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**‘Hello, World!’: Towards a New Era of
Algorithmic Contracting?’**
Implications for Laws and Regulations

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PREFACE

As a matter of tradition in the field of programming, the sentence ‘Hello, World!’ is often the first coding assignment given to beginner programmers.

In the context of this paper, it illustrates the dawn of new contracting practices, methods and capabilities, driven and enabled by algorithms.

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DECLARATION

I, Yasmine Benaich do hereby declare that this thesis is my own original work. It was not previously submitted, whether in full or in part, for a degree or certificate at another university, nor forming part of a previous thesis. To the best of my knowledge, information contained therein does not infringe any third-party rights. Utmost care and attention have been taken to ensure full referencing of any book, journal article, or court judgement used in this thesis. The full word count for this thesis is 39,257 words.

Yasmine Benaich

‘The best way to predict the future is to invent it’

Alan Kay

Abstract

This dissertation explores the potential of algorithmic contracting, referring to the practice of automating contractual agreements through computer code. While not a new concept in itself, the practice has recently generated strong interest from both scholars and commercial players as a result of the possibility to integrate advanced technologies into the process such as the Blockchain or Artificial Intelligence or to connect with data gathering technologies such as the Internet of Things, and benefit from increased capabilities resulting therefrom.

As the world seems to be increasingly driven by technological innovation, it may be that contractual practices ought to undergo a similar technological transformation too, so as to match the pace and demands of our now fast-moving digital economy.

While certainly promising, these emerging forms of contracting would nonetheless raise various commercial, technical and legal challenges that would need to be addressed, especially should algorithmic contracts aim to sustain greater commercial adoption and represent the 'future of contracting'.

Based on extensive scholarly research and analysis, this paper explores these issues in light of the wider commercial potential of algorithmic contracts, and attempts to resolve identified legal challenges by proposing a tailored regulatory approach. Provided that commercial and technological challenges can be addressed too, these emerging forms of contracting could indeed usher us into a new contracting paradigm driven by technological advancement.

INTRODUCTION

On the 19th August 2021, Elon Musk unveiled his plans to build an AI-driven humanoid robot which would be able to perform repetitive, unsafe or otherwise ‘boring’ tasks so far undertaken by humans. The underlying expectation behind this visible ambition to shift towards a robot-based workforce was that it would reduce labour costs and transform the global economy overall, freeing humans to move away from physical or otherwise labour-intensive work¹.

While it remains to be seen whether a viable prototype of this ambitious project will become available in a year’s time as promised in the presentation, or whether robots taking over humans will remain part of some imaginary dystopian future instead, it remains that automating tasks, or to the least facilitating them with the help of technology is already an everyday occurrence. Applications are for instance capable of indicating the best and fastest itinerary to get to a specific location or connecting users with nearby drivers to take them there². Websites are able to make movie recommendations based on specific user preferences³ or to make online ‘friend’ suggestions based on users’ real-life acquaintances⁴. Online search engines can rank search results by order of pertinence⁵, and online vendors can propose tailored products based on users’ specific needs⁶.

Seemingly assisting with the most trivial of tasks, the algorithms (i.e. the instructions given to a computer/machine to achieve a specific outcome or solve a problem⁷) underlying these technologies are therefore driving numerous aspects of the modern human experience, suggesting their strong promise to help do things ‘better’ or ‘more easily’.

In light of this visible shift towards a more technology-driven human experience, it may be argued that these same algorithms could also be extended to facilitate transactions and contracting practices. This is indeed the promise upon which the discussion held in this paper relies, as it looks at the compelling commercial solution proposed by algorithmic contracts (i.e.

¹ Tesla, ‘Artificial Intelligence and Autopilot’ (2021) <<https://www.tesla.com/AI>> accessed 20 August 2021

² See for instance GPS technologies or ride-hailing apps such as Uber <<https://www.uber.com/gb/en/>> accessed 13 September 2021

³ See movie/entertainment streaming services such as Netflix <<https://www.netflix.com/browse>> accessed 13 September 2021

⁴ See social media platforms such as Facebook <<https://en-gb.facebook.com/>> accessed 13 September 2021; Instagram <<https://www.instagram.com/>> accessed 13 September 2021

⁵ See for instance the Google search engines which finds and ranks results by order of pertinence in matters of milliseconds

⁶ See websites such as Amazon which offer bespoke product recommendations to users <<https://www.amazon.co.uk/>> accessed 13 September 2021

⁷ Merriam-Webster Dictionary, ‘Definition of Algorithm’, <<https://www.merriam-webster.com/dictionary/algorithm>> accessed 20 August 2021

contracts incorporating a foundation of computer code). While the practice is already successful in the field of financial algorithmic trading for instance, it remains to be determined whether it could go on automate more complex transactions and exchanges, and as a result signal a move towards a new era of fully-digitalised contracting.

In determining whether algorithmic contracts can realistically represent the ‘future of contracting’, this paper will explore various aspects of the architecture of algorithmic contracts and the socio-economic landscape in which they operate so as to propose a balanced analysis of their promise.

This paper will therefore proceed in three parts: Focusing on the ‘*Why*’ behind this discussion, Part I of this paper will begin by setting the scene on our now *digital* economy, exploring the hold technology currently has on society and how it is currently driving change in numerous industries. Following the work of scholar Richard Susskind on the matter, Chapter 1 will then position the future of contracting discussion within a narrower one on the digital future of law, purposely adopting a future-looking perspective that matches the promise of algorithmic contracts with changing legal practices. Chapter 2 will then go on to explore the commercial potential of algorithmic contracts more specifically, and outline their possible response to identified shortcomings in current commercial contracting practices.

Moving on to the ‘*What*’ behind this discussion, Part II of this paper will explore the concept behind algorithmic contracting in more depth, focusing on the work of various scholars as they lay out different algorithmic contracting concepts offering various capabilities and varying levels and types of automation: Beginning with ‘plain’ algorithmic or computable contracts as respectively discussed by scholars Lauren Scholz and Harry Surden, Chapter 3 will outline the potential of algorithmic contracts whose automation relies solely on the use of computer code. Chapter 4 will then explore the concept of smart contracts as initially laid out by Nick Szabo, considering how the blockchain technology advances it to become a promising commercial solution. Chapter 5 will then look to the future and conclude with the concept of self-driving contracts in which the drafting of the agreement would be automated through the use of machine intelligence, as imagined by scholars Anthony Casey and Anthony Niblett in their paper of the same name. While this concept remains in the realm of academic speculation, discussing a possible future, and a more ‘advanced’ form of algorithmic contract will allow to draw a fuller picture of the ‘future of contracting’.

Overall, exploring these concepts by progressive order of algorithmic automation in part II (i.e. from least to most automated), and identifying advantages and challenges they raise throughout, will allow to undertake a thorough and balanced analysis of algorithmic contracts overall.

Finally, and based on the understanding that algorithmic contracts may offer a strong commercial promise, part III will be concerned about '*How*' to ensure that algorithmic contracts can indeed represent the future of contracting. This final part of the paper will therefore undertake a discussion regarding their regulation, positioning it within a wider framework on regulating innovation in Chapter 6, to then make regulatory propositions to challenges identified throughout the paper in Chapter 7.

To conclude, a discussion evaluating the future of contracting will take place, positioning how algorithmic contracts could indeed be the drivers of it.

PART I

A ‘Perfect Storm’ for Algorithmic Contracts

CHAPTER 1

A Perfect Storm

As this dissertation aims to determine that the future of contracting lies in the automation and digitalisation of the process through the use of algorithmic contracts, it is relevant to position that future within a shifting and digitalising socio-economic landscape that may pave the way for new forms of technology-driven contracting to indeed take hold.

This chapter will therefore first explore the wider impact of data and technology on today's society, and evidence how our current reality is increasingly driven by technological developments that ushered us in the age of the *digital economy*. It will also explore the digitalisation currently underway in numerous industries so as to situate the promise of algorithmic contracts within shifting industry standards and preferences that appear to increasingly value technology integration to improve processes.

By subsequently undertaking a thorough analysis on the future of the legal sector, influenced by the work of scholar Richard Susskind on the subject, this chapter will move on to positioning the future of contracting discussion within a narrower perspective on the future of the law. Illustrating how the profession is also increasingly driven by technological advancement, and how a more digitalised approach to contracting could align with sector-specific preferences, this chapter will overall suggest how algorithmic contracts could reflect the current technology and data-driven world in which we operate. It will therefore justify the discussion held in this paper more broadly, in relation to a similarly digitalised future of contracting.

1. The Digital Economy

1.1 The Digital Transformation

Before delving into deeper discussions on the importance of technology in industry, this first part of the chapter will look at its fast and impressive development over the last decades, and its impact on society more broadly. More importantly, it will illustrate how technology development and data-driven decision making are driving us into the age of the *digital economy*.

Indeed, according to a 2019 UNCTAD report, economies and societies more broadly are experiencing a digitalisation that is fuelled by a large and increasing availability of data that can be harnessed for the purposes of technological advancement⁸.

According to this report, an increasing data traffic online and a growth of machine-readable information over the internet⁹ facilitate access to that data. It is furthermore enabled by a combination of the wide availability of fast and reliable internet connections, an increased adoption of smartphone technology, and advances in both hardware and digital content¹⁰. As the accessibility of data is seemingly made easier than ever, new technologies also operate with the sole purpose of contributing to that availability of data: The Internet of Things (IoT) for instance, referring to a network of connected devices which collect and share data about states of the world are a good example of data-creating technologies¹¹, which allow more amounts of it to be amassed.

As a result of this availability of data and ease to access it and which in turn create the perfect ground for technologies to develop, data and digitally-driven solutions have found themselves re-shaping the human experience to the extent that we are now said to live in an economy in which technologies underpin evermore transactions, and result in important economic outputs¹², justifying its now *digital* nature.

Overall, this digital economy has been identified as being increasingly inseparable from the overall functioning of the economy as a whole¹³ suggesting the already important hold of technology over the modern human experience, with the expectation that it can further drive business efficiency, offering the promise of doing things ‘better’ or at lower cost¹⁴. Similarly, new business models and behaviours based on the ability to access data and transform it into digital intelligence to derive competitiveness are emerging¹⁵. As such, parties which are in a position to create and capture data can expect to be better placed to achieve business success.

⁸ UNCTAD, ‘Digital Economy Report 2019’ (United Nations, 2019) <https://unctad.org/system/files/official-document/der2019_en.pdf accessed 20 August 2021> 2

⁹ *ibid* xv

¹⁰ Christian Twigg-Flesner, ‘Disruptive Technology – Disrupted Law?’ in De Franschi A (ed), *European Contract Law and the Digital Single Market* (Intersentia 2016) 4

¹¹ Internet of Things (IoT) refers to a network of connected devices, collecting and sharing data about the state of the world around them (See IBM, ‘What is Internet of Things (IoT)?’ (IBM) <<https://www.ibm.com/blogs/internet-of-things/what-is-the-iot/>> accessed 6 June 2021)

¹² UNCTAD (n 8) 4

¹³ *ibid*

¹⁴ Chris D’Souza and David Williams, ‘The Digital Economy’ (Canadian Economic Analysis Department, Spring 2017) 9 <<https://www.bankofcanada.ca/wp-content/uploads/2017/05/boc-review-spring17-dsouza.pdf>> accessed 20 August 2021, 4

¹⁵ UNCTAD (n 8) xvii

From the perspective of this paper, this move towards data-driven algorithmic contracting would therefore be in line with this expected continuous growth in data, as the algorithmic foundation of algorithmic contracts and resulting automation relies on computer code which itself-operates thanks to machine-readable data. Even more ‘advanced’ forms of the concept would rely on the availability of data to operate:

Smart contracts would for instance operate automatically as data is fed to them by IoT devices, while the AI-foundation of self-driving contracts could allow the contract itself to draft terms autonomously based on data regarding the parties’ intentions, and regarding the environment in which that contract would operate¹⁶. The promise of more data in our digital economy is therefore a crucial one for the development of algorithmic contracts, justifying therefore the discussion held in this paper in relation to the future of contracting.

While too early at this stage of the discussion to position algorithmic contracts as the drivers of that future, it already emerges that technologies are capable of driving change and having an impact over the human experience. In which case, moving towards technology-driven algorithmic contracting could simply represent that change within the field of contracting, and align contracting practices with current data-driven preferences and capabilities.

1.2 A Data Driven World

As the digitalization of the economy seems already well underway, it also appears that it will continue in a similar direction in the years to come too: Indeed, according to Moore’s Law, computing power doubles approximately every two years, creating ever-more amounts of data as a result¹⁷. This availability of data is what fuels technological development, and what enables the emergence of various technologies¹⁸ that are capable of drive change within the architecture of our global economy¹⁹. More relevantly and timely than Moore’s Law, advances in IoT technologies, whose purpose is to gather large amounts of data about states of the world²⁰ as discussed earlier further fuel that availability of information.

As the wealth of data available today and its potential to drive future contracting practices have been laid out, it also emerges, according to Kryder’s law, that the cost of storing it is rapidly

¹⁶ See generally Anthony Casey and Anthony Niblett, ‘Self-Driving Contracts’ (2017)

¹⁷ Gordon E. Moore, ‘Cramming More Components into Integrated Circuits’ (1965) 83

¹⁸ UNCTAD (n 8) 3

¹⁹ To take examples, key technologies such as Artificial Intelligence and its subset Machine Learning for instance rely on massive amounts of data to operate.

²⁰ IBM, ‘What is Internet of Things (IoT)?’ (n 11)

declining²¹. The promise of even more data available in the future, and an uptake in behaviours driven and motivated by this availability of data therefore appears realistic.

In the context of this paper more specifically, it appears that the data-driven technological architecture needed for ‘advanced’ forms of algorithmic contracts to develop seems to be ‘ready’. The discussion relating to this future of algorithmic contracting appears therefore both timely and pertinent.

In light of these digital developments mainly driven by the increasing availability of data, and proportionally growing storage and processing capabilities, some even go on to claim that data is *‘the new oil for the future economy’*²².

While this analogy is subject to debate in the relevant academic literature on the subject, to the extent that oil and data are very different resources, that one is finite while the other is not, and that assimilating both could have negative policy implications on the latter²³, it is relevant for the purposes of this paper to the extent that it acknowledges that both oil and big data share superficial similarities as important resources, and recognises the central value of the latter in our economy²⁴. As discussed earlier, data is essentially the foundation of its digital nature.

In the context of this discussion, data therefore holds a central role in enabling contracting practices to enter the digital realm. For the purposes of this dissertation therefore, data may be *‘the new essence for the future of contracting’*, central in the emergence and development of novel contracting methods able to fully automate the operation or drafting of agreements using computer code and data-driven technologies.

2. Technology in Society

2.1 Technology in Society

As discussed, this deluge of data, and the appropriate capabilities to harness it, have enabled technologies to emerge and re-shape the design of our socio-economic landscape to the extent

²¹ Walter Chip, ‘Kryder’s Law’ (2005) 20

²² The sentence ‘data is the new oil’ is often attributed to Clive Hunby at a marketing conference held in Northwestern University’s School of Management in 2006.

²³ Regulation of innovation is very much shaped by perception on the regulatory target. It is therefore important to be accurate in representing the specific issues big data may bring that are significantly different from that brought by oil. See generally Lauren Scholz, ‘Big Data is not Big Oil’ (2020)

²⁴ *ibid* 1

that we are now said to live in the digital economy, continuously advanced by data-driven technologies.

While we are still said to be in the early stages of this ‘digital revolution’²⁵, we, as a society (and arguably even more so in the Global North) increasingly witness the potential of new technologies every day through our own personal uses of it:

For instance, phones are now often unlocked with face or touch recognition, using Machine-learning powered software²⁶. All the friend suggestions that appear on social media platforms are based on AI predictions, using the same approach used by online streaming services that offer users accurate personalized movie recommendations²⁷. While these technological feats may be subject to debate and criticism, especially in relation to the ‘intrusive’ or personal nature of the data they gather and collect²⁸, in the context of this paper they nonetheless evidence the seeming hold of technology over the modern human experience.

From a professional perspective, technology allows the world to remain connected and operate arguably seamlessly during the Covid-19 pandemic, which forced new ways of remote working, and further catalysed the digitisation of work²⁹.

Considering that these new ‘online’ ways of working and the use of automation and AI at work are set to remain the norm even in the post-Covid world³⁰, discussing a similarly digitalised and technology-driven approach to contracting seems warranted and more importantly timely. The promise of algorithmic contracts could therefore lie in aligning contracting practices with emerging business preferences and expectations, that were further accentuated by the Covid-19 pandemic.

2.2 Technology in Industry

²⁵ UNCTAD (n 8) v

²⁶ Bernard Marr, ‘The 10 Best Examples of How AI is Already Used in our Everyday Life’, (*Forbes*, 16 December 2019) <<https://www.forbes.com/sites/bernardmarr/2019/12/16/the-10-best-examples-of-how-ai-is-already-used-in-our-everyday-life/?sh=55059aee1171>> accessed 10 April 2021

²⁷ *ibid*

²⁸ The GDPR in the EU or the CCPR in the US are examples of legislations that aim to protect users’ data.

²⁹ Laura LaBerge and others, ‘How Covid-19 has Pushed Companies Over the Technology Tipping Point –and Transformed Business Forever’ (*McKinsey & Company*, 5 October 2020) <<https://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/how-covid-19-has-pushed-companies-over-the-technology-tipping-point-and-transformed-business-forever>> accessed 11 April 2021

³⁰ Susan Lund and others, ‘What’s Next for Consumers, Workers and Companies in the Post Covid-19 Recovery?’, (*McKinsey Global Institute*, May 2021) <<https://www.mckinsey.com/featured-insights/future-of-work/whats-next-for-consumers-workers-and-companies-in-the-post-covid-19-recovery>> accessed 22 August 2021

As societal and work preferences seem to point towards greater technology acceptance, technologies have similarly found themselves reinventing entire industries, and undertaking high-stake work, suggesting some form of increased trust in them to help to do things ‘better’ or more efficiently:

In the banking/finance industry for instance, an area particularly receptive to technological developments because financial products are mainly based on data³¹, harnessing the power of that data allows financial services providers to improve their decision-making capabilities and overall workforce productivity³².

As regards the use of algorithms in the field, the use of robo-advisors is a disruptive trend in asset and wealth management where algorithms are entrusted to provide financial advice to increasingly educated and technology-receptive investors, at lower costs for financial providers, and with the expectation that the technology will experience a promising growth in the future³³. Similarly, the practice of algorithmic trading, which refers to the practice of trading of financial instruments using a computer algorithm that automatically determines parameters such as quantity, price or timing of the order with no/limited human supervision³⁴ is another successful application of algorithms in the field.

As such, it appears that algorithms have already, and arguably successfully too, found their way to facilitate financial practices, setting an insightful precedent for the expansion of the concept onto more general or complex transactions. This is indeed the argument made in this dissertation as it looks at the applicability of algorithms to facilitate more ambitious or elaborate contracts.

Similarly, the potential of technology in the healthcare sector is vast and has allowed to improve the delivery of medical services: impressive technological uses in the field include the application of AI to allow patients to keep track of their health, to detect early-stage diseases, to improve overall healthcare services by using data to better identify trends or customer expectations, to improve the research process, and to allow easier training of medical specialists³⁵. While exploring these applications in more depth falls outside of the scope of this

³¹ Thomas Pushmann, ‘Fintech’ (2017) 69-76. As will be seen in subsequent chapters this allows it to be suitable for algorithmic operation, and therefore for algorithmic contracting too.

³² Lutz-Christian Wolff, ‘Artificial Intelligence Ante Portas’ (2019) 488

³³ Mikhail Beketov and others, ‘Robo Advisors: Quantitative Methods Inside the Robots’ (2018) 363-370

³⁴ MiFID II Article 4 (1) (39)

³⁵ PwC, ‘No Longer Science Fiction, AI and Robotics are Transforming Healthcare’ (PwC) <<https://www.pwc.com/gx/en/industries/healthcare/publications/ai-robotics-new-health/transforming-healthcare.html>> accessed 10 April 2021

paper, these examples nonetheless evidence the form of trust that we seem to have placed onto technologies as they go on to perform high-stake medical work.

Arguably this same trust could be extended to allow algorithms to perform contracts on behalf of parties, or to draft the terms of the agreement, based on machine-identified best course of actions. While these features of algorithmic contracts seem promising, they nonetheless raise issues as regards the role of the algorithm in the process, as will be explained in more detail later in this paper. Whether this trust in technology is actually desirable in itself is also to be discussed. Nevertheless, in light of this precedent in the medical field (and that in the financial sector), the same trust in technology and algorithms could be extended to contracting practices too.

2.3 Technology in Law

As other industries have also undertaken their own digital shift, the legal sector has been slow to undertake its technological revolution due to its reactive rather than proactive adaptation to technological development³⁶. It is nevertheless expected to see an exponential growth in technology use which is expected to impact many aspects of the profession overall³⁷.

For the purposes of this dissertation it is important to evaluate technological implantation in the legal sector considering that algorithmic contracts could challenge the work of lawyers as regards contract drafting processes. It therefore justifies the important discussion to be held regarding the future of law, and the place of algorithmic contracts within it.

2.3.1 The Future of the Legal Sector

Legal technology expert and leading scholar in the field Richard Susskind said in 2013 that the legal world was on course to change more drastically in the following 20 years than it had in the past 200 years³⁸. While this statement may seem over-enthusiastic, it remains that this transformation of the legal sector is already underway³⁹. Indeed, digital tools and technologies are already re-shaping the provision of legal services:

³⁶ Sergio David Becerra, 'The Rise of Artificial Intelligence in the Legal Field' (2018) 30

³⁷ John O McGinnis and Russel G Pearce, 'The Great Disruption: How Machine Intelligence Will Transform the Role of Lawyers' (2014) 3042

³⁸ Richard Susskind, *Tomorrow's Lawyers* (Oxford University Press 2016) vii

³⁹ *ibid* viii

Document review tools that can review large volumes of documentations to extract specific information, can for instance be used to facilitate lawyers' due diligence exercises and do so in a way that is better, cheaper and more reliable than when done by humans⁴⁰.

More interestingly, predictive analytics can now be used to forecast case outcomes in a practice that was already successfully used in the banking sector but is now also being extended to law, after being the subject of successful experiments where it accurately forecast 70% of supreme court decisions⁴¹, and 79% that of the ECtHR⁴². While it does raise legal issues of its own including serious concerns of bias, which will be more extensively discussed later in relation to the underlying AI in self-driving contracts in Chapter 5, this use of technology in law nonetheless evidences that technology could indeed reshape what it means to provide legal services, and how.

This specific example may also be evidential of the willingness to 'trust' machine intelligence discussed earlier or to the least experiment with it in legal practice, which could in turn pave the way for the applicability of AI-based self-driving contracts that could fully automate the drafting of agreements based on similar predictive capabilities⁴³ should they indeed come to materialise. More broadly and realistically for now, as the objective seems to entrust technology with high-stake legal work (to the extent that it may assist judges in reaching verdicts), it appears realistic to expect that legal professionals could accept algorithms automating contracting processes too.

As regarding contracting practices more specifically, technology can already be found throughout the contract lifecycle, as software is now able to extract relevant clauses to re-use them more easily in subsequent contracts, and AI-driven tools are able to review non-disclosure agreements, that bind parties not to share sensitive information, faster and more accurately than humans⁴⁴. Similarly, certain systems are able to use data analytics to identify specific concepts, clauses or provisions within large numbers of agreements⁴⁵, while some are even capable of

⁴⁰ Michael Mills, 'Artificial Intelligence in Law: The State of Play 2016' (2016) 4

⁴¹ Daniel Martin Katz and others, 'A General Approach for Predicting the Behaviour of the Supreme Court of the United States' (2016) 1

⁴² Nikolaos Aletras and others, 'Predicting Judicial Decisions of the European Court of Human Rights' (2016) 2

⁴³ Self-driving contracts would use AI predictions to draft contract terms autonomously and in real-time based on the parties' intentions and the environment: see generally Casey and Niblett, 'Self-Driving Contracts' (n 16)

⁴⁴ Legal AI firm LawGeex conducted an experiment where 20 US lawyers were put against the LawGeex AI Algorithm to review NDAs. The algorithm achieved 94% accuracy rate, while the lawyers achieved 85%. (Full report available at: LawGeex, 'Comparing the Performance of AI to Human Lawyers' (*LawGeex*, December 2020) <<http://ai.lawgeex.com/rs/345-WGV-842/images/LawGeex%20eBook%20AI%20vs%20Lawyers%202018.pdf>> accessed 13 April 2021

⁴⁵ Kira Systems is an example of a contract search and review tool incorporating machine learning capabilities see <<https://kirasystems.com/>> accessed 14 September 2021

drafting new contracts based on existing templates⁴⁶, with the expectation that the automated drafting of transactional documents could possibly come to develop in the future⁴⁷.

As the emergence of such tools suggests a clear shift towards a more automated approach to contracting, it may indeed be that this move towards automated contracting is realistic, in which case, the various algorithmic contracting options discussed throughout this paper could offer a roadmap towards a full automation of the process:

Computable or ‘plain’ algorithmic contracts for instance refer to contracts that would be based on computer code, which could allow to automate certain parts of a transaction or the entirety of the exchange underlying a contract⁴⁸. Blockchain-based smart contracts would allow to fully automate a transaction, allowing users to benefit from the advantages of the blockchain (i.e. a specific type of decentralised database) to render the process more secure and efficient⁴⁹ and connect with data-gathering devices. Finally, AI-based self-driving contracts would be able to autonomously fill themselves in based on the intentions of the parties and real-time changes in the environment⁵⁰, in what would be a true revolution in the field of contracting challenging both long-standing principles of contract law, but also what it means to draft a contract⁵¹. While this promise will be more nuanced in part II of this paper, at this stage, the discussion regarding an automated future of contracting appears promising.

While more communication is needed between researchers, legal professionals and technology experts to fully appreciate the extent of the technology revolution in law⁵², the emergence and visible adoption of so many of these products and solutions by leading law firms nonetheless evidences a willingness to progress into a more technology-driven way of conducting legal work, especially if these technologies pose low risks and low friction yet offer high potential and positive impact on legal operations⁵³. The implementation of ‘simple’ tried and tested systems may therefore be more imaginable at present, while more complex or ‘risky’ ones could

⁴⁶ Clifford Chance’s Dr@ft is an example of such technology as it is capable of generating documents based on answers to questionnaires see Clifford Chance, ‘CC Dr@ft’ (*Clifford Chance*) <https://www.cliffordchance.com/hubs/innovation-hub/applied-solutions/our-solutions/document_automation_ccdraft.html> accessed 14 September 2021

⁴⁷ Kathryn D Betts and Kyle R Jaep, ‘The Dawn of Fully Automated Contract Drafting’ (2017) 233. Machine Learning may be the key to full automation of the process.

⁴⁸ See generally Harry Surden, ‘Computable Contracts’ (2012)

⁴⁹ Smart Contracts to be discussed in Chapter 4 (See generally Nick Szabo, ‘Smart Contracts’ (1994)). The work of Nick Szabo pre-dates the advent of the blockchain technology so the term smart contract has a different meaning today.

