

## THE CAMBRIDGE HANDBOOK OF THE LAW OF ALGORITHMS

Algorithms are a fundamental building block of artificial intelligence – and, increasingly, society – but our legal institutions have largely failed to recognize or respond to this reality. *The Cambridge Handbook of the Law of Algorithms*, which features contributions from US, EU, and Asian legal scholars, discusses the specific challenges algorithms pose not only to current law, but also – as algorithms replace people as decision-makers – to the foundations of society itself. The work includes wide coverage of the law as it relates to algorithms, with chapters analyzing how human biases have crept into algorithmic decision-making about who receives housing or credit, the length of sentences for defendants convicted of crimes, and many other decisions that impact constitutionally protected groups. Other issues covered in the work include the impact of algorithms on the law of free speech, intellectual property, and commercial and human rights law.

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# The Cambridge Handbook of the Law of Algorithms

Edited by  
**WOODROW BARFIELD**



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## Foreword

### *Algorithms and the Law*

Four developments have given rise to new opportunities and new challenges. They are the huge increase in the processing power of computers, the availability of data on an unprecedented scale, the fall in the costs of the storage of data, and the increasingly sophisticated software services which have become available.

The international interest in the potential of the new technologies can be seen in the rapid expansion of artificial intelligence (AI) start-ups, including in the field of financial technology, and the high level of investment in the technologies by established commercial corporations. Both governments and businesses are exploring the potential of the new technologies to improve the services which they provide and to reduce the costs of the provision of such services.

The power of AI to exceed the capacity of human intelligence to analyze data and take decisions based on that analysis is creating opportunities in many fields. Some technology involving algorithms, such as auto-pilots, is well established. More recently, the development of medical devices, robotic surgery, and driverless cars has expanded the use of the technology. In some countries, the technology is increasingly used in criminal justice in sentencing, predicting recidivism, and making decisions about whether to grant bail – matters which affect personal liberty.

Another technology, distributed ledger technology (DLT), also offers many benefits. For example, the UK government sees DLT technology as offering a means of ensuring the integrity of government records and services and the provision of such services at lower cost. The processing of “big data” holds out the prospect of enhanced accuracy in medical diagnosis and the prescription of treatment. Investment in the technologies in the financial services industry seeks to realize the substantial annual savings which have been predicted in banking transactions and cross-border payments.

At the same time, AI and big data analysis can be and are being used by autocratic regimes as an instrument of social and political control of the populations for which they are responsible. In China, the developing “social credit” system involves intrusion by the state into the lives of its citizens in ways which would not be compatible with Western values. But in the West, the technologies offer states the ability to probe into citizens’ lives – for example, to secure the proper payment of taxes and the correct distribution of social security benefits, raising new questions of data protection and privacy. There are also political questions raised on the international plane: the technologies can be and are also being used by hostile regimes to influence the outcome of democratic decision-making in Western democracies.

Questions are being raised about the intentional or unintentional use of data to underpin unacceptably discriminatory behavior. The use of AI by governmental bodies and business corporations raises questions about the protection of data and the privacy of the citizen and

the consumer. The use of the technologies by private sector organizations has caused increasing concern in the West. Those concerns extend not only to the invasion of privacy through the use of the data by corporations, but also to the vulnerability of personal data to cyber-attacks. Novel means of the use of big data in credit scoring, such as the analysis of a would-be borrower's personality through his or her interactions on social media, may enhance financial inclusion, but raise questions of unfair discrimination and privacy which call for regulation. There is also a question, which needs to be addressed, about whether governments will be able to recruit able and suitably qualified regulators with the capacity to keep up with technological developments so as to protect the citizen and the consumer.

The new technologies also pose challenges to commercial law. I am unconvinced by those who argue that operation of computer programs will remove the need for legal regulation. In my view, the law will need to be adapted to facilitate the realization of the benefits of the new technologies and to prevent or at least provide workable remedies against their abuse.

The development of self-executing “smart contracts” may require adaptations to the law of contract to ensure effective remedies – for example, where a contract is concluded, or rather set in motion, as a result of misrepresentation. The law of unjust enrichment may plug a gap by providing a remedy in many cases. If, over time, AI is developed to enable programs in communication with each other to optimize their contractual rights and obligations without human input, more radical innovation in the law of contract may be needed.

In the field of involuntary obligations, the law of tort (delict) will need to be developed. New rules will be needed to attribute liability for damage caused by computers in the absence of human foresight (in the context of negligence) or intention to cause harm (in the context of economic torts). I am not persuaded that products liability, which would impose liability on the creator of the algorithm, can provide a suitable model in most cases, as damage may be caused by a “thinking algorithm” through its analysis of data and its exercise of judgment without there being any defect in the algorithm and without its creator having the foresight or control over the work which the algorithm will perform. New rules on the basis of liability for such harm and on causation may need to be developed either by the courts or by legislation.

