEs) who increasingly conduct their commercial and personal affairs in the digital space much more vigorously and much earlier, i. e. before their lives and opportunities have been seriously limited by powerful private counterparties that have reached "Amazon status". Making "Law by Algorithm" work for (all) humans is an enormous challenge and responsibility.[24] We hope to contribute to this task with the chapters in this book.

[22] Proposal for a Regulation on contestable and fair markets in the digital sector ("Digital Markets Act"), COM(2020) 842 final; *see also* Eifert et al. (*supra* note 21).

[23] *Cf.* Ariel Ezrachi & Maurice E. Stucke, Virtual Competition: The Promise and the Perils of the Algorithm-Driven Economy 218–232 (2016) (rightly suggesting that "we must be open-minded to new enforcement instruments", *id.* at 219).

[24] *See*, *for example*, Max Tegmark, Life 3.0: Being Human in the Age of Artificial Intelligence (2017); Frank Pasquale, New Laws of Robotics: Defending Human Expertise in the Age of AI (2020); Joshua A. T. Fairfield, Runaway Technology (2021). For a broader perspective *see* Brett Frischmann & Evan Selinger, Re-Engineering Humanity (2018); Yuval Noah Harari, 21 Lessons for the 21st Century 9–98 (2018).

Chapter 2

The Rise of Robots and the Law of Humans*

In this chapter, I examine fundamental questions raised by the rise of robots and the emergence of "robot law". The main theses developed are the following: (i) robot regulation must be robot- and context-specific. (ii) (Refined) existing legal categories are capable of being sensibly applied to and regulating robots. (iii) Robot law is shaped by the "deep normative structure" of a society. (iv) If that structure is utilitarian, smart robots should be treated like humans. (v) The case against treating robots like humans rests on epistemological and ontological arguments. I develop these theses primarily in the context of accident liability for self-driving cars.

I. Artificial Intelligence (AI) and the law

When lawyers enter the discussion, the fun part is usually over. Engineers and computer scientists enjoy a similar reputation. In this chapter, I consider robots and the law. The prospects for entertainment may therefore be limited. However, the interaction of law and Artificial Intelligence (AI) poses exciting and important questions, and the answers to these questions will undoubtedly shape the future of mankind in the decades to come.

AI is now rapidly changing how we live and work. As routine tasks (both manual and cognitive) become increasingly automated, it is anticipated that robots ("embodied AI"[1]) will take approximately 1/3 of jobs in traditional professions by 2025.[2] The law will shape the future of AI. It will determine the permissible uses of AI, the costs of new products and technologies, among other things. Further, the initial regulatory decisions will be crucial. They may create path dependencies, and make it hard to change regulatory course later.

Regulating AI is going to be challenging and difficult. After all, the law is – and always has been – made by humans and for humans. Just think of fundamental

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[1] *See* Ryan Calo, *Robotics and the Lessons of Cyberlaw,* 103 Cal. L. Rev. 513, 532 et seq. (2015).

[2] *See* Christoffer O. Hernaes, *Artificial Intelligence, Legal Responsibility and Civil Rights*, Techcrunch, Aug. 22, 2015, https://techcrunch.com/2015/08/22/artificial-intelligence-legal-responsibility-and-civil-rights/. For a thorough treatment of the problem including sensible policy options, *see* Martin Ford, The Rise of Robots: Technology and the Threat of Mass Unemployment (2015).

concepts such as "personhood" and "legal personality". Historically, these concepts related to humans, i. e. natural persons. AI will thus strain the legal system: How shall we deal with robots? Shall we accord them legal personality, give them the right to acquire and hold property and to conclude contracts, etc.?[3]

In this chapter, I attempt to answer these and other fundamental questions raised by the rise of robots and the emergence of "robot law". The main theses developed in this chapter are the following: (i) robot regulation must be robot- and context-specific. This requires a profound understanding of the micro- and macro-effects of "robot behavior" in specific areas. (ii) (Refined) existing legal categories are capable of being sensibly applied to and regulating robots. (iii) Robot law is shaped by the "deep normative structure" of a society. (iv) If that structure is utilitarian, smart robots should, in the not-too-distant future, be treated like humans. This means that they should be accorded legal personality, have the power to acquire and hold property and to conclude contracts. (v) The case against treating robots like humans rests on epistemological and ontological arguments. These relate to whether machines can *think* (they cannot), and what it *means* to be human.