⁵⁰ See generally Casey and Niblett, ‘Self-Driving Contracts’ (n 16)

⁵¹ At this stage, the concept of Self-Driving Contracts falls in the realm of academic speculation, as there are not yet any real-life applications of it.

⁵² Ciaran Harper and Sarah Zhang, ‘Legal Tech and Lawtech: Towards a Framework for Technological Trends in the Legal Services Industry’ in in Gimpel H and others (eds), *Market Engineering* (Springer 2021) 193-197

⁵³ Chay Brooks and others, ‘Artificial Intelligence in the Legal Sector’ (2020) 143

remain on the side lines at present, suggesting indeed a cautiousness as regards new technologies.

In the context of algorithmic contracts, simple algorithmic contracts simply utilising a foundation of code may therefore be easier to justify, as more advanced forms of the concept would require a more careful risk/cost/benefit analysis, considering that the use of more ambitious technologies such as AI for instance often requires to be justified by an identified higher positive impact⁵⁴. The discussion held in this paper in relation to the advantages, challenges and regulation of algorithmic contracts appears therefore purposeful, and could allow industry players to better understand algorithmic contracting options that may be available to them in the future.

Moreover, the British Government committing to invest over £1bn in digitalising courts⁵⁵ demonstrates a broader governmental input in digitalising the legal profession. While there is no ambition to claim that similar attention will be invested to digitalise contracting practices, it does evidence a clear and broader move to digitalising legal work, and suggests a place for technologies to re-shape what it means to contract. This overall upheaval in the legal profession could therefore predispose algorithmic contracts to digitalise contracting practices furthermore.

2.3.2 The Timing of the Digitalisation of Law

As regards matters of timing of this digital transformation of the legal sector, Richard Susskind refers in his book to three stages of change in the legal sector:

The first is a stage of *denial* which characterises itself by a rejection of the idea of changing existing processes, the second called *re-sourcing* is characterized by some form of recognition by legal departments that things need to change. The final stage of this framework is *disruption* as new capable systems are introduced to undertake legal work autonomously only to be supervised/overseen by human users⁵⁶. In light of the various uses of technology in law outlined earlier, it would appear that we find ourselves in this final stage of the digital transformation of the field, suggesting once more the ‘timeliness’ of the discussion held in this paper in relation to the future of contracting. While this framework is to be used with ‘caution’ to the extent that it follows the observations of one scholar, it remains purposeful and offers a good foundation

⁵⁴ Brooks and others (n 53) 143

⁵⁵ Susskind (n 38) vii

⁵⁶ *ibid* 85-91

for the discussion held in this paper as it positions algorithmic contracts within a burgeoning digital legal landscape.

This framework is also relevant for the purposes of the regulatory discussion held in part III as the importance of a proactive approach to regulating innovation as it emerges and develops, is laid out.

Overall therefore, algorithmic contracts do not only seem relevant in light of other successful applications of technology in law, but also timely as regards a wider framework that positions us within a ‘disruptive’ stage in which new legal technology solutions are introduced, and arguably ‘welcomed’.

2.3.3 The Three Drivers of Change in the Legal Sector.

Overall this automation of legal services, and arguably of contracting practices too, is in line with the wider changes brought by the ‘digital economy’ discussed earlier.

But looking at this *digitalisation* of law in closer detail, it appears that it was also driven by forces internal and specific to the legal sector, as scholar Richard Susskind also eloquently explains in his book as he lays three main drivers of change in the field:

First, according to the *more for less challenge*⁵⁷, there is currently a push in the industry to do more but for less cost, which sees lawyers changing the way they work to meet changing customer expectations. Indeed, customers are becoming increasingly mindful of how legal services are delivered to them and seek efficient, responsive and lower cost services which in turn pushes legal services providers to offer new kinds of value to meet these new demands⁵⁸. Law firms are essentially being driven by clients to reduce costs⁵⁹, which could arguably be achieved by adopting a data-driven approach to legal work and by providing a tailored/made-to-order approach to legal services. The solution proposed by algorithmic contracts, which will be elaborated on in the upcoming chapters, appears furthermore as a promising one: automating contracting through algorithms, streamlining contract drafting, offering the advantages of lower cost and guaranteed and effective performance through the blockchain, or using machine intelligence to tailor contract terms on a dynamic basis to achieve set and unique objectives are

⁵⁷ Susskind (n 38) 4-5

⁵⁸ See generally John Armour and Mari Sako, ‘AI-Enabled Business Models in Legal Services’ (2020)

⁵⁹ Susskind (n 38) 60

features that would align with this *more for less challenge*, allowing to contract faster, more easily and at lower costs⁶⁰.

Second, Susskind identifies the *liberalisation* of business structures as another driver of change in law⁶¹. Indeed, legal market dynamics are changing with new non-traditional legal services providers including the big 4 accounting firms⁶², ‘LegalTech’ start-ups, and flexible resourcing platforms now offering the promise of comprehensive and multi-disciplinary legal services⁶³, and new ways of conducting legal work. As these new legal market players seem to offer more flexible and technology-enabled services that match the new customer expectations discussed earlier, and overall seem to move away from the ‘traditional’ way of conducting legal work⁶⁴, it may signal that the move towards digitised contracting may not simply be an option, but actually a real way to distinguish a legal services offering and remain competitive in a rapidly changing market. While it remains to be determined whether algorithmic contracts could be such an attractive commercial solution in practice, it remains that their theoretical promise could match the demands of a fast-moving legal sector.

Finally, *IT development* is the final key driver for change within the legal market identified by Susskind⁶⁵. Indeed, new technologies offer new ways to deliver legal services, as extensively discussed in relation to the variety of ‘Legal Technology’ tools available today. The move towards algorithmic or otherwise technology-automated contracting could therefore be embodiment of IT developments driving change within legal practices.

As these factors are said to create a ‘perfect storm’ for legal technology solutions to emerge⁶⁶, in the context of this paper, the combination of the *more for less challenge*, the *liberalisation* of legal work and recent *IT developments* may also create the ‘perfect storm’ for algorithmic contracts to re-shape existing contracting practices. These three drivers of change within the legal sector may therefore also qualify as the three drivers of change within contracting, justifying furthermore the discussion held in this paper.

⁶⁰ These promises will be discussed and nuanced throughout Part II but at this stage of the discussion, they serve to outline the *theoretical* promise of algorithmic contracts.

⁶¹ Susskind (n 38) 5-10

⁶² The Big Four accounting firms include leading professional services providers EY, PwC, Deloitte and KPMG. They now offer a range of legal services across numerous jurisdictions.

⁶³ The Clementi Report (see Sir David Clementi, ‘Review of the Regulatory Framework for Legal Services in England and Wales’ (2004); the Legal Services Act 2007 which allows the provision of legal services by ‘Alternative Business Structures’).

⁶⁴ Susskind (n 38) 8. The practice of law indeed seems to have remained unchanged over the last centuries.

⁶⁵ *ibid* 10-15

⁶⁶ *ibid* 15. In this context a perfect storm is the combination of numerous factors which combined together offer the optimal environment for something to develop or emerge.

While this remains to be ascertained in practice, as the arguments made in relation to the future of contracting remain theoretical at this stage, the increasing availability of legal technology solutions, a seemingly visible willingness of industry players to use them and government incentives to enable them⁶⁷ indeed seem to suggest that algorithmic contracts, and the capabilities they enable could have a place within these ‘legal services of the future’. This is especially relevant considering that Covid-19 might further catalyse this shift towards delivering ‘digital legal services’⁶⁸, in which case the objective will likely remain to find new ways of working that match novel technological capabilities with shifting industry and societal needs.

3. Conclusion

This chapter laid out important ideas that position and justify the discussion held in this paper in relation to a future of algorithm-driven contracting:

The now digital nature of our economy combined with ever-increasing amounts of data and matching storage and processing capabilities poise technology to re-shape furthermore the human experience, while changes in industry preferences suggest an appetite for more technology-driven solutions. In the legal sector more specifically, various forces are also pushing towards greater adoption of legal technology solutions, possibly paving the way for a future development of algorithmic contract technologies.

While it is very insightful to explore the potential of technology in the legal sector to the extent that contracting is often a lawyer-centric practice, it remains that the process of concluding transactions spans all sectors and industries. The promise of algorithmic contracts may therefore be a broader one.

All these factors combined seem to create a ‘perfect storm’ for the use and development of algorithmic contracts. As it appears therefore, the impetus that could drive a possible adoption

⁶⁷ As discussed in relation to digitalising the courts or as the UKJT LawTech Delivery Panel issued a ground-breaking Legal Statement on the Status of Cryptoassets and Smart Contracts in November 2019 which recognized the latter as capable of being enforceable under English Law: The objective seems to move towards a greater recognition of the concept in the UK (See UK Jurisdiction Taskforce (UKJT), ‘Legal Statement on Cryptoassets and Smart Contracts’ (UKJT, November 2019) <https://35z8e83m1ih83drye280o9d1-wpengine.netdna-ssl.com/wp-content/uploads/2019/11/6.6056_JO_Cryptocurrencies_Statement_FINAL_WEB_111119-1.pdf> accessed 26 September 2021)

⁶⁸ American Bar Association, ‘Legal Futurist Richard Susskind sees Technology as a Path to Better Justice’ (American Bar Association, September 2020) <<https://www.americanbar.org/news/abanews/publications/youraba/2020/youraba-september-2020/futurist-susskind-sees/>> accessed 29 August 2021

of algorithmic contracting methods is clear. Whether algorithmic contracts will indeed go on to develop in practice remains to be determined, and will be discussed over the course of this paper as their potential is nuanced with the various challenges they pose.

Nevertheless, even if futurist in its approach, this chapter laid out the important foundation upon which the discussion held in this paper relies: As the promise of algorithmic contracts appears to align with broader socio-economic and industry trends, the discussion in relation to the potential of the concept, and any regulatory attempts that may be warranted to surround it, seems justified. As such, the next chapter will proceed with further strengthening the commercial promise of algorithmic contracts, which will then be nuanced in part II in light of the various legal, technological and commercial limitations they may pose.

CHAPTER 2

Contracting Problems: Technological Solutions?

Chapter 1 set a broad picture as to the role of technology in our digital economy and explored how it enables new kinds of behaviours that have become the norm, how it governs evermore of our interactions, and how it offers a wealth of benefits that have been felt across all industries which seem to welcome new and more effective, technology-driven ways of working.

This first chapter also explored how the legal sector is also experiencing its own digitalisation as technology is redefining the provision of certain legal services. In light of a visible willingness, and arguably a need for legal industry players to harness the potential of technology to improve their processes and outcomes as a result of various drivers that push for this digitalisation, it seems plausible to expect that algorithmic contracts as discussed in this paper could offer an attractive contracting solution to them too⁶⁹.

With a view to justifying furthermore the discussion held in this paper, this chapter will now look at the commercial promise of algorithmic contracts in more detail. It will begin by discussing the role of contracting and position how algorithmic contracts could fit within it. It will then outline how such contracts could respond to shortcomings identified in current commercial contracting processes, and offer novel solutions of their own, laying out the commercial impetus that could possibly drive a future adoption of algorithmic contracting methods to facilitate contractual exchanges.

1. The Role of Contracting

Contracts have been referred to as useful, highly ‘elastic’ and pliable legal tools that safeguard the exchange of goods and services on the market⁷⁰. They are what allows individuals to demonstrate their preferences, express their valuations of products and services, and more importantly conclude exchanges⁷¹, playing therefore a key and pervasive role in formalizing, overseeing and safeguarding transactions.

⁶⁹ This paper takes the stance that algorithmic contracts could find applications in various fields and practices.

⁷⁰ Friedrich Kessler, ‘Contracts of Adhesion– Some Thoughts About Freedom of Contracts’ (1943) 629

⁷¹ Lauren Henry Scholz, ‘Algorithmic Contracts’ (2017) 131

Interestingly, moving towards algorithmic contracting (to the extent that is possible as some contracts still require some form of human performance) would therefore entail entrusting technologies to perform a key function; algorithmic or smart contracts for instance offer the benefit of automating the performance of the agreement, while self-driving contracts would automate the drafting process using machine intelligence.

Nevertheless, in light of the high-stake work entrusted to technology in other industries such as finance or medicine, allowing algorithms to perform contracts possibly appears as a realistic and timely undertaking, aligning with the demands and capabilities of our time.

2. Towards a New Era of Automated Contracting?

2.1 Considerations of Scope

Although the above statement will be nuanced and discussed throughout this paper, it remains as discussed in Chapter 1 that technologies are now profusely used in industry to facilitate processes, and even more so when tasks are numerous and repetitive, and arguably ‘automatable’ as a result. Such tasks by their very nature in turn allow to derive most value from that automation, justifying therefore the use of technologies. From a commercial perspective this is desirable as it can allow industry players, to save both time and money⁷².

As discussed earlier in this chapter, contracting is a pervasive undertaking in society, and essentially the process by which virtually all transactions and exchanges are performed, governing how parties essentially formalise the promises they make with one another. From the perspective of commercial transactions more specifically, it would appear *prima facie* that contracting is a field prone to automation as the benefits of simplifying such a common, recurring and repetitive yet time-consuming and arguably tedious process would allow to benefit from the advantages of automation brought by algorithmic contracts.

More interestingly perhaps, contract drafting has often been deemed analogous to computer programming to the extent that both follow similar conditional structure that mimics ‘if X happens, then Y, else Z’: This structure is required for a computer code to operate, but also reflects the reciprocal nature of contractual exchanges. This similarity between contracts and code will be discussed more extensively and nuanced in the next chapter, but remains relevant for the present discussion to the extent that it identifies furthermore contracting as a practice

⁷² This will be discussed in more detail in part II

suitable for technology integration, as indeed the discussion held in this paper relies entirely on this promise. In terms of *scope* therefore, contracting seems to be a suitable field to be subject to some form of automation.

2.2 Considerations of Timing

In line with the discussion held in Chapter 1, contract review software which are able to review large amounts of documents in little time to extract relevant information represent one key application of technology in the field of contracting. Similarly, technology-enabled drafting tools have been developed, although they are for now most appropriate for drafting ‘simple’ contracts that can be based on existing templates or approximate existing documents, such as real estate leases, divorce papers or trusts, but not complex commercial agreements for instance⁷³.

While inherently limited therefore, these tools nonetheless evidence already a move towards technology-facilitated contracting, and may suggest a future acceptance of technology to further automate and streamline high-volume contracting practices, or more realistically for now, to offer solutions to automate refunds, payments, ordering processes...⁷⁴ From a commercial or legal adoption perspective therefore, it may therefore be that users would be willing to experiment with algorithmic contracts, arguably even more so as we move away from the ‘technophobic’ approach to legal work discussed earlier⁷⁵.

In terms of *timing* therefore, now seems to be the perfect time to experiment furthermore with technology in contracting processes, perhaps moving to automating it, as indeed many scholars and professionals are contemplating. Similarly, now also appears to be the right time to consider regulatory matters, as the UKJT recently did in relation to smart contracts for instance⁷⁶, justifying furthermore the timeliness of the discussion held in this paper.

2.3 The Logical Next Step in Contracting?

⁷³ Betts and Jaep (n 47) 220

⁷⁴ Even though adopting a long-term and futurist view, this paper recognises that the promise of algorithmic contracts, and especially smart contracts remains limited for now to the confines of simple and deterministic transactions such as the processing of payments, orders, refunds...

⁷⁵ Provided that there are no deterring hurdles that would otherwise see parties ‘remain’ traditional.

⁷⁶ See generally UKJT (n 67)

While from both a *scope* and *timing* perspective the move towards algorithmic contracting appears as a logical one, the practice of contracting seemed for a long time shielded from technological integration, as a traditional and established way of conducting legal work led to the assumption until recently that complex contract drafting could only be done by lawyers⁷⁷. The problematic was that legal professionals could not foresee how technology could help in the process, as legal skills and legal thinking have long been considered out of the reach of machine intelligence which could not replicate it⁷⁸. Yet, today technology tools are capable of drafting simple contracts or documents, suggesting the progress of the field of contracting, as scholars and technology experts now contemplate more ambitious technology-driven contractual endeavours. Indeed, supporters of greater technological integration into contracting processes now foresee the applicability of a myriad of technologies and techniques to automate the conclusion of agreements, as technologies such as the Blockchain, and Artificial Intelligence on top of the use of computer code, have all been envisaged to enable new forms of contracting, which will be discussed in more detail throughout part II. This is more broadly the promise on which the discussion held in this paper relies.

While some may view a possible move towards algorithmic contracts as a radical digitalization of the process which arguably departs from existing contractual norms, others approach this algorithmic integration into contracting, and the resulting automation of the process, as simply a new *logical* era in the ‘codification’ of legal agreements as allowed by technological advances. This development would in many ways be similar to the emergence of the printing press in the 14th Century⁷⁹, which was a revolution at the time, departing from medieval oral contracting practices, and which led to a move towards the ‘written’ agreements on paper we know today. Arguably, this move towards ‘written’ contracts brought numerous advantages at the time (not least the possibility to keep proof of the terms of an agreement), evidencing some form of progress towards ‘improved’ contracting practices.

It is therefore possible to consider that code is simply a newer form of ‘writing’ and which matches the views of our digital world⁸⁰. Following this view, it may therefore be that the move towards algorithmic contracting is simply the *logical* next step in the development of contracting, making use of a new form of writing that is now available (i.e. computer code) and which offers more ‘benefits’ than the simple human language ‘writing’ practices we know

⁷⁷ Betts and Jaep (n 47) 216

⁷⁸ *ibid*

⁷⁹ Michele Finck, *Blockchain Regulation and Governance in Europe* (Cambridge University Press 2018) 67

⁸⁰ See David J Harvey, *Collisions in the Digital Paradigm* (Bloomsbury Publishing 2019). He claims that writing is a form of code.

today, evidencing a similar form of progress towards improved contracting experiences. Advantages of computer automation, combination with various technologies or the possibility to derive forms of business analytics thanks to a computer code foundation would certainly differentiate the offering of algorithmic contracts from that of their ‘plain’ written counterparts. We may therefore be progressing towards contracting practices that match the pace, demands and digitalisation of the 21st century.

In fact, contracting practices have already progressed from paper written forms to word-processed/digital ones. While the way a contract is drawn would arguably depend largely on party preferences, from a technological view point it would seem that the next step towards a full automation of the process would be in relation to automating contracting processes altogether. The promise of algorithmic contracts therefore appears fitting.

Moreover, technology and more precisely the data behind the technology is already what drives many contractual relationships across numerous platforms and what allows parties to identify potential targets/partners: e-commerce website channel buyers towards sellers, ride-ordering/sharing applications connect drivers with travellers, while hotel/hosting platforms such as Airbnb connect hosts with guests⁸¹. Parties to these contracts which are arguably already commonplace, at least in the Western world, are therefore already experiencing some form of technology-‘advanced’ contracting, arguably without even paying much attention to it.

Overall therefore, algorithmic contracts could be the embodiment of technological progress in contracting, aligning the practice with the wider digital wave that presently redefines how business is conducted, and with the demands and capabilities of our digital economy more broadly⁸².

2.4 An Early Promise

While this paper supports the view that algorithmic contracting *could* be the logical next step in order to bring contracting processes ‘into the 21st century’, it also acknowledges that many of the solutions under scrutiny as part of this analysis of algorithmic contracting are still at their infancy (self-driving contracts are still at a concept stage), while some may not yet be suitable for commercial implementation altogether due to the various risks, challenges and limitations

⁸¹ Stefan Grundman and Philipp Hacker, ‘Digital Technology as a Challenge to European Contract Law’ (2017) 18

⁸² This statement will be nuanced throughout the paper but remains purposeful for this present discussion.

they pose⁸³. It also recognises the possibility that they may never come to be suitable for commercial integration altogether, and that we may in fact be experiencing the most ‘advanced’ stage in algorithmic contract use⁸⁴.

Yet evaluating and forecasting demand for such products at an early stage, and identifying limitations to their development could allow to determine their possible place within a future contracting landscape, and motivate proactive regulatory input that could surround their development from the outset. As will be discussed more extensively in part III, the objective through this proactive approach would be to motivate rather than stifle innovation, justifying the timing of the discussion held in this paper which seeks to explore a digital future of contracting nonetheless. In pursuing its analysis of algorithmic contracts, it will aim to determine whether they could realistically aim to represent the future of contracting and in turn how a regulation of the challenges they raise could take shape, or whether they would likely remain in the realm of a contractual techno-utopia altogether.

Indeed, in line with the commercial perspective adopted in this paper, too many hurdles or challenges, or too high legal uncertainty on the matter could result in legal departments remaining ‘traditional’ in their contracting practices which have been ‘tried and tested’ over the course of centuries. These ‘current’ contracting practices are arguably already effective in achieving their set purpose of formalising relationships between parties.

The wider implementation of algorithmic contracts which do not offer a new solution to a *new* problem as much as they promise to facilitate *existing* processes⁸⁵ could appear justified in line of the digitisation of work and the ‘perfect storm’ of factors that pave for a similar digitalisation of contracting. But this move towards algorithmic contracts would nonetheless depend on the added-value they offer, when compared with ‘traditional’ contracting practices.

In deciding whether to adopt these technologies therefore, commercial players would therefore likely only proceed with implementing algorithmic contracting methods, if the benefits of doing so outweigh the risks, and if algorithmic contracts add more value than existing contracting techniques would. While the various advantages brought by algorithmic contracts could make it seem so, they remain to be discussed and balanced against the various challenges they pose too, as will be done throughout part II.

⁸³ Challenges and limitations will be discussed in part II.

⁸⁴ In the form of financial algorithmic contracts and very limited applications of smart contracts.

⁸⁵ Paul Todd, ‘Electronic Bills of Lading, Blockchains and Smart Contracts’ (2019) 339. In relation to the Blockchain and Smart Contracts: ‘They make no difference to what is possible but to what is practicable’.

3. A Need for Algorithmic Contracting?

3.1 A Response to Commercial Shortcomings

As it has been established that the move towards algorithmic contracting could be a logical one in light of the increasing technological capabilities and shifting industry preferences of our digital economy, it remains that despite increasing levels of technological connectivity and digital progression, practices relating to contract drafting, reviewing, monitoring and execution remain lagging when considering the pace and levels of automation seen in other business practices⁸⁶.

Yet in the US alone, it is estimated that a typical fortune 1000 company will manage between 20,000-40,000 contracts at any point in time⁸⁷. It is reasonable to infer that similarly high numbers will also be reached by large companies around the world, which prompts the idea that a solution to automate the performance of such contracts will be welcomed (to the extent that said contracts are indeed amenable to computer form to be automated in the first place). As discussed earlier, some legal technology contracting tools are already offering solutions to facilitate contract management, but it is also possible to infer that algorithmic contracts automating contracting altogether would offer an even more attractive promise.

Moreover, it is also estimated that about 83% of businesses are not satisfied with their current contracting practices which they deem too slow and cumbersome⁸⁸, as they tend to rely less on outside law firms and pay less for legal services, all while reporting an increase in legal work⁸⁹. Algorithmic contracting *could* therefore be a desirable solution to these identified ‘pain points’ by allowing to streamline the drafting and/or performance of agreements, and lower costs overall.

While this promise will be discussed extensively in part II it remains that the finance industry in which the sheer number of transactions, and the predisposition of many financial transactions to be suitable for translation into code⁹⁰, has already *successfully* justified the move towards some form of algorithmic contracting, as discussed in relation to algorithmic trading or robo-

⁸⁶ John Cummins and Christopher D Clack, ‘Transforming commercial contracts through computable contracting’ (2020) 1

⁸⁷ LawGeex (n 44)

⁸⁸ *ibid*

⁸⁹ Eegan Minn, ‘Legal Departments Facing More Work and Using Cost Controls’, (*Legal Executive Institute*, 5 June 2017) < <https://www.thomsonreuters.com/en/press-releases/2017/june/thomson-reuters-legal-tracker-ldo-index-report.html> > accessed 18 April 2021

⁹⁰ Due to the fact that they are mainly based on deterministic data.

advising for instance. A similar response, yet broader in encompassing more types of transactions could therefore be envisaged, positioning algorithmic contracts as a similarly attractive commercial solution as a result. This is indeed the promise behind smart contracts which have already been experimented with by industry players to automate the processing of payments, refunds or orders, as will be discussed more extensively in Chapter 4.

Following this commercial view that positions automated contracting as a promising solution to identified shortcomings, it also emerges that inefficient contracting leads firms to lose between 5% and 40% of value depending on circumstances⁹¹. Similarly, it has been established that efficient contract management could improve profitability by what would equal 9% of annual revenue⁹² while accounting firm KPMG identified that ineffective governance of contracts could lead to 17 to 40% of lost value⁹³.

The commercial promise of algorithmic contracts therefore appears to extend beyond facilitating tedious contracting processes to actually offer the possibility of improving financial performance through more effective contract management. This commercial impetus therefore supports the promise of algorithmic contracting, and justifies furthermore the discussion held in this paper.

3.2 A Unique Commercial Promise in itself

While offering a promising response to identified commercial shortcomings, algorithmic contracts may offer completely novel advantages of their own, deriving from their underlying technologies:

While the unique advantages of algorithmic contracts will be discussed more extensively over the next chapters, it remains that their algorithmic nature grants them numerous features that may appear attractive to industry players wishing not only to streamline their contracting process but also derive value from them:

The foundation of computer code can for instance allow to automate the operation of straightforward agreements⁹⁴, and allow other ‘more advanced’ technologies to operate on top

⁹¹ Beverly Rich, ‘How AI is Changing Contracts’ (Harvard Business Review, 12 February 2018) <<https://hbr.org/2018/02/how-ai-is-changing-contracts>> accessed 18 May 2021

⁹² Cummins and Clack (n 86) 2. Based on research by the IACCM.

⁹³ Peter Liddell and others, ‘Supply Chain Capacity Management – The Key to Value’, (KPMG, 21 March 2017) <<https://home.kpmg/au/en/home/insights/2017/03/supply-chain-capacity-management.html>> accessed 14 September 2021

⁹⁴ Recognising that more complex transactions may be more difficult to translate into code as will be discussed more extensively in chapter 3.

of it. Adding blockchain features, offers the promise of guaranteed performance and the safety of a tamper-proof foundation of code. While using artificial intelligence could allow to draft appropriate contract terms for every contingency, in a process that would surpass human capabilities.

Even for individual users, the promise of algorithmic contracting is intriguing, especially if contracts are ‘connected’ with other devices or objects to facilitate daily tasks, such as the rental of products, or the automated ordering of products or services...⁹⁵. While from the perspective of corporates offering these novel services/products the potential of algorithmic contracting could be similarly great. The promise offered by algorithmic contracting therefore goes beyond facilitating the work of legal departments to indeed offer solutions for corporates across a wide spectrum of industries, suggesting therefore a great commercial potential overall, and justifying furthermore the analysis held in this paper.