Governments and legislatures may wish to consider options such as no-fault compensation and compulsory insurance and the possibility of giving separate legal personality to programs used for specific purposes. But strict liability may impose too high a standard and the risks may be too great for commercial insurers to undertake, particularly in the field of financial services, in which potential losses may be on a wholly different scale from the damages due for personal injury or property damage caused by a driverless car. In the field of involuntary obligation, legislatures will have to navigate between the Scylla of damaging the interests of citizens and consumers by the indiscriminate facilitation of the new technologies and the Charybdis of stifling the potential of the new technologies to provide significant human benefits by imposing a crippling liability regime.

The legal profession and judges face a challenge in understanding the code which underpins the new technologies. There will be a greater need for expert evidence to guide the courts in litigation concerning the technologies, and the cost and complexity of such litigation may prove a serious barrier to the achievement of justice.

Property law may also be the subject of necessary reform. There is a need to bring a greater degree of certainty as to the legal nature as property of crypto-assets, such as crypto-currencies, in which very large sums of money have been invested. Should algorithms be recognized as a form of intellectual property? Intellectual property law may also have to be reconsidered to provide for copyright for works created by computers and patents for computer-generated inventions.

Insofar as the new technologies are used to facilitate international financial transactions and trade, there will be great benefit in achieving international cooperation on both regulation and law reform, by international conventions and model laws.

In this context of radical technological change, carefully considered initiatives of regulatory change and law reform can facilitate the realization of the potential benefits and minimize the adverse effects of the technologies. I am not persuaded that piecemeal, interstitial, legal innovation by the courts can achieve what is needed in a realistic timescale. An informed debate on the best ways to achieve these ends is a precondition of effective law and regulatory reform.

This Handbook contains contributions from judges, professors of law, other academic and practicing lawyers, economists and technologists, and policy analysts from several countries, giving an international focus to the discussion of these important issues. The contributions include discussion of contract law, tort law, patent law and other intellectual property law, competition law, criminal law, government administration and decision-making, regulation, accountability, transparency, privacy, freedom of expression, and discrimination. I warmly welcome the publication of this Handbook for its contribution to this important debate.

Patrick S. Hodge



## Preface

Recent advances in technology have resulted in numerous discussions among legal scholars on how the law relates to robotics, drones, autonomous cars, and generally any system embedded with artificial intelligence. At its core, artificial intelligence relies on algorithms to process and interpret data, to navigate artificially intelligent vehicles, and to control the motion of robots that are becoming increasingly autonomous from human supervisory control. Algorithms are also being used to control household appliances, to engage in financial transactions, to decide whether we receive credit or an offer of employment, and to give technology the ability to listen to people and to speak back to them. In the medical domain, often based on necessity, technology is becoming implanted within or attached to the body, allowing algorithms to become intimately involved with our biological well-being and in some cases our very survival. As we become more enhanced with technology designed to repair or extend our motor, sensory, and cognitive abilities, how is the law impacted? And as algorithms are embedded in technology which have the capability to follow our every movement, recognize our faces in a crowd, record our keystrokes, and monitor which websites we visit, how is privacy and free speech law impacted, and how do we make sure that individual rights guaranteed under state and federal constitutions are preserved in an age of rapid technological advancements? These are just a short list of the pressing issues that will need to be addressed by legal scholars and legislators.

Clearly, important issues of law and policy are being raised by the proliferation of algorithms throughout society and even within our bodies. This thirty-five-chapter *Handbook of the Law of Algorithms* discusses how the law is being challenged by emerging algorithmic-driven systems and what solutions may be necessary to regulate such systems. As a Handbook which may be useful for students in various fields, and for legislators, policymakers, or legal practitioners, this edited volume on the Law of Algorithms provides numerous examples of algorithmic-driven systems which are resulting in challenges to current areas of law, and as a response, includes relevant case law and statutes which directly, or indirectly, regulate the use of algorithms. The volume also discusses future directions of law in an age of increasingly intelligent algorithmic-driven systems that are designed to make decisions previously made by humans.

My goal in editing this volume was to provide outstanding legal scholars with a forum in which to discuss in some detail their views on the emerging field of law and algorithms and the opportunity to participate in the debate about the future direction of law and policy as related to algorithmic-driven systems. The volume, with chapters from US, EU, and other international scholars, is wide-ranging: there are chapters which discuss how algorithms are

challenging commercial and antitrust law, criminal law statutes, and how algorithms may lead to discriminatory conduct toward constitutionally protected groups. This last point raises an important issue, which this volume speaks to, as more technology is integrated into society, just what kind of society do we want to create and what role does the law have to play in creating a just and equitable society in a technologically advanced world?