I will develop these theses primarily in the context of self-driving cars – robots on the road with a huge potential to revolutionize our daily lives and commerce.[4] However, in order to illustrate the massive potential influence that robots will have on the fabric of our societies, I begin with a broader range of examples.

II. Varieties of robots and robot features

A. Robot applications

Self-driving cars are currently among the most discussed robot developments.[5] Indeed, most car manufacturers have experimented with self-driving cars, and these cars are already being tested on roads worldwide.[6] Google appears to have the lead in this development.[7] A key feature of its car is a rotating rooftop camera. It consists of an array of 64 laser beams that create 3D images of objects,

[3] For a summary of the issues, *see*, *for example*, Jens Kersten, *Menschen und Maschinen*, 70 JuristenZeitung 1, 6–8 (2015).

[4] *See* Horst Eidenmüller, *Whose Fault? Firms, Products and Liability in the Age of Artificial Intelligence, BMW Welcomes: Artificial Intelligence*, Youtube, April 21, 2016, https://www.youtube.com/watch?v=WI0d6yzFG24.

[5] *See*, *for example*, Hod Lipson & Melba Kurman, Driverless: Intelligent Cars and the Road Ahead (2016).

[6] *See* "40+ Corporations Working On Autonomous Vehicles" (updated March 4, 2020), https://www.cbinsights.com/blog/autonomous-driverless-vehicles-corporations-list/.

[7] *See* "Waymo Bumps A Scooter – Roundup Of Self-Driving Car Headlines" (June 21, 2021), https://www.forbes.com/sites/bradtempleton/2021/06/21/waymo-bumps-a-scooter-roundup-of-self-driving-car-headlines/?sh=9c34a8666511.

allowing the car to orient itself. The car's driving behavior is controlled by complex software.

Another important application of robots is in medicine. For instance, prototypes of nanotech medical robots with a size of a 1–10/1,000,000 of a millimeter have been developed.[8] These nanotech robots will travel through a patient's blood and into tumors where they will deliver a therapy that turns off an important cancer gene.

Robots are also beginning to enter the finance and financial consulting industry. "Robo financial advisers" might shake up the brokerage business with low-cost, automated investing.[9] For example, UBS recently announced that advisers in its American wealth management division will use a robot to cater to wealthy clients.[10] This technology, which will be used by the company's 7,000 advisers, has been developed by a San Francisco start-up, SigFigWealth Management, which is one of a growing group of robo-advisers.[11]

Finally, AI is also going to fundamentally change the legal profession.[12] Indeed, AI systems already assist in the (automated) resolution of disputes,[13] and "robo-lawyers" are entering the stage. In 2016, for example, the world's first artificially intelligent lawyer was hired by a US law firm, BakerHostedler, which licensed ROSS Intelligence for use in its bankruptcy restructuring and creditor rights department.[14] "Robo-lawyers" will be deployed especially with respect to document searches and classification in discovery.[15] In England, predictive coding (classification of documents for discovery) was recently backed by the

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[8] *See* Mike Chino, *Nanotech Robots Travel Through Blood to Turn Off Tumor Cells*, Inhabitat, March 25, 2010, http://inhabitat.com/nanotech-robots-travel-through-blood-to-turn-off-tumor-cells/.

[9] *See* Tara Siegel Bernard, *Should a robot oversee your retirement money?*, New York Times, May 3, 2016, 15.

[10] *See* Alessandra Amalito, *UBS to offer SigFig's robo-platform to its financial advisers*, Investment News, May 9, 2016, http://www.investmentnews.com/article/20160516/FREE/160519939/ubs-to-offer-sigfigs-robo-platform-to-its-financial-advisers.

[11] *See* https://www.sigfig.com/site/#/home/am (last visited on November 20, 2020).