4. Conclusion

As the broader socio-economic ‘perfect storm’ for the development of algorithmic contracts was laid out in Chapter 1, combining the availability of infinite data as a precious resource, changing industry preferences and a digitalising legal sector, this chapter focused on the commercial impetus that could predispose the technology behind algorithmic contracts to develop in commercial settings.

As such, it appears that algorithmic contracts could offer solutions to identified shortcomings found in existing contractual practices, while offering novel solutions altogether which would surpass what is currently achievable through human input only.

While this promise is to be nuanced with limitations and challenges posed by algorithmic contracts, as will be extensively done over part II, this first part of the dissertation laid out the justification behind a thorough analysis of algorithmic contracts, and their place within the future of contracting. Now indeed seems to be the time to undertake this discussion, and in turn consider how regulatory input could take shape so as to enable these novel concepts to redefine what it means to contract.

⁹⁵ These examples will be discussed in more depth in Chapter 4 as it looks at smart contracts.

PART II

print('Contract')⁹⁶: Contracts as Algorithms

⁹⁶ The print function in computer programming usually aims to print the specific message in brackets onto the screen. In the context of this part of the paper, the desired output called through this function would be the algorithmic contract, written in computer code.

CHAPTER 3

Algorithmic Contracts

Part I of this paper outlined how increased data availability and continuously-developing technologies were reshaping the human experience, and ushering us in a digital economy strongly driven by technological advancement. It also outlined how various industries, including the legal sector, were similarly driven by this ‘digital wave’ that could pave the way for both the development and adoption of algorithmic contracts in industry, and perhaps a legal recognition of the practices they enable.

In light of the promising commercial solution they offer in response to identified shortcomings in existing contractual practices, the potential of algorithmic contracts appears evident, justifying therefore the discussion held in this paper.

As this ‘perfect storm’ that *could* predispose a successful growth of algorithmic contracts has been laid out, this second part of the paper will now explore the concept in more detail, evaluating the advantages it may offer against the challenges it may raise, so as to draw a fuller and more accurate picture of the future of contracting, and the place of algorithmic contracts within it.

To introduce this discussion, this chapter will begin by analyzing the ‘simpler’ end of algorithmic contracting, in the form of ‘plain’ algorithmic or computable contracts whose performance relies solely on the use of computer code.

This chapter will begin by defining the concept, with reference to the work of scholars Harry Surden and Lauren Scholz on the matter, to then move on to outlining the main advantages computer code may bring to the practice of contracting. Discussing this promise with various challenges that arise out of the use of algorithms in the process, especially in relation to the translation from the contract into code, this chapter will also start an important discussion regarding the role of the algorithm in automating contracts.

In evaluating the commercial solution proposed by these ‘basic’ algorithmic contracts, this chapter will also have regards to the broader ‘architecture’ within which they operate. This dissertation indeed considers that algorithmic contracts do not operate in a vacuum, in which case the discussion held throughout this part of the paper will endeavor to account for the

various legal, technical, commercial and social considerations that may weigh in the development of the technology.

1. An Introduction to Algorithmic Contracting

1.1 Definition

Although the idea of algorithmic contracts has been discussed to some extent already, it is worth reiterating that this paper takes the definition of algorithmic contracts as contracts in which the terms of the agreements have been fully, or partly set out in code.

Following a definition of algorithmic contracts similar to that given by scholar Lauren Scholz in her paper of the same name⁹⁷, this foundation of computer code can in turn allow the automation of the performance of the algorithm, which can take the role of more than mere tool but that of agent of the parties, depending on the importance, complexity and predictability of the decision-making that is delegated to it⁹⁸.

Similarly, scholar Harry Surden defines the concept as ‘computable’ contracts, which are essentially agreements in which terms have been translated into computer processable and understandable form (i.e. code) so as to enable the computer to operate it⁹⁹.

As will be discussed over the next chapters, with this computer code foundation, it may be possible to envisage a full automation of the agreement (including its initiation) through the use of sensors and data-gathering technologies¹⁰⁰ or even the drafting of the contract terms using machine intelligence¹⁰¹. This discussion as regards ‘capabilities’ of algorithmic contracts will therefore be a gradual one, shining light on the potential of algorithmic contracts to undergo technological progress, but also to suggest the broader promise of a fully machine-driven contracting experience in the future.

1.2 The Commercial Potential of Algorithmic Contracts

⁹⁷ Scholz, ‘Algorithmic Contracts’ (n 71) 128. She defines algorithmic contracts as contracts in which an algorithm determines a party’s obligations (acting as a negotiator or gap-filler) or which terms they should accept.

⁹⁸ See generally Scholz, ‘Algorithmic Contracts’ (n 71)

⁹⁹ See generally Surden (n 48) In his paper he differentiates *data-oriented* contracts which are ‘readable’ by the computer, with actual *computable* contracts in which meaning has been conveyed to the code so as to allow the computer to act on it and determine compliance with certain conditions.

¹⁰⁰ As will be discussed in the case of Smart Contracts in Chapter 4.

¹⁰¹ As will be discussed in the case of Self-Driving Contracts in Chapter 5.

1.2.1 Automation of the exchange

As the concept behind algorithmic contracts has been defined, it indeed emerges that scholars and professionals have already envisaged how it could help facilitate, and more interestingly automate exchanges:

Harry Surden for instance draws in his paper the idea that computable contracts can help make deterministic assessments, such as that of expiration dates after which contractual options may no longer be valid¹⁰². Similarly, he expects that algorithmic contracts may be found within financial contracts as core terms such as price, quantity, and payment dates could be expressed in computer-processable form¹⁰³. Offering the promise of a more digitalised approach to contracting, algorithmic contracts have indeed already been identified to be suitable to facilitate financial transactions¹⁰⁴, as discussed earlier in this paper in relation to the practice of algorithmic trading or through the use of robo-advisors which provide financial advice to clients.

In a more ‘commercial’ field, Stanford’s SIPX (Stanford Intellectual Property Exchange) project is another example of the technology, in which computable IP and licensing terms allow users to bypass the time-consuming and high-cost nature of getting permission to use content. Instead, the computer automates the determination of conformance with said IP/licensing terms, and allocates permission accordingly¹⁰⁵. More recently even, Stanford’s CodeX Initiative Working Group has been working on a computable contract concept that would automate insurance contracting processes, and enable greater quality and efficiency for insurance firms whose product offering lies in the contracts they sell to their clients¹⁰⁶. The promise of algorithmic contracts thus far therefore seems to lie in enabling more efficient and ‘facilitated’ ways of contracting, through the use of computer code.

While this statement will be discussed against the various limitations and challenges these contracts raise, it remains nonetheless in line with the ‘digital wave’ that currently sees numerous industries seeking new ways of conducting work more efficiently and at lower costs. In light of the ‘pain points’ identified in chapter 2 in relation to commercial contract

¹⁰² Surden (n 48) 648-649. As he discusses the capabilities of ‘data-driven’ contracts.

¹⁰³ *ibid* 648

¹⁰⁴ *ibid* 641

¹⁰⁵ Stanford Law School ‘Stanford Intellectual Property Exchange’ (*Stanford Law School*) <<https://law.stanford.edu/projects/stanford-intellectual-property-exchange/>> accessed 11 June 2021

¹⁰⁶ See CodeX, ‘Computable Contracts and Insurance’ (*Stanford Law School*, 12 May 2021) <<https://law.stanford.edu/2021/05/12/computable-contracts-and-insurance-an-introduction/>> accessed 11 June 2021

management more specifically, automated contracting solutions could indeed offer relief to parties which have to keep on top of numerous contractual obligations. While it remains difficult at this stage of the development of the technology to predict the extent to which these contracting methods will actually gain and/or sustain adoption in the future and in which areas they will¹⁰⁷, it remains purposeful to undertake a focused analysis on their promise at this time, and identify any challenges they may raise with a view to resolving them in a proactive manner.

1.2.2 Mass Customisation?

In addition to aiding and facilitating contract management through the promise of automating agreements through code, it also emerges that computer code can be reproduced at virtually zero cost and can be modified and spread around the world at relatively high speed¹⁰⁸, essentially allowing to ‘re-use’ it in a practice that could simplify and streamline contract drafting too.

Indeed, strengthening the commercial promise of algorithmic contracts, this translation of natural language to more ‘universal’ code¹⁰⁹ could enable the creation of pre-defined formats and standards that could be scaled and shared easily, and therefore allow to bypass the need to translate human language clauses into computer-processable form for *every* transaction. Offering the promise of rendering contract drafting more modular, this ‘restructuring’ of how contracts are expressed would be in line with a broader idea that contracts follow a pattern language which can result in overall reduced drafting costs¹¹⁰ through a possible streamlining of algorithmic contract drafting:

Scholar Eric Gerding indeed very accurately identified that contracts follow a pattern language made up of symbols and rules which form the conceptual building blocks of the practice¹¹¹. As he envisaged in his paper that these patterns could be examined in large amounts to then create standards¹¹², it follows that a similar standardisation of algorithmic contract code could take place, allowing parties to re-use standard coded terms to automate their agreements. In fact, such a solution is already proposed in the form of the CommonAccord Project which aims to see smart contract templates stored in online libraries to be used and updated by users on an

¹⁰⁷ Surden (n 48) 698

¹⁰⁸ Primavera De Filippi and Sameer Hassan, ‘Blockchain Technology as a Regulatory Technology’ (2016) 6

¹⁰⁹ To the extent that programming languages can be understood by computers all around the world.

¹¹⁰ Henry E. Smith, ‘Modularity in Contracts: Boilerplate and Information Flow’ (2006) 1187–1188

¹¹¹ Erik F Gerding, ‘Contracts as a Pattern Language’ (2013) 1336

¹¹² See generally Smith (n 110)

open-source manner¹¹³. As a result, it may be imagined that programmers work together and share knowledge and innovation¹¹⁴, rendering the process of algorithmic contracting more collaborative, while ensuring better quality of contract code overall.

In the algorithmic contracting realm, parties could therefore possibly expect to choose from a library of coded contract terms, assemble them and even possibly customise them to create bespoke contracts to match their needs, hereby moving towards some ‘Mass Customization’¹¹⁵ of contract drafting. Algorithmic contracts could therefore entail a very interesting design shift in what is currently understood as contract drafting, offering a promising commercial narrative that justifies further investigation on the solution they propose.

While it could be argued that natural language clauses can already be ‘saved’ and ‘re-used’ already in our current contracting practices, as discussed in Chapter 1 in relation to the various contract management tools, they do not offer the benefit of being ‘re-used’ for automation purposes: rethinking this way that contracts are expressed and structured in code can not only streamline contract drafting, but also allow to derive and scale the improvements in productivity code may enable¹¹⁶, following the view that should contracts remain expressed in natural human language, users could miss out on the digital features offered by computer code.

As contracts today are still deemed to remain non-modular and difficult to read¹¹⁷, despite visible efforts to digitalise the process as discussed in part 1, and an ambition to use simpler legal language¹¹⁸, the solution offered by coded-contracts appears indeed promising and interesting, likely re-defining what it means to draft a contract.

1.2.3 Business Analytics

In addition to automating contractual operations and offering the possibility to streamline contract drafting, this same foundation of computer code can also allow parties to derive business intelligence by allowing them to gather insights relating to

¹¹³ See generally Jim Hazard and Thomas Hardjono, ‘CommonAccord : Towards a Foundation for Smart Contracts in Future Blockchains’ (*W3C Position Paper*, 9 June 2016) <<https://www.w3.org/2016/04/blockchain-workshop/interest/hazard-hardjono.html>> accessed 26 September 2021

¹¹⁴ Helena Haapio and Margaret Hagan, ‘Design Patterns for Contracts’ (2016) 4

¹¹⁵ Mass customisation combines the possibility to personalise (custom-made) products which are produced in mass at lower costs. (See Maya Dollarhide, ‘Mass Customisation’ (*Investopedia*, 20 October 2020) <<https://www.investopedia.com/terms/m/masscustomization.asp>> accessed 30 September 2021)

¹¹⁶ Cummins and Clack, ‘Transforming commercial contracts through computable contracting’ (n 86) 3

¹¹⁷ *ibid* 2

¹¹⁸ Shawn Burton, ‘The Case for Plain Language Contracts’ (*Harvard Business Review*, January-February 2018) <<https://hbr.org/2018/01/the-case-for-plain-language-contracts>> accessed 26 September 2021

licensing/manufacturing/purchasing/payments...¹¹⁹. Considering the potential commercial improvements that can be derived from insightful contractual information, the commercial promise of algorithmic contracts could therefore strengthen their position as a more 21st century-aligned vision of contracting.

1.3 Functional and Operational Equivalence

As the commercial advantages of these ‘simple’ algorithmic contracts have been laid out, it also emerges that these ‘simple’ algorithmic contracts do not offer *prima facie a modus operandi* that significantly challenges (1) how contracts are drafted (apart from the different language they operate in)¹²⁰ and (2) how courts and the law apply to them¹²¹.

For the purposes of this paper, this is important as it could offer justification for commercial parties to experiment with the technology as at this ‘level of automation’, the practice appears reconcilable to a great extent with what is currently known as contracting.

From a legal perspective similarly, this equivalence could suggest that algorithmic contracts could still ‘easily’ fall within the reach of contract law, which would be able to offer its protection to parties. Overall this would justify the possibility to experiment with the technology in a ‘safe’ manner within the reach of legal oversight.

1.3.1 Functional equivalence

As discussed earlier in relation to a commercial risk/benefit analysis that could justify parties remaining ‘traditional’ in their contracting practices, this promise of *functional equivalence* is an important one that could predispose a possible further development and acceptance of the algorithmic contracts as a viable and safe form of contracting.

Indeed, the principal function of algorithmic contracts as envisaged in this paper remains the same as that of more ‘traditional’ contracts: It essentially lies in formalising the relationship and exchange between parties. While it adds the possibility of automating it, the underlying *purpose* remains the same. The concept of algorithmic contracting at this level may therefore seem less ‘foreign’ to commercial parties being risk-averse in their practices.

¹¹⁹ Surden (n 48) 693

¹²⁰ To the extent that the actual contract drafting is still done by human parties.

¹²¹ *Ex post* legal intervention remains indeed possible unlike in the case of smart contracts where their immutability prevents it, as will be discussed in Chapter 4.

1.3.2 Operational Equivalence

More interestingly, it also emerges that these ‘plain’ algorithmic contracts are also the most *operationally equivalent* form of algorithmic contracting too, when compared with more ‘advanced’ forms of the concept.

Indeed, this seeming operational equivalence which looks at the actual *modus operandi* of algorithmic contracts highlights the fact that apart from the translation of terms into code¹²² and the possible resulting automation of the agreement, algorithmic contracts do not appear to depart from what is currently known as contracting: Parties still agree on some terms, undergo (with the possible help of a skilled programmer) a drafting exercise, and may have recourse to legal help in the case where ‘things go wrong’. In a similar way, existing legal doctrines (such as offer, consideration, acceptance and intention to create legal relations) could apply as usual to the extent that such aspects of the contractual relationship are ‘unaffected’ at this level of automation. In comparison, more ‘advanced’ forms of algorithmic contracting may keep parties somewhat ‘out of the loop’ of the contract, restrict their ability to re-shape their agreement as they wish, or may limit the possibility of legal recourse altogether¹²³.

From a legal perspective, the operational equivalence of ‘simple’ algorithmic contracts is therefore what could position them as most viable at present, as legal remedies and recourse also remain available ‘as usual’: courts and parties can alter, stop or reverse the operation of computable/algorithmic contracts as necessary, unlike in the case of smart contracts for instance where a feature of immutability may restrict it as will be discussed in Chapter 4.

Parties to a ‘plain’ algorithmic contract could instead be expected to bargain in the ‘shadow of the law’, with the awareness that they would still be contracting within the reach of expected legal outcomes. At this ‘basic’ level of algorithmic contracting therefore, and in light of both a seeming *functional* and *operational* equivalence, there is no evident departure from our current contracting paradigm that would justify *not* experimenting with them.

2. Contract as Code

2.1 Broad Legal Challenges of Code

¹²² Which raises its own challenges and will be discussed in more detail in the next part of this discussion.

¹²³ These claims will be discussed in more detail in Chapters 4 and 5.

While it has been outlined algorithmic contracts offer a strong commercial promise that remains both somewhat functionally and operationally aligned with current contracting practices, and as a result ‘safe’ to experiment with, it has also been established that they still depart from our contracting paradigm to the extent that they rely on a foundation of computer code, which raises its own challenges and requirements.

From a legal perspective, this use of computer code to set the terms of the agreement for instance raises interesting reflexions regarding some basic principles of contract law regarding the use of machine language, how it is understood and whether it is acceptable for parties to find themselves bound by a language they cannot necessarily understand. These will be explored in more depth in Chapter 7 as it attempts to reconcile the peculiarities of code-based contracting with legal principles.

This same use of code as contracting language also invites consideration as to who is indeed capable of undertaking that drafting in the first place. Indeed, certain jurisdictions do not allow laypeople to draft legal documents, as the practice of law is instead restricted to lawyers only¹²⁴. Algorithmic contracts on the other hand would need to be programmed by someone with the relevant skills, therefore re-defining who is in a position to undertake contract drafting.

While not limitations *per se*, these matters would likely warrant legal consideration should the practice indeed aim to become a mainstream commercial occurrence.

2.2 Translating a Contract into Code

From a more ‘technical’ viewpoint, in the purely ‘algorithmic’ contracting realm, the operation of the agreement relies on the operation of the underlying computer code, and therefore on the ability of the parties to translate their intentions *accurately* and *precisely* into such code.

Focusing on the ‘drafting’ stage in the algorithmic contract lifecycle, this part of the chapter will explore difficulties of undertaking this translation.

As very well pointed by Surden as he breaks down computable contracting in two stages (i.e. data-oriented vs computable contracts)¹²⁵, algorithmic contracts require a translation of the

¹²⁴ Even within the US the definition of authorized practice of law differs from one state to another. See American Bar Association, ‘State Definitions of the Practice of Law’ (*American Bar Association*) <https://www.americanbar.org/content/dam/aba/administrative/professional_responsibility/model_def_migrated/model_def_statutes.pdf> accessed 30 September 2021

¹²⁵ See generally Surden (n 48). Data-oriented contracts refer to contracts in which terms are expressed in computer-readable form while computable contracts are able to make assessments of conformance with certain criteria

contract from natural human language into computer-processable form, in a way that can both be (1) *processed and* (2) *understood* by the computer¹²⁶.

In light of the apparent structural similarities between contracts and computer code discussed earlier in this paper, as both follow a similar conditional structure and logic (programming languages often follow specific functions (called Boolean) that adopt the ‘if X happens then Y happens else Z happens’ structure that is indeed very similar to the reciprocal conditions imposed in an agreement or exchange), this translation exercise appears *prima facie* realistic.

Scholars indeed recognise that in contract law, promises are made in exchange for other promises¹²⁷, following indeed some form of Boolean logic already which can be easily formalized in a mathematical manner¹²⁸. This feature could certainly justify the interest surrounding algorithmic contracts, as the possibility to integrate computer capabilities seems clear, and makes for an interesting scholarly discussion linking the strand of the literature on technology with that on law.

More relevant for the purposes of this paper, these similarities between contract and code offer a strong commercial promise, as discussed already in relation to the possibility to automate the agreement, streamline contract drafting, and to be based on, and generate some form of business intelligence, considering that these algorithms could find connections or pursue logics that humans would not necessarily foresee¹²⁹.

But while this promise of reconciling contract and code appears realistic and more importantly desirable, it raises numerous challenges that warrant further consideration:

Indeed, this transposition from contract to code, seemingly a ‘simple’ translation exercise requires not only translating terms into computer form, but most importantly conveying the meaning of those terms to the computer for execution so that it operates *as intended*.

This translation from contract to code must therefore be a careful and purposeful one as code will be the main expression of some contract terms, as opposed to the natural human descriptive language otherwise used in our current contracting paradigm¹³⁰ and which can be interpreted by humans with more ‘flexibility’. As this code is essentially what will govern the automated operation of the contract in the algorithmic contract realm as it is meant to provide a precise

¹²⁶ See generally Surden (n 48)

¹²⁷ Paul Catchlove, ‘Smart Contracts: A New Era of Contract Use’ (2017) 8

¹²⁸ Oliver R Goodenough and Mark D Flood, ‘Contracts as Automation’ (2015) 2. For the same reasons that they can be expressed conditionally and in a deterministic manner and follow state-transition logics.

¹²⁹ Scholz, ‘Algorithmic Contracts’ (n 71) 160

¹³⁰ Surden (n 48) 640

code-based expression of contractual rights and obligations¹³¹, the burden on ensuring that such code is accurate is high.

Having regards therefore to both *syntax* and *semantics*¹³² of that code will therefore be key in ensuring that the contract will be both *processed* and *understood* as intended by the computer.

2.2.1 Considerations of Syntax

As discussed earlier, contracts and code seem to follow a similar conditional logic that renders both *theoretically* reconcilable:

But while this translation from contract to code is unlikely to raise issues for simple, structured and deterministic conditional scenarios (this application of code is very appropriate for deterministic transactions such as that of payments, orders or refunds, in which case the conditional logic enabled allows to decrease contractual ambiguity¹³³), should the terms of the contract be more ambiguous or open-ended in their expression, they become more challenging to translate into code. Indeed, any ambiguity in the way the contract is meant to be expressed cannot be translated in a similarly-ambiguous fashion in code as it must be capable of being integrated in the conditional ‘if X then Y else Z’ logic discussed earlier. More relevant, the code itself by its very nature must be precise enough so as to avoid any form of ambiguity or ‘bad programming’ that could result in bugs in, or more interestingly in the algorithm using ‘discretion’ to interpret poorly-coded terms, which brings its own legal issues as will be discussed shortly.

While this precise coding is possible to a great extent in various fields as suggested by the various examples of algorithms in industry and society earlier in this paper, the peculiarities of legal language render it more challenging to translate for computer processing.

Indeed, suggesting that the language of law is richer and more complex than what is allowed by computer programs¹³⁴, some abstract terms or legal terms of art such as ‘reasonableness’ or ‘best efforts’ can be challenging, if not impossible, to translate into code due to their inherently

¹³¹ Nina Gunther Kilbride, ‘Distributed Ledgers, Cryptography and Smart Contracts’ in Daniel Martin Katz and others (eds), *Legal Informatics* (Cambridge University Press 2021) 245

¹³² In computer programming, ‘Syntax’ is about the rules that make up the language (statements and expressions) and allows for computer processing, while ‘Semantics’ has regards to mapping the syntax with meaning. See Ralf Lammell, *Software Languages: Syntax, Semantics and Metaprogramming* (Springer 2018) 19

¹³³ Primavera de Filippi and Aaron Wright, *Blockchain and the law: The Rule of Code* (Harvard University Press 2018)

¹³⁴ Frank Pasquale, ‘A Rule of Persons, Not Machines’ (2018) 7

ambiguous nature that cannot be replicated into the unique form of structured, deterministic, and precise data required for computer processing.

The same issue applies in any situation which requires any form of human/professional judgement or evaluation¹³⁵, and which may also not be replicated by code with the same level of ‘openness’ without losing the flexibility granted by the use of such terms.

Indeed, while it may be possible to ‘break down’ these concepts into computer processable and actionable steps and instructions, this could be at the cost of the flexibility allowed by those terms, evidencing the extent to which this translation from contract to code is only possible and desirable to the extent that a contract is amenable into computer code, and that parties are willing to be bound by a less ‘flexible’ version of their agreement.

While it may be envisioned that some form of machine intelligence could allow the code ‘understand’ what these terms means within the context of the transaction¹³⁶, it remains that at this stage of algorithmic contracting, the translation from contract to code poses inherent limitations. It therefore emerges that precision granted by computer code is in no way more desirable than an imprecise human language, and could result in disputes if the underlying intentions of the parties cannot be accurately be expressed in code in the first place, following the view of scholar Jeremy Sklaroff, as he lays out this ‘cost of inflexibility’ of computer code in his paper on smart contracts¹³⁷.

In discussing this limitation to code-based contract drafting, scholar Jeffrey Lipshaw also accurately voiced that reconciling law, as a subjective and elastic language¹³⁸ with code which is an objective one amounts to bridging an irreconcilable bridge that would overall result in ‘dumb’ contracts persisting in the future¹³⁹. He therefore suggests that the inability of computer code to express the parties’ intentions with the desirable breadth would prevent the concept from scaling in the future.

While this paper takes the stance that this limitation of computer code does not tamper the promise of algorithmic contracts as the future of contracting altogether to the extent that they still offer a strong commercial promise, it does recognize that it limits its reach to ‘simpler’ and straightforward settings for now. The promise of self-driving contracts which could allow more

¹³⁵ Surden (n 48) 683

¹³⁶ Self-driving contracts may offer a solution to this issue using machine intelligence to draft contract terms that match the parties’ intentions.

¹³⁷ See generally Jeremy M Sklaroff, ‘Smart Contracts and the Cost of Inflexibility’ (2017)

¹³⁸ See generally the work of Grace Q Zhang who coined the term ‘elastic language’, referring to the inherent ‘vagueness’ of human language and how it is essential for effective communication (see generally Grace Q Zhang, *Elastic Language: How and Why we Stretch our Words* (Cambridge University Press 2015)).

¹³⁹ See generally Jeffrey M Lipshaw, ‘The Persistence of ‘Dumb’ Contracts’ (2018)

flexibility in the drafting through the use of machine intelligence could however support the statement that a future of (more flexible) algorithmic contracting may be foreseeable, as will be discussed more extensively in Chapter 5.

Looking at the same limitations of computer code from a more ‘relational’ view of contracting, following the work of scholars Stewart Macaulay and Ian Macneil on the subject, as they outline their views that contracting is a primarily social undertaking that enables parties to create or maintain long term relationships¹⁴⁰, it also emerges that the use of fully precise and deterministic code would prevent them from adapting their contractual endeavours as the situation evolves or in order to take advantage of opportunities as they arise. Algorithmic contracts would therefore be unsuitable for agreements in which the ability to adapt the agreement ongoingly is key, restricting therefore their applicability to settings which parties deliberately wish to be fully deterministic and unambiguous such as that of certain payments, refunds, orders... Similarly, scholar Hugh Collins identified that real-world contracting is made up of three components: the economic deal underlying the transaction, the business relationship between the parties and the contract itself¹⁴¹. Having regards to this framework, it therefore appears that algorithmic contracts only focus on one aspect of the process which is the contract itself, highlighting again the departure of algorithmic contracts from what is currently known as contracting. As such, the promise of algorithmic contracts as the future of contracting, while still an intriguing one, may be more limited.

2.2.2 Considerations of Semantics

While it emerges that *translating* a contract into code is indeed possible to some extent, the commercial promise of algorithmic contracts remains limited to the confines of certain deterministic scenarios, justifying therefore the limited reach of algorithmic contracts at present.

Interestingly, attempting to extend the concept to more complex endeavours in the future would entail the interesting task of *transmitting meaning* to code so that the computer understands and operates it *as intended*, and generates similar results than a human party would have reached¹⁴².