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## Abbreviations

ABR	Algorithm-Based Republisher
ACLU	American Civil Liberties Union
AFRL	Air Force Research Lab
AI	artificial intelligence
DLT	distributed ledger technology
HLEG	High-Level Expert Group
ASR	automated speech recognition
AUC	area under the curve
BCD	binary-coded decimal
BCI	brain–computer interfaces
BTBI	brain-to-brain interface
CAD	computer-aided design
CDA	Communications Decency Act
CESCR	Committee on Economic Social and Cultural Rights
CFPB	Consumer Financial Protection Bureau
CIPO	Canadian Intellectual Property Office
CJ	Chief Justice
CNS	central nervous system
COMPAS	Correctional Offender Management Profiling for Alternative Sanction
CONTU	Commission on New Technological Uses of Copyright Works
COP	Child Online Protection
CPU	central processing unit
CSS	computational social science
DAO	digital autonomous organization
DARPA	Defense Advanced Research Projects Agency
DEG	Digital Era Governance
DLP	digital labor platform
DMCA	Digital Millennium Copyright Act
DMV	Department of Motor Vehicle
DNN	deep neural network
DoDPI	Department of Defense Polygraph Institute
DOJ	Department of Justice
DRM	digital rights management
ECJ	European Court of Justice

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ECOA	Equal Credit Opportunity Act
EEG	electroencephalography
EPA	Environmental Protection Agency
ERP	event-related potential
ESI	electronically stored information
EU	European Union
FACTA	Fair and Accurate Credit Transactions Act
FATML	Fairness, Accountability and Transparency in Machine Learning
FBI	Federal Bureau of Investigation
FCRA	Fair Credit Reporting Act
FDA	Federal Drug Administration
FDIC	Federal Deposit Insurance Corporation
FEMA	Federal Emergency Management Agency
FICO	Fair Isaac & Company
FINRA	Financial Industry Regulatory Authority
fMRI	functional magnetic resonance imaging
fNIRS	functional near infrared spectroscopy
FOIA	Freedom of Information Act
FTC	Federal Trade Commission
GA	genetic algorithm
GAN	generative adversarial networks
GDPR	General Data Protection Regulation
GIS	geographic information system
GPS	Global Positioning System
GPU	graphics processing unit
HIC	human in command
HIPAA	Health Insurance Portability and Accountability Act
HITL	human in the loop
HMRC	Her Majesty's Revenue & Customs
HOTL	human on the loop
HRBA	human rights-based approach
ICESCR	International Covenant on Economic, Social and Cultural Rights
ICT	information and communications technologies
III	institutional information infrastructures
IoM	Internet of Minds
IoT	Internet of Things
IP	Internet Protocol
IPO	Intellectual Property Office
IRS	Internal Revenue Service
ISO	International Organization of Standardization
ITU	International Telecommunication Union
J	Justice
LAW	lethal autonomous weapon
LEI	Legal Entity Identifier
LR	likelihood ratio
MEG	magnetoencephalography
METI	Ministry of Economy, Trade, and Industry

MHLW	Ministry of Health, Labor, and Welfare
ML	machine learning
MoPP	Manual of Patent Practice
MPEP	Manual of Patent Examining Procedure
NBA	National Basketball Association
NCCUSL	National Conference of Commissioners on Uniform State Laws
NSA	National Security Agency
PET	positron emission topography
NFL	National Football League (US)
NPM	new public management
OCC	Office of the Comptroller of the Currency
OECD	Organisation for Economic Co-operation and Development
OMB	Office of Management and Budget
OODA	Observe, Orient, Decide, Act
PAC	political action committee
PAI	Partnership on AI
PCLOB	Privacy and Civil Liberties Oversight Board
PIA	privacy impact assessment
QDF	query deserves freshness
RAI	risk assessment instruments
RIA	Regulatory Impact Analysis
ROM	read-only memory
SAOP	senior agency official for privacy
SD	social dilemma
SEC	Securities and Exchange Commission
SEO	search engine optimization
SNA	Social Network Analysis
SSA	Social Security Administration
SSDI	Social Security Disability Insurance
SSL	Strategic Subject List
SVM	Support Vector Machine
SVP	sexually violent predator
TCP	Transmission Control Protocol
ToC	Tragedy of the Commons
UCC	Uniform Commercial Code
UCITA	Uniform Computer Information Transactions Act
UETA	Uniform Electronic Transactions Act
UK	United Kingdom
UN	United Nations
UNICEF	UN International Children's Emergency Fund
US	United States
USPTO	US Patent & Trademark Office
VA	Visual Analytics
VLA	Visual Legal Analytics
VR	virtual reality
VRAG	Violence Risk Appraisal Guide