[12] *See* Dana Remus & Frank S. Levy, *Can Robots Be Lawyers? Computers, Lawyers, and the Practice of Law*, November 30, 2016, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2701092; Richard Susskind & Daniel Susskind, The Future of the Professions: How Technology will Transform the Work of Human Experts 66–71 (2015); Jerry Kaplan, Humans Need Not Apply: A Guide to Wealth and Work in the Age of Artificial Intelligence 145–149 (2015).

[13] *See* Shaheen Fatima et al., Principles of Automated Negotiation (2014). For a detailed discussion *see*, Horst Eidenmüller & Gerhard Wagner, *Digital Dispute Resolution*, *infra* Chapter 10 in this volume, 223.

[14] *See* Chris Weller, *The world's first artificially intelligent lawyer was just hired at a law firm*, Business Insider, May 16, 2016, http://www.businessinsider.com/the-worlds-first-artificially-intelligent-lawyer-gets-hired-2016-5?IR=T.

[15] *See* Julie Sobowale, *How artificial intelligence is transforming the legal profession*, ABA Journal, April 1, 2016, http://www.abajournal.com/magazine/article/how_artificial_intelligence_is_transforming_the_legal_profession.

High Court in *Brown vs BCA Trading* on 17 May 2016.[16] "Robo-lawyers" will also be involved in the (online) drafting of legal documents[17], and "smart contracts" based on blockchain technology are around the corner.[18]

AI might also come in the form of "robo-judges". Based on a data set of 150,000 US felony cases, *Kleinberg et al.* found that a release rule (pending resolution of the cases) based on machine learning predictions would enable us to reduce the jail population by 25 % without any increase in the crime rate, or let us reduce crime rates by 20 % without changing the jail population.[19] Taken together, robo-lawyering and judging seem to bring significant positive developments in making legal advice more affordable, judging more accurate, and improving access to justice for many.

B. Robot features

Reflecting on the examples discussed above, certain "robot features" emerge that are important when thinking about regulating robots. As already mentioned, robots are a form of embodied AI. They consist of a sensor or other input mechanism, a controlling algorithm, and the capacity to give feedback to the outside world.[20] These three features together constitute the so-called "Sense-Think-Act Paradigm".[21] The sensor or other input mechanism may draw from multiple sources as is the case, for example, with respect to "networked cars".[22] As described, they use cameras, traffic data from GPS, and geographical data taken from the internet.

Smart robots have machine learning capabilities, i. e. they not only use huge amounts of existing data, but also use data from experiences and other new information to adapt their behavior.[23] Therefore, to some extent, these robots are

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[16] Brown v BCA Trading Ltd [2016] EWHC 1464 (Ch).

[17] On "computational law" *see*, *for example*, Jerry Kaplan, Artificial Intelligence: What Everyone Needs to Know 95–97 (2016).

[18] *See*, *for example*, Henning Diedrich, ethereum: blockchains, digital assets, smart contracts, decentralized autonomous organizations (2016); James Eyers, *Lawyers prepare for 'driverless M&A' as smart contract era dawns*, Financial Review, June 20, 2016, http://www.afr.com/technology/lawyers-prepare-for-driverless-ma-as-smart-contract-era-dawns-20160616-gpknyz; for a detailed discussion *see*, Horst Eidenmüller & Gerhard Wagner, *infra* Chapter 10 in this volume, 223, 228–235.

[19] *See* John Kleinberg et al., *Human Decisions and Machine Predictions* (NBER Working Paper No. 23180, February 2017), http://www.nber.org/papers/w23180.

[20] *See* A. Michael Froomkin, *Introduction*, in Robot Law x, xi (Ryan Calo et al. eds., 2016).

[21] *See, for example*, Henry Hexmoor, Essential Principles for Autonomous Robotics 25 (2013).

[22] *See*, *for example*, Sejoon Lim et al., *Intelligent Transportation with Networked Cars*, https://groups.csail.mit.edu/drl/wiki/images/0/0f/LimMobisysDemo08.pdf (last visited on October 15, 2021).

[23] *See* Ethem Alpaydin, Machine Learning: The new AI (2016); Erik Brynjolfsson & Andrew McAffe, The Second Machine Age: Work, Progress, and Pros-

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