¹⁴⁰ This follows Macaulay and Macneil’s relational theories of contract that consider contracts as relationships rather than just discrete transactions. See Stuart Macaulay, ‘Non-Contractual Relationships in Business’ (1963); Ian Macneil, *Contracts: Instruments for Social Cooperation* (Sweet & Maxwell 1968)

¹⁴¹ See generally Hugh Collins, *Regulating Contracts* (Oxford University Press 1999)

¹⁴² Surden (n 48) 687

In computer science, this process of conveying meaning to code is known as the semantics of a programming language, through which a description regarding how to execute and evaluate the syntax is provided to the computer¹⁴³. In the same way that computer syntax needs to be very precise, with regards to semantics too, the code must reflect a completely unambiguous expression of the parties' intentions. This is to ensure that the computer will not bring 'its own meaning' to terms that can be interpreted in different ways, hereby running the risk of the code performing an agreement that departs from the parties' intentions. The argument is therefore that removing ambiguity would prevent the algorithm from finding connections that humans would have been unlikely to ascertain or foresee¹⁴⁴, giving parties the assurance that their agreement will unfold *as planned*. While ascertainable for the 'simple' payments/refund transactions that are by their very nature deterministic and simple enough to offer the guarantee that the automated operation of the contract will indeed go on as planned, in the case of more complex agreements, this promise is more nuanced.

Indeed, even if an agreement has been translated with utmost accuracy, it may still result in unforeseen outcomes, due to the fact that computers are hyper-literal in their understanding of code which they operate very much at face value. Indeed, even if a computer program appears straightforward enough to the human eye, it may nevertheless be interpreted in an unforeseen manner: To take an insightful example given in one of law firm Norton Rose Fulbright reports on smart contracts, one may give an algorithm the following instructions: '*Go to the shop and buy a newspaper. If there are any eggs, get a dozen*¹⁴⁵'. While a human party would buy a newspaper, and if available a dozen eggs, an algorithm could interpret this same sequence of instructions as needing to buy a newspaper, to check for eggs, and if any are available, to buy a dozen newspapers¹⁴⁶.

Any ambiguity in the way a contract is programmed could therefore lead the algorithm to operate in computationally accurate manner (to the extent that it indeed executes the code as programmed), yet in ways that could be unforeseen by the parties as evidenced with the newspaper/eggs example, evidencing the opaque thinking of algorithms. While this paper acknowledges that such an error is unlikely to occur in real-life, as programmers will usually be skilled enough in ensuring that a computer program will not contain any ambiguity that

¹⁴³ Lammell (n 132) 19

¹⁴⁴ Scholz, 'Algorithmic Contracts' (n 71) 132

¹⁴⁵ Norton Rose Fulbright 'Smart Contracts' (*NRF*, November 2019)

<<https://www.nortonrosefulbright.com/en/knowledge/publications/1bcd200/smart-contracts>> accessed 26 September 2021

¹⁴⁶ *ibid*

would result in misinterpretation, this interesting issue of algorithms going ‘rogue’ or exercising their own ‘discretion’ remains possible and would raise very interesting legal considerations as regards the allocation of *liability* in the case where the algorithm is the one departing from the parties’ intentions, and more broadly as regards its *role* in automating the contract.

This issue is of particular relevance considering that real-life examples of algorithms malfunctioning can be found: A book on flies sold on Amazon was for instance priced at \$24m by pricing algorithms that mistakenly adjusted prices based on that set by competitors¹⁴⁷, evidencing the possibility that algorithms can indeed perform in unintended ways. Leading to the unfortunate terminology of ‘Franken-Algorithms’¹⁴⁸, this possibility of code distorting the intentions of the parties nuances the promise of using algorithmic contracts to automate more elaborate scenarios, especially considering that setting up and testing code to avoid such errors may be costly and time-consuming. As such, the promise of algorithmic contracts for more complex or high-stake contractual endeavours is nuanced furthermore.

In some cases of algorithmic contracting, as for smart contracts, conveying meaning effectively and accurately is even more paramount as the code operating the agreement cannot be altered nor stopped once started due to the tamper-proof and immutable features granted by the blockchain¹⁴⁹. Similarly, in the case of self-driving contracts which self-generate clauses based on the parties’ intentions¹⁵⁰, these considerations gain in importance, otherwise running the risk of the algorithm setting terms that do not correspond to what the parties initially intended.

Having a clear system for accounting for the role of the algorithm, and more importantly allocating liability in the case where it fails to perform to standards or in line with the parties’ intentions appears therefore key, and will be discussed in greater depth in Chapter 7, as a more detailed legal analysis is undertaken.

Moving beyond the issue of the algorithm performing something ‘commercially unintended’, this gap between the design and coding of the algorithm, and what it ultimately performs may actually lead to serious ethical issues as the algorithm could engage in discriminatory, fraudulent or otherwise illegal behaviours¹⁵¹ given that it lacks the agency to draw the distinction between those, and more legitimate undertakings.

¹⁴⁷ Michael Eisen, Amazon’s \$23,698,655.93 book about flies (*Berkeley Blog*, 26 April 2011) <<https://blogs.berkeley.edu/2011/04/26/amazon%E2%80%99s-23698655-93-book-about-flies/>> accessed 26 September 2021

¹⁴⁸ Andrew Smith, ‘Franken Algorithms’ (*The Guardian*, 30 August 2018) <<https://www.theguardian.com/technology/2018/aug/29/coding-algorithms-frankenalgos-program-danger>> accessed 26 September 2021

¹⁴⁹ These will be discussed in greater detail in the next chapter.

¹⁵⁰ See generally Casey and Niblett, ‘Self-Driving Contracts’ (n 16)

¹⁵¹ Scholz, ‘Algorithmic Contracts’ (n 71) 132

This issue of the algorithm moving beyond the intentions or capacities of their authorizing entity is therefore an important one that would warrant prompt legal consideration regarding the role and agency of the algorithm in the process.

3. The Role of the Algorithm

According to scholar Lauren Scholz, the current stance of contract law on the role of the algorithm in algorithmic contracts currently relies on two assumptions: (1) that algorithms are mere tools, and that even if they are not (acting more as agents as will be discussed shortly), (2) that the parties to the agreement can understand and anticipate all possible outcomes¹⁵².

Both assumptions are however mistaken, as algorithmic contracts, as enabled by a spectrum of technologies, can take on great levels of contractual responsibility¹⁵³, suggesting that they are more than ‘mere tools’. They can also operate in unexpected ways, as discussed for instance in the case of algorithms performing contracts that depart from the parties’ intentions. Some form of update regarding the legal perception of algorithms is therefore called for.

3.1 Algorithms as Mere Tools Assumption

As regards the first assumption, it emerges that contract law currently assumes that algorithms are mere tools that can automate transactions¹⁵⁴. But as technologies grow evermore capable, we seem to be moving beyond this¹⁵⁵. This is especially relevant in light of the possibility of algorithms acquiring more responsibility and discretion in the contractual decision-making: In the case of smart contracts, algorithms can ‘initiate’ the agreement upon fulfilment of certain conditions, leading even to the possibility of devices capable of interacting with one another and concluding economic transactions even if those were not initially planned or agreed by the owner¹⁵⁶. Surden himself noted that algorithmic contracts may allow parties to achieve improved future contractual efficiency through code-enabled automation, which could enable some form of computer-to-computer contracting in which the computers would act as agents of their respective human parties¹⁵⁷. Similarly, in the self-driving contract realm, AI-led

¹⁵² See generally Scholz, ‘Algorithmic Contracts’ (n 71)

¹⁵³ As will be discussed more detail in Chapters 4 and 5.

¹⁵⁴ Scholz, ‘Algorithmic Contracts’ (n 71) 132

¹⁵⁵ *ibid* 133

¹⁵⁶ Surden (n 48) 695

¹⁵⁷ *ibid* 694

algorithms could exercise discretion in determining the best contract terms to achieve a broad contractual objective¹⁵⁸.

As the role of algorithms seems poised to evolve within the algorithmic contracting realm to that more akin to that of an agent of the parties, contracting on their behalf, it appears logical to move away from this ‘mere tool’ assumption too.

While interesting again from the perspective of commercial parties wishing to derive benefits of computer code within their contracting practices, from a legal perspective, this move away from the ‘mere tools’ assumption would suggest that some form of legal update to account for the more ambitious role of algorithms in the process is warranted. Arguably, only then will parties feel ‘safe’ that the ‘role’ of algorithms in the process accounted for, and that they will be protected in the case where ‘things go wrong’: the use of agency law to achieve such an objective appears warranted, as will be discussed more extensively in Chapter 7 as solutions are proposed to address legal challenges arising out of algorithmic contract practices.

3.2 Possibility to Foresee all Outcomes Assumption

While recognising that algorithms may be more than ‘mere tools’ is indeed key, it is similarly important to recognise that the company or party employing them cannot necessarily fully understand nor anticipate their actions. In light of the discussion held earlier in relation to ‘Franken-Algorithms’ and the fact that algorithms seemingly have their own ‘thought-processes’ and are capable of drawing their own connections, this is indeed an important consideration that would also warrant an appropriate legal response that allocates liability accordingly in the case of algorithms departing from their authorising parties’ intentions. Again, agency law could provide relief in accounting for this possibility, as will be explained in Chapter 7.

Overall, as long as contract law relies on mere tools assumption or assumes that parties can foresee every possible outcome, enforceability and liability issues will remain, as the possibility of fraud or otherwise illegal behaviour through algorithmic means will not be prevented enough through a fitting legal framework, and parties will remain vulnerable to deal with issues resulting from the seeming interpretive discretion of algorithms. Should such issues be considered appropriately by a fitting legal response instead, and protection be granted to parties

¹⁵⁸ See generally Casey and Niblett, *Self-Driving Contracts*’ (n 16)

in the case where things ‘go wrong’, the promise of algorithmic contracts as the future of contracting will be less nuanced.

4. Conclusion

This chapter laid out strong commercial advantages to using algorithmic contracts, as they may allow to automate the operation of the agreement, streamline contract drafting and allow to use data analytics to derive business intelligence. It also outlined how their peculiar code-based nature raises some interesting, yet non-negligible challenges that seem to restrict their applicability to very specific settings such as deterministic processing of payments, refunds or orders, and in financial and insurance transactions which often follow the conditional and precise logic required for computer programming and processing.

The inherent limitations of computer code which cannot accommodate ambiguity or openness impact on contract flexibility, and seem to limit the possibility to scale algorithmic contracts onto more ambitious endeavours for now. More importantly, the ability of code to bring its own meaning to terms raises some more serious legal considerations that will require the law to update its stance on the agency of algorithms. As more ‘advanced’ forms of algorithmic contracts (i.e. smart and self-driving contracts) entail even greater levels of automation than afforded in this more ‘basic’ algorithmic contracting realm, these legal considerations gain in relevance.

Nevertheless, in light of the already ‘successful’ applications of the concept in industry, because of their seeming ‘functional’ and ‘operational’ equivalence with current contractual practices, and most importantly because of the commercial advantages they offer, the place of algorithmic contracts within the future of contracting remains promising.

CHAPTER 4

Smart Contracts

As the commercial promise of ‘plain’ algorithmic contracts was discussed in Chapter 3, highlighting how automation of the agreement, streamlining of contract drafting, and how the use of business analytics could truly drive us towards a ‘smarter’ way to contract, interesting challenges raised by the use of algorithms also began to emerge.

Nevertheless, based on the realistic ideation as to the capabilities of algorithmic contracts to automate ‘simple’ and deterministic transactions as opposed to complex ones, and the possibility that more advanced versions of algorithmic contracts could offer solutions to said technical limitations¹⁵⁹, the place of algorithmic contracts in future contracting practices remains indeed promising.

Progressing to a more ‘advanced’ form of the concept, this chapter will now look at smart contracts incorporating the blockchain technology, and benefiting from the resulting capabilities and advantages this integration may offer¹⁶⁰.

Defining both smart contracts and their underlying blockchain technology which grants them numerous features that attracted both scholarly and commercial interest, this chapter will undertake an analysis similar to that conducted in relation to ‘plain’ algorithmic contracts in Chapter 3. It will outline their commercial promise with real-life examples, and nuance it with the unique legal, technical, commercial and ‘social’ challenges they raise, drawing a fuller picture as to their viability for commercial use. A clearer view as to the potential of smart contract for future commercial contracting will therefore emerge, and positioned within a wider discussion regarding a future of algorithm-driven contracting.

1. An Overview of Smart Contracts

1.1 A Definition of Smart Contracts

¹⁵⁹ The use of the underlying AI of self-driving contracts could for instance resolve the lack of flexibility of computer code to formulate the parties’ intentions.

¹⁶⁰ This paper recognises that smart contract may operate independently of the blockchain, but purposely discusses blockchain and the features it enables in relation to it.

The term ‘smart contract’ was first coined in the late 1990s when cryptographer and legal scholar Nick Szabo defined them as computer-based protocols that can formalize and secure contractual relationships¹⁶¹. Smart contracts indeed essentially entail a one-off automation of certain parts of an agreement¹⁶², mainly the terms that correspond to the exchange underlying the contract. In many ways therefore, they retain their ‘algorithmic’ function as a main feature. However, moving beyond the algorithmic contract model, in a smart contract setting, once certain conditions are met, as fed to the smart contract by an ‘oracle’ that gathers real-time data¹⁶³, the agreement set in code automatically and autonomously initiates and executes itself. For this reason, they have also been defined as a pieces of computer code that can monitor, execute and enforce an agreement¹⁶⁴, evidencing their dual self-executing and self-enforcing nature that justifies their unique commercial offering and their ‘smart’ nature.

Enabled by the blockchain technology which will be defined and discussed shortly, smart contracts are not digital contracts, nor based on AI or any other similar technology that would grant them intelligent behaviours or attributes¹⁶⁵. Instead they operate in a rather robotic manner¹⁶⁶, self-monitoring and operating the agreement upon fulfilment of certain conditions¹⁶⁷, following therefore the conditional logic required for computer processing. Because of their ‘reactive’ nature, and arguably their lack of machine intelligence too, some consider the name smart contracts to be misleading¹⁶⁸. In the context of the discussion held in this paper, actually ‘smart’ contracts could in fact be envisaged in the form of agreements that would incorporate some form of machine intelligence, as will be discussed in Chapter 5.

While not ‘smart’ *per se*, scholars in the literature on the subject also dispute their status as contracts. For the purposes of this paper however, and based on the recent recognition of the

¹⁶¹ See generally Nick Szabo, ‘Smart Contracts: Formalising and Securing Relationships on Public Networks’ (1996)

¹⁶² Bronwyn E Howell and Petrus H Potgieter, ‘Uncertainty and Dispute Resolution for Blockchain and Smart Contract Institutions’ (2021) 548

¹⁶³ Oracles are trusted centralized 3rd parties that monitor the state of the world and link it to the smart contract, acting as an interface between both. See Stuart D Levi and Alex B Lipton, ‘An Introduction to Smart Contracts’, (*Harvard Law School Forum on Corporate Governance*, 26 May 2018)

<<https://corpgov.law.harvard.edu/2018/05/26/an-introduction-to-smart-contracts-and-their-potential-and-inherent-limitations/>> accessed 26 September 2021

¹⁶⁴ Tom Hingley and Andy Robinson ‘A Smart New World’ (*Lexology*, 2016)

<<https://www.lexology.com/library/detail.aspx?g=3937c417-f5de-4a73-b030-09e1fa5301fd>> accessed 26 September 2021

¹⁶⁵ Lin-William Cong and Zhiguo He, ‘Blockchain Disruption and Smart Contracts’ (2019) 1762

¹⁶⁶ *ibid*

¹⁶⁷ Levi and Lipton (n 163)

¹⁶⁸ There is indeed extensive discussion as to the fact that smart contracts are not really smart. See Mateja Durovic and Andre Janssen, ‘Formation of Smart Contracts under Contract Law’ in Larry A DiMatteo and others (eds), *The Cambridge Handbook of Smart Contract, Blockchain Technology and Digital Platforms* (Cambridge University Press 2019) 63

concept as capable of satisfying the criteria of an enforceable contract under English Law¹⁶⁹, this terminology will not be disputed.

1.2 A Modern Vending Machine?

Because of Szabo's work, smart contracts are often compared to vending machines which are considered early examples of the technology as they process the sale transaction automatically on demand of the customer¹⁷⁰. In such a setting, the vending machine would provide a product to a customer upon reception of payment, illustrating again the necessary conditional 'if X then Y' logic required for computer processing.

According to scholar Eliza Mik, this example is however misleading as a vending machine is more akin to an offer to the world at large whereby the machine simply automates the formation and ensures performance of the sale, as opposed to an actual contract. The vending machine is essentially not capable of embodying all the terms that would normally be comprised in such a transaction such as exclusion clauses, warranties... in its hardware¹⁷¹ as arguably a smart contract would in its code.

This paper takes the stance that this analogy, while common in the literature on smart contracts is also misleading as it is more akin to 'plain' algorithmic contracts in which a reciprocal exchange has been encoded rather than smart contracts as currently known which are able to *initiate* a transaction without human input and solely based on the fulfilment of certain conditions. As such, it may appear that Szabo's ideation was closer to algorithmic contracts, than smart contracts are currently known, especially considering that neither the blockchain, nor oracles and data-gathering technologies existed at the time, or with the capabilities they have today.

In the current stage of automation now allowed by smart contracts, we indeed seem to be moving beyond the capabilities of 'simple' vending machine which still require human input to initiate the machine-facilitated exchange, towards a new and *fully automated* contracting paradigm, able to accommodate blockchain-features that grant the additional promise of a secure and tamper-proof contracting experience.

1.3 The Underlying Blockchain Technology

¹⁶⁹ See generally UKJT (n 67)

¹⁷⁰ Szabo (n 161)

¹⁷¹ Eliza Mik, 'Smart Contracts: Terminology, Technical Limitations and Real-World Complexity' (2017) 5

1.3.1 Definition of the Blockchain

Indeed, as discussed earlier, while the first mention of smart contracts was in the 90s, it is only recently, with the development of the blockchain, that the concept truly ‘took off’, as the technology is at the foundation of the now sought-after automation of smart contracts¹⁷², and what grants them many of their distinguishing features.

The blockchain is essentially a specific type of digital database which is permanent, tamper-proof and decentralised to the extent that it is carried out by all the participants in the system in a collective manner¹⁷³: Indeed, each transaction taking place on the blockchain will be stored in a node only to be verified and approved by a network of computers, hereby granting it the nature of a distributed ledger technology¹⁷⁴.

There are different types of blockchains with differing functionalities: for instance, public or ‘permissionless’ blockchains allow anyone to interact with other parties on a pseudonymous or anonymous basis and all transactions are visible to all participants¹⁷⁵.

This peculiar feature of pseudonymity leads to the emergence of what some call ‘a shift from trusting people to trusting math’¹⁷⁶, in which individuals are invited to trust the ‘reliable’ and ‘universal’ mathematics and computation underlying the technology, as opposed to human parties which may be deemed less or ‘untrustworthy’ and who could be prone to error or political/commercial bias¹⁷⁷. In the blockchain paradigm, they do not need to trust (nor indeed know) other participants in the network to transact with them. This peculiarity extends to smart contracts. On the other hand, a private version of the blockchain database would only allow certain individuals to access the ledger and view the data/transaction¹⁷⁸. In the middle, permissioned blockchains allow structured access to the blockchain via designated permissions that would grant participants specific roles and access levels¹⁷⁹.

¹⁷² Durovic and Janssen (n 168) 63

¹⁷³ Marcella Atzorri, ‘Blockchain Technology and Decentralised Governance: Is the State Still Necessary?’ (2016) 2

¹⁷⁴ Vida J. Morkunas and others, ‘How Blockchain Technologies Impact your Business Model’ (2019) 2

¹⁷⁵ *ibid* 19

¹⁷⁶ Andreas Antonopoulos, ‘Bitcoin Security Model: Trust by Computation’ (*Radar*, 20 February 2014) <<http://radar.oreilly.com/2014/02/bitcoin-security-model-trust-by-computation.html>> accessed 26 September 2021

¹⁷⁷ Eliza Mik, ‘Blockchains’ in Larry A DiMatteo and others (eds), *The Cambridge Handbook of Smart Contract, Blockchain Technology and Digital Platforms* (Cambridge University Press 2019) 160

¹⁷⁸ Morkunas and others (n 174) 19

¹⁷⁹ Investopedia, ‘Public, Private Permissioned Blockchains Compared’ (*Investopedia*) <<https://www.investopedia.com/news/public-private-permissioned-blockchains-compared/>> accessed 2 May 2021

Each type of blockchain therefore offers its own set of advantages and disadvantages which will be more or less suited depending on the type of transaction at hand: In a commercial transaction for instance, it is unlikely that parties would want the specifics of their dealings to be available for all to see on a public blockchain. Similarly, in the case of certain commercial transactions, parties could need to know (and trust) each other, in which case the use of the blockchain altogether may not be the most logical option. Depending on the personal needs and preferences of the parties therefore, the most suitable type of blockchain will differ.

While a more thorough discussion on the workings of the blockchain falls outside of the scope of this paper, it remains that the technology is one of the key trends in our digital economy¹⁸⁰, and essentially the driving force behind smart contracts, allowing the automated and immutable operation of the agreements¹⁸¹, and granting them the numerous features that place them as an interesting commercial promise.

2. The Potential of Smart Contracts in Practice

2.1 The Industry Promise

Indeed, according to the World Economic Forum, smart contracts could enhance global payments, credit, the management of collaterals, the issuance of securities ...¹⁸². In light of the suitability for algorithmic contracts to facilitate payment-type transactions, it may be that this statement is realistic.

From a commercial perspective still, according to leading law firm Clifford Chance, smart contracts are approaching viability with early adopters getting a head start¹⁸³, motivating therefore an early experimentation with the technology so as to win out in longer term. As this remains to be seen in practice as the technology is still at its infancy, the firm nuances this statement by identifying that it would be best to first trial the technology in simple contexts, to then scale up¹⁸⁴. Linking this statement to the discussion held in Chapter 3, it may indeed be

¹⁸⁰ UNCTAD (n 8) 2

¹⁸¹ Durovic and Janssen (n 168) 64

¹⁸² World Economic Forum, 'Digital Assets, Distributed Ledger Technologies and the Future of Capital Markets' (*World Economic Forum*, May 2021)

<http://www3.weforum.org/docs/WEF_Digital_Assets_Distributed_Ledger_Technology_2021.pdf> accessed 26 September 2021

¹⁸³ Clifford Chance, 'Smart Contracts Legal Agreements for the Digital Age' (*Clifford Chance*, April 2018)

<https://www.cliffordchance.com/briefings/2017/06/smart_contracts_-_legalagreementsforth.html> accessed 26 September 2021

¹⁸⁴ *ibid*

that due to the technical limitations of the concept and the difficulty of translating complex agreements into computer code, commercial players *will* have to experiment with the technology for simple transactions regardless. Arguably this could allow to develop an appropriate regulatory response in the meantime, able to minimise risks posed by the concept, and in turn enable to scale the practice onto more complex and ambitious endeavours in the future. From this perspective therefore, the place of smart contracts within future contracting practices is not to be ruled out.

From a more technical viewpoint, the future of smart contracts is the processing of information as a result of the oracle-contract connection. In light of the discussion held in Chapter 1 of this paper relating to the ever-greater availability of data, and the proportionally growing capabilities to store and manage it, it seems possible to envisage a future growth of the technology as a result. From this perspective therefore, smart contracts may indeed be the future.

While it is impossible to firmly assert that this prediction will become true at this stage, according to the World Economic Forum, 10% of global gross domestic product will be stored on the blockchain by 2027¹⁸⁵: Considering that the blockchain is the foundation of smart contracts, it appears sensible to predict that should blockchain technologies sustain increased adoption in the commercial world, so could the automated contracting method they enable.

2.2 Applications of Smart Contracts

Already, smart contracts offer the promise of automating transactions, as leading industry players have already experimented with the technology, although for now smart contracts are most successfully implemented in financial settings. As discussed earlier, this is because financial agreements have the capacity to be conducted on a dynamic basis due to their conditional nature, and based on the fact that they rely on data: As such, payments could be automatically triggered by certain events, interest rates could be triggered to increase, a penalty clause could be activated, or a repayment period could be lengthened or shortened as the situation evolves¹⁸⁶.

¹⁸⁵ World Economic Forum, 'Deep Shift, Technology Tipping Points and Societal Impact' (*World Economic Forum*, September 2015) <http://www3.weforum.org/docs/WEF_GAC15_Technological_Tipping_Points_report_2015.pdf> accessed 18 April 2021

¹⁸⁶ Teresa Rodriguez De Las Heras Ballell, 'A Technological Transformation of Secured Transactions Law' (2017) 708

In commercial settings, the concept has also been linked to the automatic processing of payments for goods purchased on platforms such as E-Bay or Craigslist¹⁸⁷.

It also emerges that the combination of the technology with data-gathering devices such as the IoT discussed earlier could facilitate a number of daily transactions: Smart contracts have indeed the potential to be connected to physical properties to which they can give access autonomously and on a dynamic basis upon receipt of payment¹⁸⁸. The automated rental or purchase of goods/services could therefore be suitable for automation, suggesting the potential of smart contracts to move beyond the limitations of algorithmic contracting and the confines of ‘simple’ transactions, to interconnect instead with other technologies (making use of a potential link between the oracle and IoT devices¹⁸⁹), and in turn automate exchanges that have a human/physical component to them as opposed to mere exchanges of payments...

It therefore seems possible to imagine a world where smart contracts, the blockchain and IoT devices form a dynamic ecosystem of technologies offering a myriad of opportunities that could drive the future of digital commerce¹⁹⁰, at the risk however of creating machines that could be difficult to control¹⁹¹, linking to the unpredictable nature of algorithms discussed earlier: Should these algorithms be given the ability to connect with other technologies/objects and transact ‘on their own’, it may raise further non-negligible issues that would need addressing, not least the possibility for the contract to *physically act* in unforeseen ways. The questions regarding the *role* of the algorithm, its *responsibility* and the allocation of *liability* in the case of things ‘going wrong’ therefore only gains in relevance in the smart contract realm, especially in light of the promise of immutability of transactions which may result in irremediable losses or in the parties unable to stop or amend an otherwise ‘faulty’ smart contract.

While offering broadly the promise of great potential in practice, it is unclear for now whether these ideas will come to fruition or whether existing projects will sustain a wider adoption in the future¹⁹², as the technology does not always take off as expected, despite ‘ticking all the boxes’ in terms of commercial/legal/technical viability and being *prima facie* a strong solution to identified commercial shortcomings:

¹⁸⁷ De Filippi and Wright (n 133)

¹⁸⁸ Rosa M Garcia-Teruel, ‘Legal Challenges and Opportunities of Blockchain Technology in the Real Estate Sector’ (2020) 135

¹⁸⁹ IoT devices could provide relevant data to the oracle who could then trigger the operation of a smart contract for instance

¹⁹⁰ Frank Casino and others, ‘A Systematic Literature Review of Blockchain-Based Applications’ (2018) 11

¹⁹¹ Adam J Kolber, ‘Not So Smart Blockchain Contracts and Artificial Responsibility (2018) 202 (As he discussed that TheDAO was difficult to control)

¹⁹² Garcia-Teruel (n 188) 135. This part of the article is about whether securing land titles on blockchain is viable in the future, but the same question may be asked in the case of other blockchain applications.

Indeed, as mentioned earlier in this paper, a great example of a smart contract in commercial operation was launched by insurance firm AXA: its smart-contract-based platform called Fizzy, would gather real-time flight information thanks to oracles that would constantly monitor such data, and would issue compensation or refunds automatically to customers who suffered flight delays or cancellations¹⁹³. While promising as a concept as it indeed launched in an area where the applicability of smart contract technology was high due to the ‘simple’ and arguably ‘automatable’ nature of insurance transactions, AXA cancelled this product shortly after due to lack of commercial demand¹⁹⁴.

In light of this, it is possible to question whether commercial entities and customers more broadly are truly ready for the smart contract technology to automate their transactions, and in turn whether the enthusiasm surrounding smart contracts is justified at this time.

This issue is especially important considering the significant technical and legal hurdles that need to be overcome in order to make smart contracts a mainstream reality of transacting as will be discussed shortly. In which, case, is it worth it trying to overcome these hurdles to make smart contracts happen?

Moreover, while this paper focuses on the beneficial applications of algorithmic contracting technologies in commercial settings, it must also be considered that they could also be used for illegal or fraudulent purposes. Considering that algorithmic contracts lack the agency to draw the difference between legitimate and unlawful agreements and automate them regardless instead (with the added immutability granted by the blockchain), it is clear that these drawbacks will have to be accounted for by an appropriate regulatory regime at some point.

2.3 Contracting Advantages

Nevertheless, as their offering remains *prima facie* promising, smart contracts also offer a broad range of advantages which parties may wish to take advantage of:

The self-enforcing and self-executing nature of smart contracts could for instance suggest improvements in transactional productivity and efficiency¹⁹⁵ as the transaction is fully automated and operates in real time as the data is collected¹⁹⁶.

¹⁹³ AXA, ‘AXA goes Blockchain with Fizzy’ (*AXA*) <<https://www.axa.com/en/magazine/axa-goes-blockchain-with-fizzy>> accessed 18 July 2021

¹⁹⁴ See ArtificialLawyer, ‘AXA Scraps Fizzy Insurance Smart Contract’ (*Artificial Lawyer*, 8 October 2020) <<https://www.artificiallawyer.com/2020/10/08/axa-scraps-fizzy-insurance-smart-contract-but-still-interested-in-the-tech/>> accessed 26 September 2021

¹⁹⁵ Scott Farrell and others, ‘Lost and Found in Smart Contract Translation’ (2018) 24-31

¹⁹⁶ *ibid*

Many of the advantages of algorithmic contracts, namely speed, efficiency and the ability to automate a transaction through code also apply by extension to smart contracts. The streamlining of code drafting could therefore similarly allow parties to bypass the need to build, test, certify and deploy new code for every new transaction, leading therefore to potential lower costs and easier future development of the concept¹⁹⁷. It could also limit the risk of contracting via algorithmic means, as re-using ‘tried and tested’ code in such a way would indeed offer the promise of that the contract will not raise any unexpected issues (given the immutability of smart contracts, this could be desirable). Similarly, standard clauses could be assembled and reassembled in a modular fashion, leading to the possible creation of libraries of smart contract code that could be stored openly to all, and continuously improved by professionals in the area¹⁹⁸ as discussed earlier in relation to the CommonAccord project.

While modular in this respect, smart contracts may also be deemed similarly so to the extent that parties retain discretion in choosing the level of automation, or the separation between agreed and coded terms in their agreement in the first place¹⁹⁹.

Parties could indeed choose to automate only the execution of the contract or both the execution and the conclusion of the agreement²⁰⁰, retaining therefore some discretion on their preferred smart contract experience.

Scholars in the field even argue that the entirety of the contract, including mechanisms such as dispute resolution²⁰¹, could in fact be embedded into the smart contract code and that this possibility to code self-protection mechanisms/remedies within the contract itself would render court intervention superfluous in the case where the performance of obligations does not go as planned²⁰². The argument made is therefore that smart contracts could be a substitute, rather than a complement to traditional contracting methods as arguably ‘plain’ algorithmic contracts are, strengthening therefore their promise as a unique and ‘advanced’ form of contracting. This promise would also evidence the greater level of discretion granted to parties as they oversee and control the entirety of their exchange.

3. Unique Challenges of Smart Contracts

¹⁹⁷ Christopher Clack and others, ‘Smart Contract Templates: Foundations, Design Landscape and Research Directions’ (2016) 10

¹⁹⁸ de Filippi and Wright (n 133)

¹⁹⁹ Durovic and Janssen (n 168) 65

²⁰⁰ *ibid*

²⁰¹ Howell and Potgieter (n 162) 554-556; See also Riikka Koulu, ‘Blockchains and Online Dispute Resolution’ (2016) 40-69

²⁰² Smart contracts are indeed said to be a self-help mechanism, as will be discussed more extensively in Chapter 7. See generally Max Raskin, ‘The Law and Legality of Smart Contracts’ (2016)

As the promise of smart contracts and their underlying blockchain technology have been laid out, the same unique features that render them interesting from both a scholarly and professional perspective are also ones which raise some challenges that have to be recognised and/or addressed.

3.1 Technical Challenges

3.1.1 Programming Challenges

Indeed, issues relating to the lack of flexibility enabled by computer code and the risks that it may operate ‘at face value’ and interpret terms in unexpected ways also apply. Smart contract programming (just like other forms of algorithmic contracting) also has to follow an unambiguous, structured, deterministic and objective computer-processable conditional logic while traditional contracts base their interpretation on more subjective criteria and analogous thinking that can be processed by the human brain²⁰³. This is not always desirable as while the language of smart contracts was deemed *imperative*, it was identified that the use of a *declarative* one was more suitable to reflect legal arrangements²⁰⁴ suggesting again the incompatibility between legal language and computer code.

In the case of smart contracts more specifically, additional challenges arise out of (1) the decentralised nature of the blockchain network and (2) the immutable and tamper-proof nature of smart contracts.

Indeed, in relation to the decentralised nature of the blockchain, it may be that quality and integrity standards may be breached if code is created by private actors and in a decentralised manner²⁰⁵. Considering that in contract drafting, the design of both the code, and any legal rules always reflect to some extent the politics of its creator²⁰⁶ (i.e. the programmer who could be more or less skilled), this issue may affect the programming of smart contracts, and resulting performance of the transaction which parties may have to be aware of.

In relation to this same decentralised and to some extent public nature of the blockchain, issues may arise as to the privacy and confidentiality of the information contained in the code: from a

²⁰³ Alexander Savelyev ‘Contract Law 2.0’: ‘Smart’ Contracts as the Beginning of the End of Classic Contract Law’ (2016) 13

²⁰⁴ See Guido Governatori and others, ‘On Legal Contracts, Imperative and Declarative Smart Contracts, and Blockchain Systems’ (2018)

²⁰⁵ Gabriel Oliver Benjamin Jaccard, ‘Smart Contracts and the Role of Law’ (2017) 8

²⁰⁶ *ibid*

commercial perspective, it may not be desirable to have transaction information available to all participants on the blockchain network. While encryption of that data could render it more private, experts in the field have identified that this would not be a good solution as the smart contract would not be able to decide and act on that data²⁰⁷. The commercial promise of smart contracts within the future of contracting appears therefore more nuanced.

Second, in relation to the immutable and tamper-proof nature of smart contracts, it emerges that while plain algorithmic or computable contracts enable the parties to retain some form of oversight over their agreement to the extent that they can amend or stop their contract, in the case of smart contracts which cannot be stopped or amended once initiated, the risks of malfunctions, bugs, or hacks that compromise the integrity of the mechanism become more problematic. It may also be that faulty smart contract will continue to operate until completion due to this feature²⁰⁸.

Indeed, should the algorithm be poorly programmed, or bring its own interpretation to the agreement, it would also raise more issues than for ‘simple’ algorithmic contracts in which the situation could be remediated with relative ease. It therefore places a much higher burden on the parties to program everything ‘perfectly’ *before* the contract is initiated, as changes or amendments will not be possible later on during or after the performance of the agreement. For this reason, parties contracting through such means would have to be mindful that the process of setting up a smart-contracts may be both more complex and more costly than traditional contracts for instance²⁰⁹. They would indeed have to endeavour to exercise utmost precision, requiring both time and skills so as to consider *every* contingency which must then be translated accurately into code. It would also not be humanly possible to foresee every possible turn or event, nor to translate *all* of them, limiting therefore the applicability of smart contracts to scenarios in which the possible results are both easily foreseeable and capable of being translated.

Moreover, considering that the smart contract relies on the data input of the oracle, parties would have to ensure that said oracle is trustworthy²¹⁰, and that the data-feed/communication

²⁰⁷ Aldenio de Vilaca Burgos and others, ‘Distributed ledger technical research in Central Bank of Brazil. Working Paper’ (2017) 11

²⁰⁸ Valentina Gatteschi and others, ‘Technology of Smart Contracts in Larry A DiMatteo and others (eds), *The Cambridge Handbook of Smart Contract, Blockchain Technology and Digital Platforms* (Cambridge University Press 2019) 54

²⁰⁹ Levi and Lipton (n 163)

²¹⁰ Mik, ‘Blockchains’ (n 177) 176

channel is as seamless as possible, taking into account risks of alterations or time delays²¹¹. Again, the contract would be operating on an immutable manner based on this data, raising the stakes in ensuring that this contract-oracle communication is both seamless and accurate. In relation to this *ex ante* focus therefore (i.e. *before* the operation of the contract), smart contracts only make sense if the expected value of the contracts outweighs that of any *ex post* (i.e. after) litigation costs²¹², otherwise running the risk of expensive costs in the event things go wrong. For this reason, it is likely that the promise of smart contracts within the future of contracting will remain more limited.

3.1.2 From *ex post* to *ex ante* Paradigm

Looking at the immutability and tamper-proof nature of smart contracts and resulting promise of guaranteed enforcement in more detail, it emerges that it relies on the ability of the parties to set up their smart contracts with utmost accuracy and precision entirely *ex ante*.

While challenging for both technical and commercial reasons as discussed earlier, it is more broadly evidential of a shift in legal paradigm within the smart contract realm, as the focus moves from an *ex post* to an *ex ante* one²¹³:

Indeed, ensuring that everything is coded with utmost precision and dealing with the particulars of the agreement *before* it unfolds with the knowledge that the transaction will not be amendable or reversible afterwards appears to make the primarily *remedial* function of contract law redundant. From a practical perspective, *ex post* legal recourse may indeed offer only limited relief, especially if losses are non-remediable.

Considering that there is an important function to legal rules which essentially tell courts how to decide a case or situation *ex post*²¹⁴, the role of the law within the smart contract realm is questioned. For the purposes of this paper, this is an important consideration as it takes the stance that the law should not be dissociated from algorithmic contracts if they aim to represent the future of contracting.

As regards the operation of smart contracts, the burden of not only translating the contract into code, but also dealing with all matters, including that of dispute resolution...at the drafting

²¹¹ Mark Clement, 'Smart Contracts and the Courts' in Larry A DiMatteo and others (eds), *The Cambridge Handbook of Smart Contract, Blockchain Technology and Digital Platforms* (Cambridge University Press 2019) 280

²¹² Raskin (n 202) 312

²¹³ See generally Jerry IH Hsiao, 'Smart' Contract on the Blockchain-Paradigm Shift for Contract Law' (2017)

²¹⁴ Eric Tjong Tjin Tai, 'Formalising Contract Law for Smart Contracts' (2017) 7

stage must be therefore dealt with *completely ex ante*, in a way that seemingly goes against how the law is meant to operate. While the possibility of guaranteed performance of the contract are indeed strong promises allowed by smart contract, it appears that from a practical perspective, this immutability raises issues that may limit the applicability of smart contracts in complex scenarios. Indeed, taking the view that parties may not wish to be bound by contracts that may malfunction, with the knowledge that the law may be of limited assistance, smart contracts may remain within the confines of unambiguous and easy to foresee exchanges or payments.

Moreover, another aspect of legal rules is that they allow parties to deduce how to act *ex ante*²¹⁵. In the case where parties do not expect to rely on legal enforcement, it may mean that their behaviours and approaches will also likely change, essentially moving away from ‘bargaining in the shadow of the law’. Indeed, the way smart contracts operate seems to go against the very foundation of legal rules and their purpose: smart contracts focus solely on the contractual obligation and seem to live outside of classic contract law remedies²¹⁶, arguably voluntarily so. Instead, some scholars perceive the technology to be a form of self-help²¹⁷, and therefore a solution meant to respond to legal shortcomings, although this view is considered simplistic to the extent that it prevents a deeper analysis into the applicability of contract law²¹⁸.

Nevertheless, following this view, scholars expect it possible to integrate online dispute resolution clauses within the code²¹⁹, in what would indeed signal a departure from contract law oversight. While arguably possible for the simple transactions in which they are currently explored, smart contracts cannot however be considered to be a consistent and reliable replacement for judicial contract adjudication²²⁰. It would indeed not be possible to foresee and code such clauses foreseeing all possible outcomes.

Moreover, although smart contracts are initially designed to operate outside of the scope of the law as discussed earlier as one of the main selling points of the blockchain, this could lead to parties voluntarily harnessing the technology for fraudulent or otherwise illegal purposes.

In light of this departure from the reach of legal oversight, it may also be that commercial parties and other stakeholders to a contract would be unlikely to engage with the practice without the assurance that they are not sacrificing the safety granted by their legal rights.

²¹⁵ Tjong Tjin Tai (n 214) 7

²¹⁶ Jakub J Szczerbowski, ‘Place of Smart Contracts in Civil Law: A Few Comments on Form and Interpretation’ (2017) 335

²¹⁷ See generally Raskin (n 202)

²¹⁸ See generally Savelyev (n 203)

²¹⁹ See generally Koulu (n 201)

²²⁰ Kevin Werbach and Nicholas Cornell, ‘Contracts Ex Machina’ (2017) 353

Arguably, until the law, and the protection it offers are reconciled with the automated universe created by smart contracts, commercial players will remain cautious as regards the technology.

3.2 A New Type of Trust.

Another challenge raised by smart contracts is in relation to trust. Trust is another key aspect of contractual relationships: it is essential for economic exchanges and what fuels markets²²¹, especially considering that one can use trust to build reliance on a system, or use it as a form of enforcement²²². In the context of smart contracts, it appears that parties shift from trusting each other, or placing their trust on the legal system to oversee their transaction as would arguably be the case in 'traditional' contracting practices, to instead trust the underlying blockchain network. It is indeed often stated that transacting on the blockchain represents a 'shift from trusting people to trusting math'²²³.

3.2.1 Trust in the Blockchain

Indeed, as the immutable and tamper-proof nature of smart contracts has been established to lead towards a new *ex ante* focus, it also emerges that it raises another interesting discussion in relation to trust in the blockchain-driven smart contract paradigm.

The underlying transactional security granted by the blockchain through its promise of tamper-proof and guaranteed performance gives parties greater transparency and increased confidence in the contracting process²²⁴ and is more importantly what enables them to fully *trust* the underlying blockchain network to perform the transaction without having to trust (or indeed know) one another²²⁵.

As it appears therefore, the blockchain itself is a particular form of trust mechanism, in which human players put trust to deal with and manage risk²²⁶. As the parties are bound by their promise and cannot go back on it²²⁷, the risk of the counterparty defaulting due to non-

²²¹ Helena Eenmaa- Dimitrieva and Maria Schmidt-Kessen, 'Creating Markets in No-Trust Environments' (2019) 77

²²² *ibid*

²²³ Antonopoulos (n 176)

²²⁴ Raffaele Lener, 'The Development of Fintech in Italy and Europe' (2020) 369-370

²²⁵ Durovic and Janssen (n 168) 64

²²⁶ See generally Kevin Werbach, 'Trust but Verify' (2017)

²²⁷ Alicia Lim, '502 Bad Gateway: Rebooting Smart Contracts' (2020) 106

compliance with the contract terms is eliminated²²⁸. It may however be argued that this ‘trustlessness’ depends on how trustworthy the coder is²²⁹ in light of the *need* for perfect programming that reflects the parties in so much that it will be performed in a tamper-proof manner. As such, the trust may only have been shifted to a third party as opposed to ‘removed’ altogether’.

3.2.2 Challenges of Pseudonymity

Nevertheless, this same shift in trust towards the underlying blockchain technology is also what enables the promise of pseudonymous or anonymous ‘smart contracting’.

In fact, it may be argued that the promise of a reduced need to trust human parties is a broader occurrence within the algorithmic contracting world to the extent that any code-based automation of agreements seems to derive from an ambition to reduce human intermediaries in the process as the computer is trusted to automate performance instead²³⁰. In the algorithmic contracting realm (including smart contracts), the ambition to move away from ‘human trust’ is therefore made clear.

But while the commercial advantages of this streamlined and automated contracting processes have been made clear in the discussion held in this paper, it remains to be determined where features of pseudonymity and anonymity would in fact be desirable in commercial practices.

Indeed, from a legal viewpoint, these features open up possibility for various issues, not least the possibility that a party may contract with a minor, with someone who would not otherwise have legal capacity to enter into binding agreements, or with someone who are pretending they are somebody else²³¹.

It would appear that some form of legal input to account for identity issues in the smart contract world is needed.

3.3 Departing from Legal Oversight?

3.3.1 The role of Law

²²⁸ Randall E. Duran and Paul Griffin, ‘Smart Contracts: Will Fintech be the Catalyst for the Next Global Financial Crisis?’ (2020) 104-122

²²⁹ Mik, ‘Blockchains’ (n 177) 164

²³⁰ Werbach and Cornell (n 220) 335

²³¹ Mark Giancaspro, ‘Is a ‘Smart contract’ really a smart idea?’ (2017) 6-7

As evidenced to some extent that this shift in trust is not without raising some legal challenges, it is important to recognise that this move towards fully trusting the blockchain is in fact *intended* to move away from a trust in law, as smart contracts are indeed initially meant to bypass the law²³².

The underlying assumption is that smart contracts could operate with the blockchain as their own legal systems²³³, which has been identified as a selling point of the technology²³⁴.

Yet as discussed earlier, it remains to be determined in which settings this would be desirable as in commercial practice; this very lack of legal oversight may be problematic, and result in parties remaining ‘traditional’ in their contracting practices which grant them the safety of legal recourse. The lack of an appropriate legal framework to surround the technology and mitigate the risks it may pose could therefore only hinder its growth.

From a more socio-legal perspective therefore, supporters of the promise of guaranteed performance through the ‘coercive power of code’²³⁵, therefore seem to underplay the important role of the law to protect citizens and ensure their safety and security, arguably even more so on the blockchain²³⁶. They also seem rely on both a minimalist view of the role of the state in the practice of contracting and on an arguably ‘too-strict’ division between public and private spheres²³⁷, arguably placing the latter at a too high level that does not reflect how contracting is structured in reality, and how important the legal system is in the process. From this perspective therefore, smart contracts should not replace contract law, and will not²³⁸.

3.3.2 Legal Challenges

The need for a legal presence appears furthermore warranted in the smart contract realm considering that they raise unique legal issues that need addressing should the concept aim to scale in the future.

Indeed, their peculiar operating mode also raises numerous issues such as that relating to consent, and unfair application of penalties²³⁹: in the case where a smart contract has

²³² Nataliia Filatova, ‘Smart Contract from the Contract Law Perspective’ (2020) 218

²³³ See generally Carla L Reyes, ‘Conceptualizing Cryptolaw’ (2017)

²³⁴ Tjong Tjin Tai, (n 214) 4. One of the major selling points of smart contracts is outlined as doing away with the law.

²³⁵ Mark Verstraete, ‘The Stakes of Smart Contracts’ (2019) 790. Participants on the blockchain believe that the authority of enforcement by code is valid

²³⁶ Karen Yeung, ‘Regulation by Blockchain’ (2019) 14

²³⁷ Verstraete (n 235) 743

²³⁸ Werbach and Cornell (n 220) 353

²³⁹ Rodriguez de Las Heras Ballell (n 186) 711

automatically triggered penalties, and knowing that parties cannot go back on their promise, how should the law respond? And how should it respond if it causes a loss that is non-remediable?

Smart contracts could also allow to conclude contracts where no contracting would otherwise take place and could result in creating illegal markets²⁴⁰, which would also warrant a bespoke legal response.

Overall in light of all these legal considerations, it seems logical to prompt further regulatory discussions, as neither the blockchain nor smart contracts are surrounded by fitting and effective regulatory frameworks, nor even recognised consistently across the globe to begin with²⁴¹. So long as those challenges are not addressed, smart contracts will arguably remain in a universe parallel to that of the legal system²⁴², proposing an attractive contracting solution but remaining in a realm outside of legal oversight where risks remain unaddressed.

While the need for an appropriate legal framework has been established, it has been difficult to create rules in practice²⁴³ because more analysis is needed to understand smart contracts more fully²⁴⁴. A form of smart contract law update will have nonetheless to be considered as any discrepancies between law and informatics may result in unfair or otherwise unlawful smart contracts being enforced in the meantime²⁴⁵ and leave parties vulnerable to the risks they pose. With such a view, it may indeed be that smart contracts have everything to gain from legal input²⁴⁶.

3.4 Challenging Social Contracting Practices

As the legal view on the case of smart contracts was explored, it is also relevant for the purposes of the discussion held in this paper to consider how they would fit within social and societal contracting preferences, furthering the view that algorithmic contracts do not operate in a vacuum and instead factor in various considerations²⁴⁷.

²⁴⁰ Eenmaa-Dimitrieva and Schmidt-Kessen (n 221) 16

²⁴¹ US states of Arizona and Tennessee have for instance been among the first jurisdictions to provide a definition of Smart Contracts but across the world, legal recognition of the concept remains limited.

²⁴² Savelyev (n 203) 16

²⁴³ Filatova (n 232) 231

²⁴⁴ *ibid* 218

²⁴⁵ Jaccard (n 205) 8

²⁴⁶ *ibid* 10

²⁴⁷ This paper indeed considers commercial, legal, technical and social matters in its analysis. See generally Lawrence Lessig, *Code and Other Laws of Cyberspace* (Basic Books 1999)

As regards social factors, scholars in the field have pointed that many challenges raised by smart contracts stem less from the limits of law than they do from the differences between how the smart contract code is intended to operate and how the parties tend to transact in business settings²⁴⁸. The underlying assumption behind this statement is that smart contracts are purely technical artefacts that operate on what appears to be a ‘thin’ concept of contracting that excludes the social context within which it operates²⁴⁹. As such, the enthusiasm surrounding smart contracts is to be tampered with the more human side to business dealings to link with the relational theory of contracting discussed earlier.

While it may seem that the practice of contracting is all about the exchange *itself* (which is essentially the promise behind self-enforcing and self-executing smart contracts that reject trust in human parties or in the law), in reality contracting is a much more social process²⁵⁰. Scholars have in fact drawn a difference between the *real deal*, i.e. the relationship between the parties, and the *paper deal*, which is the contractual representation of that relationship²⁵¹, to follow a framework similar to that proposed by Hugh Collins and discussed in Chapter 3 in relation to the three factors of contracting (i.e. the economic deal, the business relationship and the contract).

As discussed in Chapter 3 in relation to the often voluntarily open-ended and ambiguous nature of contracts which aim to safeguard long-term business relationships and allow parties to embrace opportunities as they arise, there is indeed an important social element to contracts²⁵². While it may be more nuanced in the case of commercial dealings, disregarding this social element would amount to keeping the technology within the confines of the transactions it is already able to automate, with limited scope for progress onto more complex endeavours.

The objective with smart contracts should they aim to take on a greater role in contracting, would be to reconcile their automated *paper deal* offering within a broader *real deal*.

More interestingly, while contracts are often intertemporal incorporating the possibility of future promises²⁵³, this is not necessarily the case of smart contracts which instead operate in the ‘now’ (they indeed operate in real-time as data is fed to them). By failing to reflect an

²⁴⁸ Levi and Lipton (n 163)

²⁴⁹ Karen E.C. Levy, ‘Book Smart Not Street Smart: Blockchain Based Smart Contracts and the Social Workings of the Law’ (2017) 1

²⁵⁰ See generally Macaulay (n 140); Macneil (n 140)

²⁵¹ See generally Catherine Mitchell, ‘Contract and Contract Law: Challenging the Distinction between the ‘Real’ and ‘Paper’ Deal’ (2009)

²⁵² See generally Macaulay (n 140); Macneil (n 140)

²⁵³ Alan Schwatz and Robert E. Scott ‘Contract Theory and the Limits of Contract Law’ (2003) 557

arguably important future-oriented view of contracting, it is evidenced how smart contracts depart furthermore from what is currently understood as contracting.

Whether reconciling both is achievable remains to be determined, but makes for an interesting scholarly discussion linking this relational view with the full trust granted onto the underlying blockchain technology of smart contracts, and the ‘shift from trusting people to trusting math’²⁵⁴.

4. Conclusion

Smart contracts are created in a technological universe that operates parallel to the legal realm²⁵⁵. They are again a manifestation of the digital economy we live in and offer the promise of numerous advantages, granted by both their algorithmic foundation and the underlying blockchain technology on which they operate.

In addition to facilitating certain types of transactions, they also offer the possibility to connect with IoT devices and objects, enabling entirely new forms of automated machine-to-machine contracting altogether. From the perspective of innovation therefore, they offer indeed a compelling contracting solution.

Yet from a more practical viewpoint, they raise numerous commercial, technical and legal challenges that diminish the perception of the technology as a viable technocratic response to current contractual shortcomings. The risks they pose and their apparent departure from the oversight of contract law may be problematic to some parties, which justifies an important regulatory discussion to reconcile the concept with both legal doctrines, and what is currently understood as contracting. Until then, it is likely that the technology will remain primarily suitable for the automation of simple exchanges and transactions, offering nevertheless the promise of a progress towards a more technology-driven contracting experience in such settings.

²⁵⁴ Antonopoulos (n 176)

²⁵⁵ Savelyev (n 203) 16

CHAPTER 5

'Self-Driving' Contracts

As chapters 3 and 4 evidenced the potential of technology to facilitate contracting practices, moving towards some form of fully automated exchange, they also demonstrated that this move towards code-based contracting is not without raising challenges. Identified as one key barrier to the development of algorithmic contracts, the inherent limitations of computer code indeed limit their reach to the confines of straightforward and deterministic transactions, which can be translated accurately into code with the guarantee that it will run as planned.

While raising other unique challenges that could arguably be resolved by regulatory input, technological limitations of computer code seem to place breaks on the development of algorithmic contracts. The promise of incorporating machine intelligence onto the process could however allow to bypass these limitations of code, and raise its applicability to more complex scenarios.

Progressing to what would be the most 'technologically-advanced' form of algorithmic contracting, the promise of 'self-driving' contracts could indeed be one that would grant true 'intelligent' capabilities to the algorithm, and position algorithmic contracting as a practice that could truly re-define what it means to contract.

While recognising that the concept remains in the realm of academic speculation at present, this chapter nonetheless considers that it could solve existing limitations of algorithmic contracts.

As such, a discussion focusing on the concept behind self-driving contracts as set out by scholars Anthony Casey and Anthony Niblett in their paper of the same name will be undertaken.

Beginning with an introduction on artificial intelligence and its current applications in law, this chapter will go on to define and discuss the concept of self-driving contracts, following a similar approach to that adopted in chapters 3 and 4, which evaluates the promise of the technology against the various challenges it may raise.

It will then discuss how the machine-driven solution proposed by algorithmic contracts could address limitations of existing forms of algorithmic contracts and possibly allow the concept of code-based contracting to scale and develop in the future.

1. An Introduction to AI

Before going on to discuss the concept of self-driving contracts, this first part of the chapter will define and position its underlying foundation of artificial intelligence. This will allow both to appreciate the nature of the solution proposed by Casey and Niblett, and account for any specific risks it may pose.

1.1 The Imitation Game

Pioneer in the field of computer science, Alan Turing considered in his 1950 paper ‘Computing Machinery and Intelligence’, whether computers could think, or more accurately, whether digital computers ‘could do well in the imitation game’²⁵⁶. This game, more commonly referred to today as the Turing test, aimed to assess a machine’s ability to ‘exhibit intelligent behaviour’ by answering a series of questions.

The objective was to assess the extent to which the machine’s performance would become indistinguishable to that of a human taking part in the experiment²⁵⁷: If an evaluator was unable to differentiate the machine from the human in the game, the former passed the test²⁵⁸.

At that time, whether computers could succeed was very much subject to debate, but Turing was hopeful that at some point, machines could compete with humans in intellectual fields²⁵⁹.

In his paper, he even predicted that in fifty years’ time, computers could play the imitation game so well that an evaluator would in 70% of cases, not be able to make the difference between a human or machine player within the first 5 minutes²⁶⁰. Over fifty years later, this has become true to the extent that technology is now capable of assisting in ways not envisaged at the time, and it can now match human intelligence, surpassing it even in certain settings.

Indeed, artificial intelligence (AI), which has first been coined as ‘the science or engineering of making intelligent computer programs’ by Stanford scholar John McCarthy²⁶¹, is one such technology, which is now able to perform tasks that would otherwise require human intelligence

²⁵⁶ See generally Alan Turing, ‘Computing Machinery and Intelligence’ (1950)

²⁵⁷ *ibid* 433-435

²⁵⁸ *ibid*

²⁵⁹ *ibid* 460

²⁶⁰ *ibid* 442. He states that by the end of the century expectation that people will think about ‘thinking’ machines without being ‘contradicted’.

²⁶¹ John McCarthy, ‘What is Artificial Intelligence?’, (*Stanford*, first published 1956, Revised in 2007)
<<http://jmc.stanford.edu/artificial-intelligence/what-is-ai/index.html>> accessed 27 April 2021

such as visual perception, speech recognition or language translation²⁶², but also, and most interestingly, decision making²⁶³.

While AI technologies are also said to be able to reason and use common sense, for now they are still far from achieving human level aptitudes²⁶⁴. They can nonetheless succeed in generating ‘human-like’ intelligent results²⁶⁵ that may be learned and used as part of later inputs²⁶⁶ in a process more commonly known as machine learning, as part of which previous experiences or data are used to improve machine performance²⁶⁷. In fact, the technology has gone on to surpass human abilities: In 1997 for instance, an AI program (IBM Deep Blue) became the first computer to become world chess champion²⁶⁸ after beating then title-holder Garry Kasparov²⁶⁹. In 2011, another one (IBM Watson) won the famous game ‘*Jeopardy!*’ by beating two game champions²⁷⁰. And in 2015, one called AlphaGo, developed by Google DeepMind won the very complicated game Alpha by absorbing expert human technique to then use it to win against a professional player, in what was a major achievement in AI development at the time²⁷¹. The promise of machine replicating (and even surpassing) human intelligence envisaged by Turing has therefore indeed become true.

While a more thorough discussion on the history of AI falls outside of the scope of this paper, it is important to position the capabilities of AI envisaged in the self-driving contract realm. Indeed, for the purposes of this discussion in relation to self-driving contracts in which AI undertakes the contract drafting, this ability to ‘imitate’ human intelligence is an important one. In fact, the concept of AI itself is about trying to make machines *mimic* human intelligence and behaviour²⁷². Technology professionals have indeed drawn the distinction between weak and strong AI, as the former mimics human intelligence while the latter is as capable as humans

²⁶² HM Government, ‘Industrial Strategy: Building a Britain Fit for the Future’ (*HM Government*, 2017) 37 <https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/664563/industrial-strategy-white-paper-web-ready-version.pdf> accessed 20 April 2021

²⁶³ Oxford Reference, ‘Overview Artificial Intelligence’ <<https://www.oxfordreference.com/view/10.1093/oi/authority.20110803095426960>> accessed 13 April 2021

²⁶⁴ McCarthy (n 261)

²⁶⁵ Miriam C Buiten, ‘Towards Intelligent Regulation of Artificial Intelligence’ (2019) 43

²⁶⁶ *ibid* 44

²⁶⁷ Mehryar Mohri and others, *Foundations of Machine Learning* (MIT Press 2018) 1

²⁶⁸ IBM, ‘Deep Blue’ (*IBM*) <<https://www.ibm.com/ibm/history/ibm100/us/en/icons/deepblue/>> accessed 6 April 2021

²⁶⁹ Murray Campbell and others, ‘Deep Blue’ (2002)

²⁷⁰ IBM, ‘A Computer Called Watson’ (*IBM*) <<https://www.ibm.com/ibm/history/ibm100/us/en/icons/watson/>> accessed 6 April 2021

²⁷¹ Deep Mind, ‘AlphaGo’ <<https://deepmind.com/research/case-studies/alphago-the-story-so-far>> accessed 6 April 2021

²⁷² See generally Wolff (n 32)

are²⁷³. Arguably for many applications, including self-driving contracts, weak AI that *mimics* human thinking may be enough.

Then entire promise of self-driving contracts indeed lies in the extent to which they are able to (1) replicate the way human parties would have drafted contract terms so as to achieve the set objective, yet (2) do so in a way that would nonetheless exceed human capabilities through a greater processing of environmental data and factors that would ‘optimise’ the process, as will be discussed in more detail later in this chapter. This concept would therefore entail ensuring that AI is capable of both analysing large amounts of data, but more interestingly harness this analysis to replicate human-like legal drafting. While it may be argued that this ability of AI to mimic and exceed human intelligence has been seen in the past, its ability to perform legal work remains to be determined.

1.2 AI in Law

Indeed, AI in law for now takes primarily the form of predictive analytics though which predictions as to case outcomes are made²⁷⁴. As discussed in Chapter 1, this practice was somewhat successful to the extent that predictions were to a high percentage accurate. Yet this use of AI to make legal predictions is subject to strong controversy due to the non-negligible ethical concerns of bias it may raise.

Indeed, in the case of *State v Loomis*, a US case, the use of an algorithm to assess crime recidivism exacerbated race-based biases, and shone light on the ethical challenges arising out of using forms of machine intelligence²⁷⁵. Similarly, at the time of writing, the UN has just issued a statement calling for a limit to the use of AI for various violations of human rights²⁷⁶. The promise of AI in law therefore appears much more nuanced at this stage, and prompts to question the extent to which we wish to trust and delegate legal work to non-humans in the first place.

Nevertheless, following from the other technology-driven applications in the legal sphere, the use of AI has been deemed the ‘next frontier in law’²⁷⁷, and arguably the logical next step in

²⁷³ See generally John R Searle, ‘Minds, Brains and Programs’ (1980)

²⁷⁴ See generally Katz and others (n 41); Aletras and others (n 42)

²⁷⁵ *State v Loomis* 2016 WI 68

²⁷⁶ United Nations, ‘Urgent Action Needed over Artificial Intelligence Risks to Human Rights’ (*UN News*, 15 September 2021) <<https://news.un.org/en/story/2021/09/1099972>> accessed 30 December 2021

²⁷⁷ Thomson Reuters, ‘Ready or Not: Artificial Intelligence and Corporate Legal Departments’ (*Thomson Reuters*, 2017) <<https://legal.thomsonreuters.com/en/insights/articles/artificial-intelligence-ai-report>> accessed 30 September 2021

the digitalisation of the profession. It may be that for less ‘controversial’ or lower-stake applications of the technology than predicting case outcomes, this promise could be more realistic. Moreover, considering that one of the key barriers to AI development has been identified as the lack of access to data²⁷⁸, and that it was established that larger amounts of data were created with matching storage and processing capabilities, future growth of the technology could indeed be envisaged. In fact, according to an industry report, 70% of companies will use some form of artificial intelligence in their operations by 2030, as the technology is expected to deliver \$13 Trillion of additional global economic activity overall²⁷⁹. It may therefore indeed be foreseeable to see the technology extend into contracting practices too. The promise of self-driving contracts may therefore be a timely one.

Moreover, a lot of legal work has indeed been identified to require some form of prediction such as likelihood of winning a case, negotiating a settlement...²⁸⁰. The ‘strategic’ planning required to assess a situation and evaluate how to respond indeed suggest the ‘suitable’ nature of law to accommodate a solution to automate said predictions. Again, suggesting that self-driving contracts would be a lower-stake application of the predictive capabilities of AI, it may be that the success of predictive analytics could lie in ‘predicting’ the right course of actions to achieve a set contractual objective, and which would then be translated into actionable contract terms²⁸¹.

2. Self-Driving Contracts

2.1 Definition

Looking at the concept in more detail, self-driving contracts, as envisaged and defined by scholars Anthony Casey and Anthony Niblett in their paper of the same name, refers to contracts in which parties agree to broad objectives leaving the contract essentially ‘empty’, and let it

²⁷⁸ Wolff (n 32) 497. He states that the more access the AI has to data, the quicker it will be able to improve itself

²⁷⁹ Jacques Bughin and others, ‘Notes from the AI Frontier: Modelling the Impact of AI on the World Economy’ (*McKinsey Global Institute*, September 2018)

<<https://www.mckinsey.com/~media/McKinsey/Featured%20Insights/Artificial%20Intelligence/Notes%20from%20the%20frontier%20Modeling%20the%20impact%20of%20AI%20on%20the%20world%20economy/MGI-Notes-from-the-AI-frontier-Modeling-the-impact-of-AI-on-the-world-economy-September-2018.ashx>>

accessed 12 April 2021

²⁸⁰ Susskind (n 38) 54

²⁸¹ See generally Casey and Niblett, ‘Self-Driving Contracts’ (n 16)

write its own terms, acting as a ‘gap-filler’²⁸². Scholar Lauren Scholz indeed recognised in her own analysis of algorithmic contracts that they could indeed take on a ‘gap-filler’ function in the contracting process²⁸³.

In the self-driving contract realm, the AI would predict and decide on the appropriate course of action to take in order to achieve the desired outcomes, based on real-time contingencies and turns of events²⁸⁴, as information (relating to both the parties’ intentions, behaviours and states of the world) is gathered *after* the parties have agreed to contract²⁸⁵. In filling the gaps of incomplete contracts in light of the environment and the goals of the parties, the algorithm would act in the way a mediator or a court would²⁸⁶ replicating therefore a key legal function, as will be more extensively discussed later in this chapter.

In a self-driving contract setting therefore, the parties would decide and commit to a broad *ex ante* objective without knowing the exact *ex post* consequences of that decision at the time of signing²⁸⁷ instead letting the AI interpret their standards and let automated analytics fill in specifics in real time to achieve their designated outcome²⁸⁸. Moving towards self-driving contracts would therefore entail an impressive trust in machine intelligence as it is allowed to fill in the terms of the agreement as it ‘deems appropriate’²⁸⁹, and update its directives as the situation evolves²⁹⁰. It may therefore be argued that self-driving contracts would create an entirely new *ex durante* contracting paradigm as the contract adapts in real-time as the situation unfolds. The underlying structure of self-driving contracts would also move beyond the ‘simple’ conditional ‘if X happens then Y happens’ logic found in the current contracting/algorithmic contracting paradigm to a more *advanced* ‘if X happens then Y is *the optimal scenario*’ logic.

By bypassing human limitations as no human party can realistically foresee and transcribe every possible scenario²⁹¹, self-driving contracts (should they indeed come to be) would represent a truly interesting advance in the field of contracting, creating a bridge between contracts as currently known and what would be *perfect* and *complete* contracts by economic standards. Indeed, a perfect economic contract would be complete in that it anticipates all future state

²⁸² See generally Casey and Niblett, ‘Self-Driving Contracts’ (n 16)

²⁸³ Scholz, ‘Algorithmic Contracts’ (n 71) 136

²⁸⁴ See generally Casey and Niblett, ‘Self-Driving Contracts’ (n 16)

²⁸⁵ *ibid*

²⁸⁶ Howell and Potgieter (n 162) 556

²⁸⁷ See generally Casey and Niblett, ‘Self-Driving Contracts’ (n 16)

²⁸⁸ *ibid*

²⁸⁹ *ibid*

²⁹⁰ *ibid*

²⁹¹ *ibid*

contingencies with an outcome provided for each²⁹². While there is an argument that all contracts are by nature incomplete to the extent that it is unrealistic to expect human parties to foresee all possible outcomes, this promise appears for the first time feasible using machine intelligence.

Interestingly, self-driving contracts would also be highly *incomplete* as they would have to be written at a very high level and essentially full of gaps at the moment of signing, only to be filled afterwards and in real-time by the algorithm²⁹³. This would likely prompt some form of legal discussion as to the recognition of such incomplete contracts.

2.2 Applications of Self-Driving Contracts

As the broad lines of the underlying concept behind self-driving contracts have been drawn, it emerges that while it is still hypothetical at this stage, early forms of a similar technology are beginning to emerge in the form of micro-directives and self-pricing agreements²⁹⁴.

Indeed, self-pricing contracts for instance, such as that found in the auto-insurance sector are an early form of the concept in which the pricing of the insurance contracts adapts terms autonomously based on various factors such as driver speed, distance, driving patterns...²⁹⁵.

Looking into the future of the practice of law, this predictive foundation of self-driving contracts could be used in ‘contractual micro directives’ which Casey and Niblett define as automated directives that automatically update and optimise for their situation as it evolves²⁹⁶. The expectation is that using this same predictive feature of AI could lead to creating laws that would ultimately be able to respond to *every* possible scenario in a very precise and tailored manner²⁹⁷.

While a full analysis of this proposition would warrant its own research paper, these possible applications of machine intelligence in law suggest that the promise of the predictive capabilities of algorithms to translate *general ex ante* objectives into *specific ex post* actions could lie in applications other than forecasting court outcomes. For the purposes of this paper, self-driving contracts could indeed offer a unique proposition in the field of contracting.

²⁹² See generally the contract theory and Oliver Hart’s work (See Oliver Hart ‘Incomplete Contracts and Control’ (2017))

²⁹³ See generally Casey and Niblett, ‘Self-Driving Contracts’ (n 16)

²⁹⁴ *ibid* 3

²⁹⁵ *ibid* 2

²⁹⁶ Anthony Casey and Anthony Niblett, ‘Self-Driving Laws’ (2016) 7-8

²⁹⁷ See generally Casey and Niblett, ‘Self-Driving Laws’ (n 296)

2.3 Towards a Legal Intelligence of AI?

As the possibility of extending predictive abilities of AI to contract drafting has been set out, it remains to be determined the extent to which machine-intelligence can replicate human intelligence in translating said predictions as to the best course of action into actionable contract terms.

Indeed, to elaborate on the process of drafting a contract term, this paper takes the stance that it requires (1) the ability to ‘understand’ the objective of the parties, and (2) the capacity to translate this understanding into clear and unambiguous actionable contract terms.

In relation to (1), the objective appears to relate to the technology’s cognitive ability to enter into contracts, compare utilities and ownership of the assets, and essentially mimic human-like behaviours²⁹⁸ in its understanding of the contractual objectives. The technology should therefore demonstrate sufficient autonomy and mutuality in contracting, and be able to interact, and adapt as the contract unfolds²⁹⁹. These are aptitudes that can arguably be achieved by the technology as it processes large amounts of information to predict how to achieve an objective, much like it analyses large amounts of information to predict case outcomes. It however also suggests that the technology is also limited to the extent that if a situation is not similar or reminiscent to any previous data, the AI will not be able to make predictions. Should self-driving contracts indeed develop therefore, they would be limited to the confines of a scenario in which data is indeed available to be fed to the underlying algorithm.

As regards contract drafting more specifically (2), which entails both a creation and revision of documents and may sometimes entail the use of specific ‘legalese’ language to express contractual clauses³⁰⁰, it remains to be determined how well terms will be expressed by the AI, as the idea behind self-driving contracts is indeed still at concept stages. It may be for now that this drafting of terms will be inherently limited to the confines of ‘easy-to-express’ terms.

Nevertheless, linking this problematic to John Searle’s ‘Chinese Room’ experiment in which he supposed that a computer was able to pass the Turing Test, convincing a human Chinese speaker that it was itself capable of speaking Chinese while it was in fact taking Chinese characters as input and following computer instructions³⁰¹, it may be that mimicking the

²⁹⁸ John Linarelli, ‘Artificial General Intelligence and Contract’ (2019) 344

²⁹⁹ *ibid* 343

³⁰⁰ Jamison Wilcox, ‘Teaching Legal Drafting Effectively and Efficiently’ (2007) 3

³⁰¹ See generally Searle (n 273)

drafting of contract terms in a similar manner will be enough for the parties to benefit from the AI intelligence.

Considering that some scholars argue that training an AI engine is similar to training a new lawyer to do its job (through exposures to numerous and various examples for it to develop a sufficient understanding of the practice of the law³⁰²), it may be that ‘teaching’ contract drafting more specifically to an AI engine is a possible endeavour that could suggest that the technology could scale in the future. While interesting from a scholarly perspective in discussing the challenges that lie at the intersection of technology and law, from a legal viewpoint, it remains to be determined whether technologies can be tasked with conducting legal work in the first place, as not all jurisdictions allow non-lawyers to do so. It also raises the question as to whether it is desirable to do so at all: Is the promise of a fully-bespoke and ‘complete’ contract by economic standards worth the inherent risks and opacity of employing algorithms?

2.4 The Promise of Self-Driving Contracts

2.4.1 Unique advantages of the concept

In order to get a better and more balanced understanding of the promise of self-driving contracts, this part of the chapter will explore the advantages they offer.

In relation to their ‘predictive’ capabilities which are based on the data that is fed to the AI, it may be that firms which create large amounts of data can envision a high promise for self-driving contracts.

Moreover, the ability to consider all contingencies could also reduce both the thinking (linked to coming up with and negotiating clauses) and writing (actually drafting) costs of drafting the contract, offering therefore the promise of reduced costs overall as well³⁰³.

From this cost perspective still, self-driving contracts could also guide the parties towards actions that are cost-justified³⁰⁴ and optimal, arguably much like the underlying Uber algorithm that calculates the fastest itinerary for lowest price, justifying therefore an ‘optimisation’ purpose of self-driving contracts. This unique approach to contracting may lead to some form of manufacturing-like ‘just-in-time’³⁰⁵ contracting, in which terms are drafted to express

³⁰² LawGeex (n 44)

³⁰³ Casey and Niblett, ‘Self-Driving Contracts’ (n 16) 11

³⁰⁴ *ibid* 8

³⁰⁵ Just-in-time is a specific type of inventory management in which supplies are received on an as-needed basis, minimising inventory and maximising efficiency. See Investopedia, ‘Just-In-Time (JIT)’ (*Investopedia*)

exactly what the parties wish to achieve, reducing the need for any variation clauses, and with a view to maximizing contract efficiency. From such a view, the potential of self-driving contracts would indeed be compelling. For the same reason, self-driving contracts would also reduce the likelihood of breach and the need to renegotiate clauses as a result of having *every* possible state of events considered in the automated drafting of the agreement³⁰⁶. Instead, parties could have the confidence to be guided towards the most effective and appropriate way to conduct their operations with no need for amendments or renegotiations.

For this reason, self-driving contracts could also offer the promise of reflecting the dynamic nature of the acquisition of knowledge over time³⁰⁷, as they would be able to adapt continuously to the environment, in a way that plain algorithmic or smart contracts are not able to. From the view of the more ‘relational’ theory of contract which sees the practice as an open-ended, flexible way to further business ends accounting for the possibility of changing environmental factors and their possibly changing intentions, it indeed appears that self-driving contracts are more aligned with the social aspect of the architecture of contracting.

Moreover, self-driving contracts creators advance the argument that this contracting method could acknowledge power asymmetries³⁰⁸, instead putting the parties on equal footing, delegating the drafting of key terms to the agreement *itself*.

In addition to being more aligned with a more flexible vision of contracting and proposing a party-neutral contract drafting experience, it also emerges that self-driving contracts could offer a technocratic response to some of the challenges raised by other forms of algorithmic contracts. The use of self-driving contracts could for instance enable parties to translate ambiguous terms/legal terms of art into actionable terms that reflect what those terms of art mean within the specific setting in which the contract operates³⁰⁹: It could for instance breakdown terms such as ‘reasonable efforts’ or ‘reasonable price’ into situation-specific and appropriate steps. These steps could then be more easily amenable to code. As such, it could be said that self-driving contracts could indeed allow to enter a new frontier in contract drafting, proposing an interesting solution on their own, but also seemingly when combined with other forms of algorithmic contracts as well.

2.5 Challenges of Self-Driving Contracts

<<https://www.investopedia.com/terms/j/jit.asp>> accessed 27 September 2021

³⁰⁶ See generally Casey and Niblett, ‘Self-Driving Contracts’ (n 16)

³⁰⁷ Howell and Potgieter (n 162) 557

³⁰⁸ *ibid*

³⁰⁹ Casey and Niblett, ‘Self-Driving Contracts’ (n 16) 6

As the broad promise of self-driving contracts has been set out, it remains to be nuanced with the various challenges it raises.

2.5.1 Trust in AI

Indeed, one important consideration in the self-driving contract realm is one of trust, given that users would be prompted to trust the contractual recommendations made by the AI in the process.

In the context of technological developments, it has been identified that people tend to rush towards implementing technology-based solutions without necessarily understanding them, solely based on the promise of more efficiency, lower costs, greater reach to customers...³¹⁰. But people working regularly with technologies or in technological fields usually know enough about technological failures to exercise caution and scepticism in their regards³¹¹. These non-negligible technical issues also evidence another wider problem in the technology sphere, referring to what is called *automation bias* in which users are encouraged to follow ‘blindly’ technological recommendations instead of critically assessing information³¹². This indeed seems to be the underlying promise offered by self-driving contracts which prompt users to trust and act on the directives they propose.

While not likely to raise significant legal issues to the extent that parties retain some form of oversight over their contractual endeavours (unlike in the self-enforcing and immutable smart contract paradigm for instance), this unique operating mode calls again for some legal consideration as to the role of the technology in the contracting process, and for the *responsibility* it undertakes in directing the parties in achieving their objectives. AI decision-making can indeed be very opaque, in which case legal input accounting for said responsibility seems warranted, together with a framework on addressing the situation where parties have been wronged by following AI-made propositions.

2.5.2 A New Architecture for Self-Driving Contracts

³¹⁰ Patricia L. Hardré, ‘When, How and Why Do We Trust Technology Too Much’ in Sharon Y Tettegah and Dorothy L Espelage (eds), *Emotions, Technologies and Behaviours* (Elsevier 2016) 85

³¹¹ *ibid*

³¹² See generally Linda Skitka and others, ‘Does automation bias decision-making?’ (1999)

Moreover, as self-driving contracts rely on the promise of machine intelligence, it may be (just like other forms of algorithmic contracts) that regards should be placed on any technology-related considerations they may warrant.

Indeed, Casey and Niblett identified in their paper that self-driving contracts would create a new market for third party independent vendors or programmers who would provide self-driving contract solutions to parties³¹³. Self-driving contracts could therefore entail a further change in contracting dynamics as currently known, moving away from the programmer-driven contract translation into code towards the emergence new specialised business providers specialising setting up self-driving contract solutions³¹⁴. As a result of this shift in ‘contract creation’, the role of the law could also be poised to evolve, so as to support, oversee and more importantly regulate these new algorithmic contract markets³¹⁵.

From a technical perspective, it also emerges that AI is vulnerable to the extent that it relies on data accuracy. As a result, poorly programmed or calibrated algorithms, or ones containing errors could lead to a need for renegotiation despite the technology offering the promise of bypassing renegotiation processes³¹⁶.

Similarly, the technology is also susceptible to cybersecurity attacks and breaches³¹⁷, meaning that extending existing legal provisions on matters of data management would be purposeful, while extending legal protection to account for the possibility that parties may have their agreement hacked or poorly programmed could promote the technology as ‘safe’ for use. Again, the objective would be to extend the reach of the law on the matter and ensure it is fit-for-purpose.

3. Conclusion: The Future of Contracting or Much Ado About Nothing?

As this paper explored various forms of algorithmic contracts, with various features, capabilities and levels of automation, having regards to both the advantages they bring and the challenges they pose, their position within the ‘future of contracting’ appears clearer.

Indeed, while limited in scope due to technical and legal limitations that seem to position ‘traditional’ contracting practices as ‘safer’ alternatives for complex contractual endeavours, the promise of automation of the agreement, streamlining of contract drafting, or connectivity

³¹³ Casey and Niblett, ‘Self-Driving Contracts’ (n 16) 1

³¹⁴ *ibid* 28. It is worth mentioning that this is not a reality yet.

³¹⁵ *ibid* 30-32

³¹⁶ *ibid* 21

³¹⁷ Teresa Rodriguez De las Heras Ballell, ‘Legal Challenges of Artificial Intelligence’ (2019) 304

with other technologies, to summarise the advantages of algorithmic contracts in broad terms, make for a compelling commercial proposition nonetheless. In light of the digital economy we find ourselves in and which sees technologies develop and be used to facilitate processes, it may indeed be that algorithmic contracts could represent the future of contracting.

Should this prediction indeed become true, it could suggest that lawyers would have to adopt a symbiotic relationship with technology and eventually becoming ‘digital lawyers’³¹⁸. They may indeed be brought to work with programmers to ensure the seamless translation of the contract into code for instance³¹⁹. In addition to assisting with contract design, lawyers could also assist in reconciling algorithmic contracts with the law, or work towards achieving some form of international harmonisation regarding a universal recognition of the concept³²⁰. Some form of re-skilling, as opposed to fully de-skilling lawyers could therefore be envisaged.

In *Tomorrow’s Lawyers*, new legal roles such as that of legal technologists were envisaged to bridge this gap between law and technology³²¹. As such, it could be possible to similarly envisage the creation of roles such as ‘contract technologists’ bringing code and law together for instance. Similarly, legal data scientists as described by Susskind and who combine machine learning and predictive technologies with law³²² could work on making AI-enabled self-driving contracts a reality.

Adopting an even more ‘futurist’ view, it would be interesting to explore whether these algorithmic contracting methods could be combined to form ‘truly intelligent’ contracts.

Indeed, using this algorithmic foundation, AI and predictive analytics could automate contract *drafting*, enabling the translation of *every* possible contingency and even ambiguous terms.

While the ‘smart’ nature of smart contracts could allow to automate the *transaction* itself and in real time thanks to oracles while providing the security and immutability of the blockchain.

While this does remain in the realm of a contractual techno-utopia, it is interesting to imagine how the future of contracting could take shape, as indeed scholars seem to have already done so extensively in the relevant literature on the subject. While these ‘truly intelligent’ contracts are not a reality yet, and recognising that they may very well never be, the discussion held throughout this dissertation so far nevertheless built an interesting case for the future of algorithmic contracts.

³¹⁸ See generally Susskind (n 38)

³¹⁹ This will be discussed in more detail over the next chapters.

³²⁰ As will be discussed later in this paper in Chapters 6 and 7, a lack of universal recognition or harmonisation in relation to smart contracts for instance restricts their growth.

³²¹ Susskind (n 38) 136

³²² Susskind (n 38) 140

While it has been acknowledged that algorithmic contracts make an interesting proposition, it must also be recognised that some of these features which are positioned as unique advantages could lead to undesirable consequences: AI can distort the way it is meant to operate, standardizing legal work can be detrimental to customers, and automating legal work may result in downplaying the role of law³²³.

In addition to the various challenges raised throughout Part II, should algorithmic contracts indeed aim to represent the future of contracting, the law would have to intervene and account for and mitigate any risks they may pose while re-affirming its oversight on the practice.

As such, Part III of this paper will now undertake a thorough discussion on the regulation of algorithmic contracts, and explore how adequate regulatory input could enable the concept to indeed scale in the future.

³²³ Pasquale (n 134) 59

Part III
Regulating Innovation

CHAPTER 6

Regulating Innovation

While the proposition made by algorithmic contracts was deemed intriguing, it follows that as visionary and promising a concept may seem, it must not be outright accepted at face value without regards to reason and rationality.

Indeed, as Part II recognised the great features of algorithmic contracts, and acknowledged their great promise of a fully digitalised future of contracting, it also identified numerous challenges that hinder their reach and development for now. While resolving technical limitations and reconciling algorithmic contracting concepts with contracting practices, if ever possible, falls outside of the scope of this paper, providing regulatory solutions to address the legal challenges they raise appears a more feasible undertaking. As such, this final part of the paper will have regards to regulatory matters.

Chapter 6 will begin with a broad discussion on the challenges of regulating innovation and new technologies, considering factors such as timing, scope and purpose of regulation and more importantly whether the identified suitable regulatory approach for algorithmic contracts is realistic and feasible to implement. Chapter 7 will then undertake a more targeted analysis on the regulation of algorithmic contracts, providing possible solutions to challenges identified throughout the paper.

1. Regulating Innovation

1.1 What is Regulation

Regulation has been defined as the focused and sustained attempt to alter the behaviour of others, with the intention of achieving a specific outcome³²⁴. Its main purpose is to reduce social harm while improving social welfare³²⁵. Given the various challenges and risks posed by algorithmic contracts which remain to some extent unaddressed, yet in light of the potential they offer to facilitate contracting practices, the objective of regulation in their regards is made clear.

³²⁴ See generally Julia Black, 'Critical Reflections on Regulation' (2002) 13

³²⁵ Marta K Kolacz and others, 'Who Should Regulate Disruptive Technology?' (2019) 6

Regulation can take numerous forms, as it can be achieved through the use of legal rules, standards, or even via a technocratic approach through which technology mandates compliance with certain behaviours as will be discussed in more detail in this chapter. Broader in scope than a law-based approach which is both stricter and narrower, regulation is capable of encapsulating soft law mechanisms and adopts a more distributed approach to oversight³²⁶.

1.2 The Purpose of Regulating Innovation

While it may appear trite to justify the purpose of this regulatory exercise, it remains important to identify the specific objectives that must be achieved, so as to ensure any regulations align with them.

Indeed, in broad terms, the goals of policy makers are to maximise the benefits of innovation while minimising any negative effects³²⁷. It also emerges that policies can either encourage or stifle innovation³²⁸. The objective of regulators as regards innovations, and more specifically in relation to algorithmic contracts is therefore twofold: They should (1) regulate any risks that arise out of novel practices, and (2) do so in a way that will promote rather than stifle innovation.

1.2.1 Minimising Risk

As discussed extensively throughout this paper, technologies are having a great impact on industries, commerce, and more widely society, which welcomes the benefits they offer.

They also facilitate new forms of conduct³²⁹ which seem to question the applicability of existing laws and regulations, especially when they cannot be easily classified within existing concepts³³⁰. As algorithmic contracts indeed enable new kinds of behaviours (such as fully automated contracting, machine-driven contract drafting...), and most importantly pose novel risks, the need for regulatory input accounting for those appears warranted.

Taking the stance that the trust in technology, arguably a central feature in the algorithmic contract paradigm³³¹, does not outweigh the trust in law, the discussion held in this final part of

³²⁶ Lyria Bennet Moses, 'How to Think about Law, Regulation and Technology' (2013) 4

³²⁷ UNCTAD (n 8) 37

³²⁸ Bennet Moses (n 326) 11

³²⁹ Lyria Bennet Moses, 'Recurring Dilemmas: The Law's Race to Keep Up with Technological Change' (2007) 12

³³⁰ *ibid*

³³¹ As it has been expressed in the form of trust in code for 'plain' algorithmic contracts, as trust in the blockchain in the case of smart contracts, and as trust in AI in the case of self-driving contracts.

the paper appears purposeful in positioning algorithmic contracts as the future of contracting: Without some form of legal or regulatory input to account for the novel challenges and risks algorithmic contracts raise, it may indeed be that algorithmic contracts will not progress onto more ambitious endeavours, placing breaks on their promise as a result.

Scholar Kevin Werbach in fact accurately pointed that innovators have most to lose by delaying government involvement in the development of a technology³³². As such, the discussion held in this final part of the paper will attempt to provide solutions to legal challenges identified throughout, with a view to resolving the regulatory gap that does not account for the novel features of algorithmic contracts.

1.2.2 Promoting Innovation

As the first, yet important objective of regulation has been set out, it also emerges that regulating innovation more specifically entails another objective, which is to promote rather than stifle innovation.

Legal certainty is indeed key to encourage commerce³³³ and has a direct impact on whether a technology or concept is welcomed or rejected by the public³³⁴. As discussed earlier in this paper, it may be that parties will indeed not want to experiment with algorithmic contracting technologies if it means that they will depart from the protection they enjoy under legal oversight. Extending regulations could therefore lead to parties being more likely to experiment with the technologies.

Moreover, an *innovation-friendly* regulatory framework may also allow to further encourage innovation³³⁵: it may result in catalysing the development of more technologies and further prepare legal systems to the possible development of other disruptive concepts in the future³³⁶. Setting up appropriate regulatory regime could therefore foster innovation, and in turn possibly enable algorithmic contract progress, yet within the reach of legal oversight.

³³² Werbach and Cornell (n 220) 319

³³³ Lord Mansfield in *Vallejo v Wheeler* [1774] 1 Cowp 143 ‘in all mercantile transactions the great object should be certainty’ [143]

³³⁴ Souichirou Kozuka, ‘A Governance Framework for the Development and Use of Artificial Intelligence’ (2019) 316

³³⁵ Catalina Goanta, ‘How Technology Disrupts Private Law: An Exploratory Study of California and Switzerland as Innovative Jurisdictions’ (2018) 8-9

³³⁶ Rodriguez de Las Heras Ballell, ‘Legal Challenges of Artificial Intelligence’ (n 317) 307

From a commercial perspective, this ambition to promote innovation links to the idea that that the first system to regulate new technologies effectively will win out in future innovations³³⁷. There is therefore an important economic rationale that sees the regulatory objective not just in relation to regulating current technologies and promoting them as ‘safe’, but also to showcase that future ones will also benefit from the same treatment.

Indeed, considering that just as technology is shaping the world as we know it, forces such as changes in law, client expectations, and regulations will also impact the course of AI and technology implementation³³⁸, it follows that the regulatory response, in whichever form it takes, will indeed have to be future-oriented and able to continuously adapt, and apt to promote a future technological development. The demands placed on regulators are therefore complex. In the context of the discussion held in this paper, and considering that algorithmic contracting practices *could* continue to develop in the future, it places high stakes on providing the right regulatory framework so as to surround a potential development of the concept, but also with a view to positioning English Law and the UK more generally as regulatory leaders in the area.

2. Challenges of Regulating Innovation

As the broad objectives of regulation have been set out, this part of the chapter will move on to outlining the specific challenges of regulating innovation, which call for specific approaches to be taken. Discussing these approaches, will allow to determine the most appropriate regulatory course of actions to surround the development of algorithmic contracts, which will then be translated into actionable propositions in the next and final chapter.

2.1 The Challenge of Regulatory Connection

As discussed in Chapter 1, technologies now emerge seemingly with evermore capabilities, and take on a key role within the architecture of our digital economy, in part thanks to the ever-increasing amounts of data, and matching storage and processing capabilities to accommodate this growth.

³³⁷ See generally Maya Chilaeva, ‘Smart Contracts: Can They be Aligned with Traditional Principles or are Bespoke Norms Necessary’ (2018). (This paper is about regulating smart contracts, but the same thinking could be extended to technologies more generally).

³³⁸ See generally Becerra (n 36)

As these technologies enable new behaviours, they depart from the applicability of existing laws and regulations which were fit for a past technological landscape, as very accurately pointed by scholar Roger Brownsword as he outlines the *Challenge of Regulatory Connection*³³⁹. According to him, this technological progress leads to a mismatch between laws and regulations that were appropriate to tackle a past technological ecosystem, but which now require some form of continuous ‘reconnection’ with technological developments³⁴⁰. This challenge applies to both new technologies which bring their own capabilities and challenges, but also to existing ones, which have developed and progressed beyond the regulatory regime they were initially under³⁴¹.

This problematic appears indeed timely and relevant in our digital economy as both new technologies and emerging business models challenge existing legal frameworks which they do not fit into³⁴², and which must as a result be ‘re-connected’. More relevantly, this challenge would be relevant in the case of algorithmic contracts too: any regulation tackling issues arising out of the use of ‘plain’ algorithmic contracts would be ineffective in addressing the novel challenges raised by more ‘advanced’ smart or self-driving contracts.

While arguably a challenging undertaking, the law has already successfully shown that it is able to adapt to technological progress. To take Francis Sayre’s example for instance, the rise of ‘high-powered automobiles’ in the earlier part of the 20th century was extremely disruptive at the time and required the creation of new forms of traffic regulations³⁴³. Similarly, when computers took greater ‘responsibility’ in business functions a few decades later, lawyers and lawmakers were unsure as to how this responsibility would be accounted for³⁴⁴, yet today, despite what is arguably very fast progress in the sphere with the prominence of the internet in everything we do today, computers are now successfully included in day-to-day work arguably without raising issues that are incapable of being resolved by regulatory or legal recourse.

More generally, changes in medical technologies, communication advances... have all called for legal change over time³⁴⁵, and the law has been able to respond appropriately, whether by fitting new principles within existing frameworks, or by creating new ones. In terms of ‘regulatory connection’ therefore, the law has shown that it is indeed able to ‘connect’ to new categories of conduct enabled by new technologies.

³³⁹ See generally Roger Brownsword, *Rights, Regulation and the Technological Revolution* (Wiley 2008)

³⁴⁰ *ibid*

³⁴¹ See generally Bennett Moses, ‘How to Think about Law, Regulation and Technology’ (n 326)

³⁴² Goanta (n 335) 5

³⁴³ See generally Francis B Sayre, ‘Public Welfare Offences’ (1933)

³⁴⁴ Bennett Moses, ‘Recurring Dilemmas’ (n 329) 29

³⁴⁵ *ibid* 1-4

From a contract-specific view, Lord Wilberforce accurately pointed that courts confronted with novel forms of transport, automation, business practices have managed to enforce so far principles of offer acceptance consideration³⁴⁶. It may therefore be argued that such an exercise could (and arguably already is³⁴⁷) replicated in the case of algorithmic contracts.

In light of this challenge nevertheless, any rules deployed or extended must be *flexible* so as to adapt to the change and progress enabled by our digital economy, and essentially be *future-proofed* so as to account for a possible future development of the concept too. To follow the view of Lord Hodge, it appears law adapting will indeed remain an important topic, even as technology advances³⁴⁸, and even in the algorithmic contract realm.

2.2 The Pacing Problem

As the challenge of regulatory connection had regards to the *nature* of technological progress, offering the promise that continuously updating regulatory frameworks and re-connecting them with novel features of technologies would allow to better surround technological development, it emerges that in practice, this undertaking is more challenging, as existing laws and regulations appear to struggle to keep up with the *pace* at which technologies develop³⁴⁹.

This problematic was very well evidenced by Larry Downes, as he referred to the ‘Pacing Problem’ in his 2009 book *The Laws of Disruption*, illustrating the fact that while technologies progress *exponentially*, economic, social, and most importantly perhaps, legal systems, only progress in an *incremental* manner that does not match the speed of technological development³⁵⁰.

While the speed at which technological progress and adoption that will be experienced in the algorithmic contracting realm remain to be determined, considering that much of the discussion held in this paper is futurist and speculative in approach, discussing this pacing problem remains nonetheless relevant. Indeed, should the concept indeed go on to scale, this objective of aligning regulations with the novel behaviours enabled by algorithmic contracts would have to be

³⁴⁶ Roger Brownsword, ‘Regulatory Fitness: Fintech, Funny Money, and Smart Contracts’ (2019) 16. He refers to Lord Wilberforce’s view in the case of *New Zealand Shipping Co Ltd v. A.M. Satterthwaite and Co Ltd: The Eurymedon* [1975] AC 154, [167]

³⁴⁷ See generally UKJT (n 67)

³⁴⁸ Lord Hodge, ‘Technology and the Law’ (The Dover House Lecture 2020, London 10 March 2020) 12

³⁴⁹ See generally Gary E Marchant and others, *The Growing Gap between Emerging Technologies and Legal-Ethical Oversight* (Springer 2011)

³⁵⁰ See generally Larry Downes, *The Laws of Disruption* (Basic Books 2009)

achieved consistently and in a timely manner so as to avoid any regulatory gaps that would leave risks unaddressed.

As such, the suitable regulatory approach would have to be *flexible* and *continuously-reviewed* and *re-connected* so as to account for a possible fast development of the concept.

2.3 The Collingridge Dilemma

As the challenge of regulatory connection and pacing problem had regards to the type of regulatory attempt best able to respond to the *speed* and *nature* of technological progress, it emerges that the *timing* at which this regulation is proposed is indeed important in achieving a regulatory objective that both promotes innovation while mitigating any risks it may pose.

The Collingridge Dilemma indeed accurately expresses this timing challenge, recognising that early regulation is rendered difficult due to a lack of information surrounding the innovation yet later regulatory input, once enough information is available, is rendered more difficult to integrate due to the technologies having become too entrenched to be affected by said regulations³⁵¹:

2.3.1 The Information Problem

Indeed, looking at this regulatory paradox in more detail, it indeed emerges that in the early stages of technological development, regulating new developments is difficult because not enough is known about the technologies, their potential applications but also their potential harmful social consequences.

When regulating innovation, especially in light of the pace of current technological developments, one should indeed be wary of rushing/hasting towards introducing new legal rules directly as a response to new developments and instead carefully consider any resulting issues that would affect both business and consumers³⁵². A rushed regulatory response could indeed result in creating more challenges than solving them³⁵³. A wait-and-see approach may therefore be warranted on certain occasions, and would mean that the creation of *appropriate* regulations will be delayed until enough information is available, once people have experimented with the technology.

³⁵¹ See generally David Collingridge, *The Social Control of Technology* (Frances Pinter 1980)

³⁵² Twigg-Flesner (n 10) 1

³⁵³ *ibid*

This approach recognises also that potentially negative effects could appear at a later time, linking to Clayton Christiansen's theory of 'disruptive innovation' raised in his book *The Innovator's Dilemma*, as he informs business leaders that innovations tend to have *fluid* futures to the extent that it is difficult to predict from the outset the disruption they will cause once they mature³⁵⁴.

Yet, as discussed earlier in this paper, this very lack of legal and regulatory certainty may prevent experimentation with technologies in the first place, and especially in the commercial sphere, due to parties being potentially risk-averse in their practices. This lack of experimentation with technology that would otherwise result in enough information available to craft an appropriate regulatory response, could therefore prevent regulation, if a wait-and-see approach is indeed adopted.

Evidencing the paradoxical nature of regulating innovation, this may in turn lead to the creation of an 'in-between' scenario in which technologies emerge but are neither regulated nor exploited to their full potential. It may also lead these new technologies to be applied in undesirable settings due to a lack of regulatory reform, or pose unmanaged risks, which may fuel further uncertainty and caution in their regards, preventing furthermore experimentation with them in commercial settings.

In the Collingridge Dilemma, this paradox of technology information has been identified as the '*information problem*' and should arguably be avoided in the algorithmic contracting realm otherwise running the risk of placing a break on the development concept, should it be deemed too risky or uncertain for commercial application, and associated with a negative public perception. Some form of proactive regulation appears therefore called for.

2.3.2 The Power Problem

As it has been established that early regulation, while desirable to mitigate risks and address challenges from the outset, is not necessarily feasible if information is not available to fuel it, it also emerges that waiting to gather more information is not necessarily a better alternative. Indeed, the second verse of Collingridge Dilemma evidences that once enough information is eventually gathered about a technology that could allow regulators to draft appropriate rules, that control has become too difficult or expensive to implement as technologies have become

³⁵⁴ See generally Clayton M Christiansen, *The Innovator's Dilemma* (Harvard Business School Press 1997)

too entrenched and established to change, resulting therefore in what is called the '*power problem*'³⁵⁵.

This paradox therefore evidences the fact that, while more difficult to achieve, regulating technologies in their early development stage while they are still 'malleable' may allow to shape them and minimise the risks they pose much more easily than if a regulatory attempt is made at later stages. Suggesting some form of hare and tortoise relationship between regulation and innovation that is evidential of the difficulty of regulating it, this problematic nevertheless supports the idea that regulators should act *promptly*, otherwise running the risk that the desired regulation of new technologies will only become more difficult to implement over time.

In the case of algorithmic contracts, it therefore follows that the suitable regulatory attempt should be *flexible* and *future-forward* as discussed earlier, yet also *proactive* in approach so as to regulate the concept while still in its early stages. This would arguably be now.

Indeed, it may be argued that we do have enough information about algorithmic contracts already in light of the extensive scholarly interest they have generated and considering the early commercial examples that have emerged. Seemingly past the 'information problem' yet still at relatively early stages in the technological development of the concept, now indeed appears to be the right time to propose regulatory solutions³⁵⁶.

2.4 Regulating *Disruptive* Innovation

As it has been established that early regulation would be most appropriate and more importantly feasible in light of the amounts of information available today in relation to algorithmic contracts, it emerges from a practical viewpoint that the rapidity of coming up with an appropriate legal response will vary depending on the pace at which technological developments progress: if changes are slow and incremental for instance, the law has shown that it will aim to balance certainty and flexibility³⁵⁷. Slower technological progress would therefore grant regulators sufficient time to apprehend the technology and the risks it may pose, and craft an appropriate regulatory response, assessing and addressing the potential risks of technologies as they emerge.

³⁵⁵ See generally Collingridge (n 351)

³⁵⁶ This paper follows the view that early thinking about the impact of technologies could in turn lead to a proactive national and international development of appropriate safeguards. See generally Barbara Pasa and Larry A DiMatteo, 'Observations on the Impact of Technology on Contract Law' in Larry A DiMatteo and others (eds), *The Cambridge Handbook of Smart Contracts, Blockchain Technology and Digital Platforms* (Cambridge University Press 2019)

³⁵⁷ Nick Yeo, 'The Legal Statement on Cryptoassets and Smart Contracts: An Extremely Useful Baseline' (2020)

Similarly, when these changes are slow and incremental, it means that any form of regulatory input could be valid for ‘longer’ than if technologies develop both rapidly and radically, reducing the need for continuously re-connecting the law with innovation.

Finally, such a slow yet regulated approach to innovation would enable various parties to keep on experimenting with innovation, with the knowledge that they are doing so within the reach of the law, and allowing more information to allow regulators to tailor their regulatory attempt. By many accounts therefore, this slow yet regulated approach to regulation would create a ‘sandbox’³⁵⁸ with arguably optimal conditions for safe technology development.

Where technological changes are sudden or extreme however, the legal position will be much more uncertain³⁵⁹, as considerations of re-connection emerge yet without the desired amount of information to actually perform that re-connection as per the problematic raised by Collingridge Dilemma. In such an instance therefore, the early regulation praised as the best option to promote and shape technological development will be less practical to implement.

As regards algorithmic contracts, it may be argued that we are still at the early stages of their development. They are indeed experimented with in limited ‘simple’ settings, and while their promise is indeed encouraging, many of the great applications they enable remain at concept stage at present. There is nonetheless ‘enough’ information in their regards, that could enable to propose an appropriate regulatory framework. Yet recognising that such an early regulation may be feasible, it is equally important to recognise that the concept may progress fast and in unexpected ways, in which case this early regulation could require updating.

Indeed, while the pace at which they will progress in the future is not known at present, it may be argued that algorithmic contracts are a form of disruptive innovation that would warrant *flexibility* on the part of regulators, aware of the possibility that the concept may develop fast or in unexpected ways in the future. It may indeed be said that the disruptive nature of algorithmic contracts (to take a broad definition of the term) may be reflected in the new contracting behaviours they enable and which have an impact on both parties whose contracting practices are being re-defined and on the law which may have to adapt as a result.

More interestingly following the definition of a *disruptive innovation* given by Clayton Christiansen, it follows that a *disruptive* innovation is not one that disrupts current standards or

³⁵⁸ Similar to the FCA regulatory sandbox which allows businesses to test novel innovations in a controlled environment. See Financial Conduct Authority, ‘Regulatory Sandbox’ (FCA) <<https://www.fca.org.uk/firms/innovation/regulatory-sandbox>> accessed 29 September 2021

³⁵⁹ Yeo (n 357)

traditional ways of operating following the definition we seem to assign to the word³⁶⁰. Instead, it is one that initially underperforms alternatives yet ends up performing better in a different setting than initially envisaged, opening up new markets even, and winning over users who initially disregarded the product/technology³⁶¹. Following this definition, disruption would therefore be a process, beginning at a small scale to then become mainstream in new ways, and often recognised too late, as both market leaders and customers have been identified as slow to recognise the potential of a disruptive innovation in its early days³⁶².

While a more thorough analysis on disruptive innovation falls outside of the scope of this paper, it is arguably the case that algorithmic contracts are a form of *disruptive* innovation following this definition.

Indeed, smart contracts for instance were first imagined in the 1990s, yet it is only with the advent of the blockchain technology that the concept truly took off, in different ways than initially envisaged: the combination of smart contracts and IoTs automating daily transactions could not have been foreseen by Nick Szabo in his paper due to the fact that the technologies did not exist back then. Yet today this combination is arguably the one that holds most potential for smart contracts to develop.

It may therefore be argued that as a *disruptive* form of innovation, algorithmic contracts are more challenging to regulate as they could continue to develop in similarly unexpected ways. While very predictive, this statement would be relevant for regulators who should acknowledge this possibility, and adopt a *flexible* and *adjustable* approach to regulating them.

2.5 Towards ‘Permissionless’ Innovation?

As discussed earlier, the regulatory exercise to be achieved should both mitigate risks while promoting innovation.

In achieving this arguably paradoxical objective, some have called for a ‘permissionless innovation’ approach whereby people are encouraged to experiment freely with technology and innovation without asking for prior approval³⁶³. This approach would in theory bring technology closer to ‘people with ideas’ in a process that would increase the speed of invention

³⁶⁰ See Cambridge Dictionary, ‘Definition of Disruption’

<<https://dictionary.cambridge.org/dictionary/english/disruption>> accessed 29 September 2021

³⁶¹ Clayton M Christiansen and others, ‘Disruptive Technologies: Catching the Wave’, (*Harvard Business Review*, 1995) <<https://hbr.org/1995/01/disruptive-technologies-catching-the-wave>> accessed 29 September 2021

³⁶² Susskind (n 38) 43-44

³⁶³ Adam D Thierer ‘Permissionless Innovation and Public Policy’ (2016) 3

of new solutions³⁶⁴, taking a very enthusiastic approach to innovation that raises technological progress as the one and only goal.

Yet such a permissive approach, and more broadly an under-regulation of technologies, are undesirable to the extent that disregarding the potential negative effects of innovation could allow unwanted applications of technologies to develop unregulated, creating arguably unacceptable levels of risk on society. This regulatory uncertainty could also result in deterring innovation in the first place as legal uncertainty could disincentivise people from experimenting with new tools in the first place as discussed in earlier chapters.

Conversely, too restrictive rules could also impede on the development of new technologies to the extent that they would either prevent experimentation with technologies in the first place or limit it to a too great extent that it could become ‘useless’. This scenario is equally undesirable. Moreover, while ensuring some form of clarity and compliance, strict rules would also likely have to change and be updated because of fast-paced technological advances, linking to the ‘challenge of regulatory connection’ and possibly *disruptive* nature of innovation discussed earlier that could require these ‘strict’ regulations to be updated. Arguably, this is not a sustainable approach to face the challenges raised in our digital economy.

It therefore places difficult and contradictory demands on regulators and lawmakers who should not over, nor under-regulate new technologies, and succeed in achieving a subtle equilibrium between maintaining regulatory certainty yet without being too cautious so as not to stifle innovation. Arguably this calls again for some form of *flexibility* in the regulatory approach that would be both effective and continuously relevant as technologies develop so as to avoid ‘reinventing the wheel’ anytime a new technology emerges or progresses³⁶⁵. The regulatory exercise at hand is therefore essentially a difficult balancing act.

3. Regulating Algorithmic Contracts

3.1 Available Regulatory Approaches

As it has been established that the appropriate regulatory response would have to be *proactive*, *flexible* and *able to adapt* yet *certain* enough to provide a clear enough framework, this part of the chapter will outline the various regulatory approaches that could be used, following the

³⁶⁴ Henry Chesbrough and Marshall Van Alstyne, ‘Permissionless Innovation’ (2015) 24

³⁶⁵ Buiten (n 265) 48

work of scholar Roger Brownsword on the matter, as he identifies three regulatory mindsets that could drive a regulatory exercise³⁶⁶.

The first one is a *coherentist* mindset, in which regulators aim to fit novel concepts into existing legal doctrines with arguably little regards as to whether these laws are fit for purposes. While functional similarities between algorithmic and ‘traditional’ contracts could justify the use of the notion of functional equivalence (i.e. the view that new products that are different yet functionally equivalent to previous ones and which would see the extension of existing doctrines), the operational difference of algorithmic contracts discussed earlier renders this proposition inappropriate. In the context of innovation therefore and with the objectives identified earlier of both mitigating risks appropriately and fostering innovation, this mindset appears ill-suited.

The second one is a *regulatory-instrumentalist* view, in which the objective is to actually ensure that regulations are fit for purpose as opposed to forcing new concepts into existing categories. It is therefore about undertaking a benefit/risk analysis of the technology to then propose a balanced and appropriate framework³⁶⁷. As regards algorithmic contracts which offer new capabilities and enable new kinds of behaviours as discussed throughout this paper, this approach may be more suited and could lead to the creation of new, appropriate laws, or see existing ones be extended to fit a potentially re-defined contracting landscape. As such, this approach will be followed in the next chapter as solutions are proposed to address identified challenges.

Finally, the last mindset identified by Brownsword is a *technocratic* one which also follows a regulatory-instrumentalist approach but recognises the potential of technology to be a regulatory tool in its own right. In such a scenario, ‘technocratic’ solutions are used to drive or prohibit certain behaviours: scholars have imagined cars that would not start until passengers have put their seatbelts on, in what would be a great example of a technocratic regulatory mechanism³⁶⁸. In such a scenario, the use of new technologies, rather than being deemed a challenge to regulate, could in fact facilitate that regulation.

In the context of the present discussion on algorithmic contracts, it may be said that they are already a technocratic response to existing challenges in ‘traditional’ contracting practices:

³⁶⁶ See generally Roger Brownsword, ‘Law and Technology: Two Modes of Disruption, Three Legal Mindsets, and the Big Picture of Regulatory Responsibilities’ (2018)

³⁶⁷ Brownsword, ‘Regulatory Fitness: Fintech, Funny Money, and Smart Contracts’ (n 346) 5

³⁶⁸ Brownsword, ‘Law and Technology: Two Modes of Disruption, Three Legal Mindsets, and the Big Picture of Regulatory Responsibilities’ (n 366) 21

Smart contracts have been for instance identified as technocratic solutions to the extent that they can be seen as a form of self-help that guarantees performance of the agreement as a result of the tamper-proof and immutable nature of the blockchain³⁶⁹.

It may therefore be argued that features of code and technology could be used to aid in the regulation of algorithmic contracts, in what would arguably be a timely outlook on regulation. Indeed, this approach that recognises the potential of technology to aid in regulatory efforts, was identified as a second wave of disruption within the sphere of regulation:

The first wave questioned the adequacy of existing regulations, prompting some form of regulatory update, while the second acknowledges the potential of technology to act as a regulatory tool, in what would be an important disruption to traditional legal approaches³⁷⁰. Technology is indeed increasingly used as a mechanism to enforce rules, arguably sometimes with greater effectiveness than law³⁷¹. As we seem to be entering a new phase in which we are increasingly reliant on code to enforce but also draft and elaborate rules³⁷², following the view that code is a regulatory tool in its own right³⁷³ and that some scholars argue that the governance of the behaviours of people is shifting from contract to code³⁷⁴, it may be argued that a technocratic approach to regulation would indeed be both appropriate and timely. Considering that the objective is to respond to innovation in ways that will be both reasonable and rational³⁷⁵, technocratic solutions will also be proposed in the next chapter.

3.2 Various Forces that Impact Regulation

Finally, as it has been established that the appropriate regulatory output could take shape in various ways and indeed incorporate various mechanisms to achieve its purpose, it also emerges that various forces are to be considered in this regulatory exercise, as they all shape the development of the technology, with the law being only one of those forces.

Indeed, in the regulation of the internet and in the cyberlaw sphere for instance, scholar Lawrence Lessig identified that four relevant forces (the law, the market, the social norms and

³⁶⁹ See generally Raskin (n 202)

³⁷⁰ Roger Brownsword and Alon Harel, 'Law, Liberty and Technology: Criminal Justice in the Context of Smart Machines' (2019) 109

³⁷¹ De Filippi and Hassan (n 108)

³⁷² *ibid*

³⁷³ See generally Lessig (n 247) as he discusses the promise of 'code is law'.

³⁷⁴ *ibid*. He points that on the internet, actions of users are very often determined by code, regardless of what the legal position is, as indeed the law can only have a limited role in such a setting.

³⁷⁵ Brownsword, 'Law and Technology: Two Modes of Disruption, Three Legal Mindsets, and the Big Picture of Regulatory Responsibilities' (n 366) 5

the underlying architecture of the internet network) would play a role³⁷⁶. Similarly, drawing on this theory of regulation scholars Aaron Wright and Primavera De Filippi consider that regulation of smart contracts/the blockchain more specifically takes place through a combination of law, social norms, market intervention and code³⁷⁷. To take another variation of this theory of regulation, scholar Mimi Zou in her own analysis of smart contracts considered that regulation of the concept was driven through a combination of relationships, the economic deal, the law and the code³⁷⁸. Finally, scholar Kevin Werbach referred to the ‘architecture of trust’, or the relationship between blockchain, law, regulation and governance³⁷⁹ to be drivers of a blockchain regulation more broadly.

It therefore emerges that a polycentric view of regulation accounting for the various factors that make up the architecture of algorithmic contracts is called for. While a more detailed analysis of these framework falls outside of the scope of this paper, these approaches highlight the fact that focusing on the technology or innovation solely in regulatory attempts would fail to recognise the important relationship between law, regulation, technology and society³⁸⁰.

This view justifies the cross-disciplinary discussion held in this paper as it included commercial, legal, technical and social considerations in its analysis of algorithmic contracts. The regulatory approach proposed, in whichever form it may take will therefore have to account for the socio-economic landscape within which algorithmic contracts operate, and for the demands and preferences of various stakeholders (i.e. users, customers, programmers, regulators...) that take part in the practice. As such, these considerations will be extended to the more focused regulatory discussion held in Chapter 7.

4. Conclusion

This chapter laid out the broad challenges of regulating innovation, and the various approaches that could allow to bypass these challenges, and achieve the desired objectives of mitigating novel risks, while fostering innovation. As such, the ‘right’ regulatory framework for the regulation of algorithmic contracts would be *proactive, flexible, future-forward* and able to *adapt continuously*, recognising the possibly disruptive nature of the solution they propose.

³⁷⁶ See generally Lessig (n 247)

³⁷⁷ Wright and De Filippi (n 133)

³⁷⁸ See generally Mimi Zou, ‘Code and Other Laws of the Blockchain’ (2020)

³⁷⁹ See generally Kevin Werbach, *The Blockchain and the New Architecture of Trust* (MIT Press 2018)

³⁸⁰ Bennet Moses, ‘How to Think about Law, Regulation and Technology’ (n 326) 2

Looking at the ways in which this regulatory exercise could take shape, it was established that a mix of a regulatory-instrumentalist approach, ensuring that new or existing laws are fit for purpose, with a technocratic one recognising the regulatory powers of code would be suitable. Finally, this chapter recognised that algorithmic contracts do not operate in a vacuum, in which case commercial, legal, technical and social considerations raised throughout this paper would have to be borne in mind as the regulation of algorithmic contracts is undertaken.

Whether it is realistic or practicable to achieve such a complex regulatory exercise remains to be determined. And while this paper takes the stance that this would be most appropriate in enabling algorithmic contracts to develop, it may be that in real-life, other factors facilitate or on the other hand hinder this development, furthering the view that law/regulation is only *one* of the many factors that make up the architecture of algorithmic contracts.

Nevertheless, considering that the impact of these factors is difficult to predict at present, and that such an analysis would fall outside of the scope of this paper, the next and final chapter will focus on the regulatory response, and make propositions to address some of the challenges identified earlier.

CHAPTER 7

Regulating Algorithmic Contracts

Chapter 6 laid out the broad challenges linked to regulating innovation, suggesting broad attributes that could enable the regulatory response to achieve its purpose of minimising the risks posed by algorithmic contracts, without stifling innovation.

Indeed, as per the challenge of regulatory connection that sees laws needing to be constantly ‘reconnected’ to new technologies³⁸¹, it was established that the appropriate regulatory response would have to be flexible and able to adapt ongoingly especially as algorithmic contracts were deemed a disruptive innovation.

As per the pacing problem, which highlighted the speed at which technologies develop and challenge regulations which struggle to keep up³⁸², a similarly flexible regulatory approach was called for, considering that the pace of algorithmic contract development remains undetermined.

Moreover, the Collingridge Dilemma highlighted a paradoxal problematic that sees it more difficult to regulate innovations early due to a lack of information while later regulatory input is rendered challenging as innovations have become too entrenched to influence³⁸³. In light of the information already available about algorithmic contracts, a proactive approach to regulating them from the outset was deemed realistic.

As these factors highlighted the difficult balancing exercise placed on regulators who should not under nor over-regulate innovation, this paper took the stance that a blend of a regulatory instrumentalist approach, ensuring that the law was fit for purpose, and a technocratic one recognizing computer code as a regulatory modality in its own right would be most appropriate. In achieving this objective, it was also established that regards should be had to the various factors (commercial, legal, technical and social) that make up the architecture of algorithmic contracts, as the promise of algorithmic contracts is not to be dissociated from the broader landscape within which they operate.

³⁸¹ See generally Brownsword, *Rights, Regulation and the Technological Revolution* (n 339)

³⁸² See generally Downes (n 350)

³⁸³ See generally Collingridge (n 351)

As the broad lines of the regulation of algorithmic contracts have been drawn, this final chapter will now undertake a more focused discussion as to how this response should take shape.

It will begin by summarizing key legal challenges raised throughout the paper, justifying why they would warrant regulatory input in particular.

It will then move on to proposing various solutions, drawing on approaches found in various jurisdictions and which could be insightful in resolving algorithmic contract challenges, following the regulatory-instrumentalist approach discussed earlier, and based on the idea that algorithmic contracts could represent a universal solution to contracting (code is indeed an international language). As such, it could appear appropriate to draw from international perspectives in ‘crafting’ the appropriate regulatory response.

In proceeding with this analysis, this chapter will also identify where new laws may be required and establish where a technocratic response may in fact be more suitable.

This chapter will then conclude with a broad discussion on the regulation of algorithmic contracts, establishing whether the solutions proposed mitigate reservations raised by the concept, and in turn perhaps enable it to scale to represent the ‘future of contracting’.

1. Regulating Algorithmic Contracts

1.1 Regulatory Focus

While it has been established that algorithmic contracts may be broadly *functionally equivalent* to contracts as we know them, as they essentially serve the same function of formalising exchanges between parties, from an *operational* view, their *modus operandi* may depart from what is currently known as contracting.

Indeed, while offering the promise of an ‘improved’ contracting experience from a commercial viewpoint, as discussed in relation to advantages of contract automation, streamlining of contract drafting, connectivity with data-gathering technologies... it emerges that contract law principles do not apply equally across the spectrum of new behaviours enabled by algorithmic contracts. While some of these novel behaviours fall within the reach of contract law doctrines, others depart from them to the extent that appropriate regulatory approaches need to be crafted or adapted, as will be more extensively discussed over the course of this chapter.

It is arguably in this departure from legal oversight that lies the regulatory challenge, as this gap between *novel* contracting behaviours and *existing* legal principles may result in risks and

challenges remaining unaddressed. Adopting a focused regulatory approach that targets these novel behaviours *specifically* could therefore ease the burden on regulators who would prioritise resolving the specific challenge these issues raise.

Considering that the value of the law comes from whether it is effective or not in achieving its purported objectives³⁸⁴, addressing these specific challenges could allow to (1) mitigate the risks they pose and (2) enable innovation to develop by surrounding it with a suitable framework from the outset, to follow the view held in Chapter 6 in relation to the purpose of regulating algorithmic contracts.

From a practical viewpoint, achieving these objectives could also lead to attaining a desirable level of legal certainty that could enable these forms of contracting to expand in more settings, enabling the promise of algorithmic contracts to become more ‘viable’ in practice, as the more complex, uncertain or ‘unsafe’ an algorithmic contract solution is, the less appeal it has³⁸⁵. Moreover, proposing approaches that could become standardised and harmonised internationally could reduce any form of ‘jurisdiction arbitrage’ and render digital activities more predictable overall³⁸⁶. While this paper does not endeavour to form the basis of internationally-approved regulatory input, it does recognise that its approach in addressing the novel challenges raised by algorithmic contracts is a purposeful one that could allow the concept to scale. As such, the discussion held in this final chapter is pertinent in discussing *how* to make algorithmic contracts the future of contracting.

1.2 Reconciliation with Contract Law

As the broad justifications behind a *focused* regulatory approach have been set, it is further justified by a broad view that sees algorithmic contracts capable of being considered ‘contracts’ to follow the legal definition of the term. Indeed, in the case of ‘plain’ algorithmic contracts for instance, doctrines of offer, consideration, acceptance, and intention to be bound would apply ‘as usual’ to the extent that apart from the expression of some terms in code, the contractual relationship itself, remains ‘unchanged’. In the smart contract realm, these same rules on offer and acceptance would similarly apply, especially considering that they apply in an objective manner that can be evidenced by the simple act of committing the contract to the blockchain:

³⁸⁴ Brownsword, ‘Law and Technology: Two Modes of Disruption, Three Legal Mindsets, and the Big Picture of Regulatory Responsibilities’ (n 366) 15

³⁸⁵ Durovic and Janssen (n 168) 76. In relation to smart contracts but could apply to other forms of algorithmic contracts as well.

³⁸⁶ Rodriguez de Las Heras Ballell, ‘Legal Challenges of Artificial Intelligence’ (n 317) 304

one party posting it would represent the offer while the other signing or performing it would represent acceptance³⁸⁷. The digital exchange taking place on the blockchain could be similarly capable of evidencing consideration, while it would have to be determined on a case by case basis considering that some smart contracts while being exchanges, do not always amount to exchanging consideration³⁸⁸. Overall it was deemed that using smart contracts as mere tools does not challenge contract law principles of formation including offer acceptance consideration intention to create legal relations³⁸⁹, allowing to consider them smart *legal* contracts³⁹⁰.

In the case of self-driving contracts, the prerogative would arguably be the same, as while machine intelligence offers the promise of reinventing contract drafting, the actual contractual relationship and pre-contractual considerations would remain unchanged: parties would still agree to a contractual objective, agree to contract via algorithmic means... while their performance of those terms could constitute acceptance. In fact, considering that the intention to create legal relations is objectively presumed in common law, it may be argued that, by choosing to contract using algorithmic methods, parties are expressing their intentions to be bound³⁹¹.

While arguably 'simplistic' in approach, this analysis could suggest that, in broad terms, algorithmic contracts *could* indeed be forms of contracting capable of satisfying the criteria of an enforceable contract under English law in the instances where the criteria of a contract have been met. This could in turn justify undertaking a regulatory exercise to bridge the gap between what could essentially be novel forms of contracts, with established contract law principles. This perspective would follow the stance adopted in the Legal Statement on Cryptoassets and Smart Contracts as it recognised smart contracts to be *capable* of satisfying the criteria of an enforceable contract in certain instances³⁹². A similar view could therefore be realistically extended to other forms of the concept.

In light of a possible reconciliation between algorithmic contacts and contract law, it is therefore justified to focus the regulatory discussion solely on the behaviours that depart from existing

³⁸⁷ Durovic and Janssen (n 168) 67

³⁸⁸ *ibid* 70. In some cases, consideration of such a contract will be its performance

³⁸⁹ *ibid* 79. If they are agents, this promise is more nuanced as they are also concluding the contract and not just executing it.

³⁹⁰ Drawing the difference between computer software and contracts incorporating algorithms and intended to be legally binding. See Herbert Smith Freehills, 'Inside Arbitration: Smart Legal Contracts vs Smart Contracts' (*Herbert Smith Freehills*) <<https://www.herbertsmithfreehills.com/latest-thinking/inside-arbitration-smart-legal-contracts-vs-smart-contracts-%E2%80%93-two-very-different>> accessed 30 September 2021

³⁹¹ Savelyev (n 203) 11

³⁹² See generally UKJT (n 67)

doctrines so as to bridge the gap between both. Whether it is actually possible to bridge this gap in practice remains however to be determined, as much of the focus of contract law is on the ‘human side’ of contractual dealings, while it has been established that algorithmic contracts are more focused on the exchange itself. The inherent departure from human input and oversight in the process could therefore challenge the applicability of important legal doctrines, suggesting the limits of the reach of the law in some instances. Where the law would be unable to apply, a technocratic solution may however be proposed, suggesting how a symbiotic relationship between the regulatory-instrumentalist and technocratic views may indeed be the way forward in regulating algorithmic contracts.

2. Key Legal Challenges

As the broad objectives of regulating innovation have been laid out, this part of the chapter will proceed onto summarizing key challenges that were raised throughout the paper, explain why these in particular would warrant regulatory input, and in turn propose how this input could take shape. Recognising the limitations of this dissertation, many of the solutions proposed would warrant a more detailed analysis and research. Nevertheless, for the purposes on this discussion on the future of contracting, they offer insightful perspective as to a *possible* reconciliation between algorithmic contracts and contract law, and how the ‘clash of paradigms’ discussed by Harvey (which sees post-digital paradigms challenging the applicability of pre-digital legal doctrines³⁹³), could be mitigated.

2.1 The Use of Code

The first key challenge that was identified in this paper was in relation to the use of computer code in the contracting process. While it is indeed the underlying feature of algorithmic contracts, using code has been identified to raise numerous issues ranging from a lack of understandability by the parties, to the presence of mistakes or bugs, or even to code being interpreted *by itself*, in unexpected ways.

2.1.1 Code as a Contract Language

³⁹³ See generally Harvey (n 80). Overall reliance on earlier reasoning may not be appropriate in the digital era.

This first part of this analysis on the use of code in contracting takes the stance that computer code is simply another form of language. In addition to being understandable by humans to some extent, it is more interestingly understood by computers, allowing to derive the numerous ‘algorithmic’ features discussed in this paper.

Following the argument that freedom of contract implies that parties should be able to contract in whichever language they choose, including code³⁹⁴, it follows that the use of computer code in contracting is not problematic in and of itself, and is instead simply the form through which parties have wished to express the terms of their agreement.

Scholars Harry Surden and Lauren Scholz in their respective analysis of algorithmic contracting, similarly pointed that contract law doctrines already allow for some form of flexibility in the form of expression of the agreements, to the extent that there are no restrictions as to the types of formulations that are allowed³⁹⁵. By extension therefore, there is nothing precluding the use of code as a contracting language.

As per the recognition of smart contracts as capable of being enforceable contracts (even though they incorporate a foundation of computer code), and in light of the use of code to automate many financial transactions already, it follows that the problematic lies more in the interpretation of those code-based terms than in determining whether contracts incorporating code are enforceable in the first place.

2.1.2 Understandability Issues

Indeed, as the use of code is not problematic in itself from a legal perspective, it remains that it is not a language that is universally understood. This use of code could mean that parties are not able to read coded terms, nor ascertain *themselves* that these terms accurately reflect their intentions. It does raise questions as to whether courts would enforce contracts which parties are not able to understand, although it may be argued that even natural language contracts today are so complex that they are similarly incomprehensible to the average person.

Nevertheless, while a seemingly novel issue deriving from the integration of computer code into the contracting process, this dissertation takes the stance that this problematic is fact not new, and could instead be analogous to bilingual contracts or those incorporating clauses in foreign languages, and which may similarly be unintelligible to some parties. Adopting this

³⁹⁴ Szczerbowski (n 216) 335

³⁹⁵ See Surden (n 48) 656

perspective could indeed be the most appropriate way to account for the ‘language barrier’ posed by algorithmic contracts, and retain ‘human’ understanding as a primary goal.

As such, similar solutions to those proposed to bilingual contracts could be extended to algorithmic ones, while new ‘technocratic’ propositions, using the technological foundation of algorithmic contracts could be envisaged to bridge the gap between a coded contracts and human parties’ understanding of it.

2.1.2.1 Technocratic Ways to Reconcile Code and Natural Language

As regards ‘technocratic’ solutions, it may for instance be proposed to reconcile both languages in a way that would ensure that the contract is understandable by all:

The first of solution was in fact proposed by Ian Grigg’s in 1996 in the form of the Ricardian Contract which aimed to be readable by both humans and computers³⁹⁶.

More recently, many scholars in the field of algorithmic contracting have similarly proposed to link coded clauses with their natural language equivalent to remove ambiguity and render court enforcement easier, to take the example of Arianne Garside and Natasha Blycha’s Smart Legal Contract model³⁹⁷. In such a scenario, parties could agree that natural language clauses (arguably easier to comprehend) could take primacy should contractual interpretation become challenging so as to reduce ambiguity furthermore³⁹⁸.

Similarly, scholar Philip Paech envisaged to combine ‘smart’ and ‘dumb’ contracts, leaving some immutable terms on the blockchain while some off it³⁹⁹. While more concerned about the immutability of terms deriving from the blockchain, a similar demarcation between coded and natural language terms determining which benefit from algorithmic features and which do not, and a link between both could be envisaged across the algorithmic contract paradigm so as to remove issues of ambiguity.

More generally, smart (and algorithmic contracts more broadly) can be imagined to operate on a spectrum ranging from fully based on natural language to fully operating thanks to code⁴⁰⁰.

³⁹⁶ See generally Ian Grigg, ‘The Ricardian Contract’ (2004) for a full explanation of the concept.

³⁹⁷ See generally Ariane Garside and Natasha Blycha, ‘Smart Legal Contract’ (2020). The contract would be legal because it is intended to be legally enforceable.

³⁹⁸ *ibid* 15

³⁹⁹ Philip Paech, ‘The Governance of Financial Networks’ (2017) 1097

⁴⁰⁰ Durovic and Janssen (n 168) 77

In addition to combining natural language and coded terms, parties therefore retain some form of discretion as to the extent to which they wish to be rely on computer code, possibly limiting the issues of understandability to a scope they feel comfortable with.

Legal input as opposed to a more technology-driven approach reconciling code and natural language is therefore not warranted at this stage which can see the emergence of ‘bimodal’ contracts (i.e. contracts mixing code and natural language)⁴⁰¹ to address any understandability issues, and offer parties the guarantee that in the case of interpretation challenges, a natural language version of the agreement would prevail.

In the instance where the use of a bimodal contract is not desired, the use of some form of certification by a skilled programmer (in the form of sworn affidavits such as those required in various US jurisdictions in relation to bilingual contracts⁴⁰²) could similarly allow parties to ascertain that the code-based translated terms match the intentions they initially set.

2.1.2.2 Resolving ‘Understandability’ Disputes

Should disputes arise between what has been coded and what the parties initially intended however, it would appear that legal update is warranted as regards court interpretation considering that it is usually based on objectively assessing parties’ intentions based on what a reasonable person with the background knowledge would have understood the *language of the contract to mean*⁴⁰³. It could however be assumed that a reasonable person (and even the parties themselves and the courts) may not understand what the language of the contract means in code due to the specific programming skills required to comprehend it.

Additionally, if pre-contractual considerations (including the setting of intentions) are to be excluded following Lord Hoffman’s approach, it may be even more difficult to reconcile said parties’ initial intentions with what has been translated into code when attempting to interpret the meaning of the agreement. Considering that the agreement itself can depart from what has been encoded in it, it may require courts to reconsider this approach and instead consider pre-contractual setting of intentions of the parties as a key component of algorithmic contract

⁴⁰¹ See generally Garside and Blycha (n 397)

⁴⁰² See American Bar Association statement on bilingual contracts: ABA, ‘Drafting Multiple-Language Contracts’ (ABA)

<https://www.americanbar.org/groups/gpsolo/publications/gp_solo/2011/april_may/drafting_multiple-languagecontractswhenyounonlyspeakenglish/> accessed 20 September 2021

⁴⁰³ *Chartbrook Ltd v Persimmon Homes Ltd* [2009] UKHL 38, [14]. (Lord Hoffman)

interpretation. In the case where parties diverge in explaining their initial intentions however, contractual interpretation would remain more challenging to undertake.

Parties retaining some proof of their initial intentions would therefore be purposeful, linking to the need for a ‘bimodal’ approach to algorithmic contracting, able to bridge the gap in understanding posed by the use of computer code. In evidencing said intentions, parties may therefore have to offer a natural language version of their agreement so as to resolve any disputes, evidencing again the bimodal nature of the solution that would have to be proposed. While indeed possible to foresee such a proposition, it does go against the promise of algorithmic contracts which are initially meant to delegate many aspects of the contracts to machines. As such human oversight in the contractual relationship remains needed.

2.1.3 Code Containing Mistakes

As issues of contract interpretation can be addressed primarily via a technocratic response, it could nevertheless be argued that legal doctrines could be extended to resolve disputes should the code contains mistakes or not reflect what the parties initially intended.

Indeed, to account for the possibility of errors or negligence, programmers could for instance be held to certain standards of duty of care in relation to quality and safety standards or in relation to the integrity of the code, ensuring that liability for code containing errors would fall on them. This tort of negligence could therefore apply ‘as usual’.

Should mis-programming be intentional, the applicability of existing doctrines of misrepresentation or fraud could similarly apply⁴⁰⁴. Some level of protection is therefore arguably already afforded to parties to an algorithmic contract, against suggesting the extent to which contract law is adept at responding to novel challenges.

From a ‘language’ perspective, bearing in mind that code is not understandable by all, insights from previous instances of language barriers in contracting and the applicability of what are otherwise very narrow and specific legal doctrines (drawing from various jurisdictions) could interestingly gain in relevance in specific algorithmic contract settings, and offer relief to parties in the instances where the contract did not reflect what they initially intended, and/or where one of the parties attempted to take advantage of the other’s lack of code understanding.

⁴⁰⁴ Cristina Poncibo and Larry A DiMatteo, ‘Smart Contracts’ in Larry A DiMatteo and others (eds), *The Cambridge Handbook of Smart Contracts, Blockchain Technology and Digital Platforms* (Cambridge University Press 2019) 122

The doctrine of unconscionability could for instance apply if one party takes advantage of the others' *known* lack of programming skills and understanding to hide and impose unfair terms in the contract. In the US case of *Frostifresh v Reynoso* for instance, a contract negotiated orally in Spanish but containing unfair terms in English and incomprehensible by the parties, was deemed to be unconscionable by the courts⁴⁰⁵. Conversely, in the UK this particular issue was also subject to legal enquiry in the case of *Portman Building Society v. Dusangh and others* where an Indian national was deemed to have sufficient understanding of the contract by the Court of Appeal due to sufficient verbal expressions, despite a poor understanding of the English language in which the contract was drafted⁴⁰⁶. As it appears, the US-style interpretation on the matter was broader and would arguably be better apt at providing relief in an algorithmic contract setting so as to reduce the possibility of parties taking advantage of others' lack of computer savviness.

While the applicability of this doctrine could be done on a case-by-case basis, this paper takes the stance that a wider US-like adoption of the doctrine could offer protection to parties, assuming that algorithmic contracts would progress to become a common alternative to 'traditional forms of contracts' in the future, used by individual parties.

More realistically in remediating mistakes in code, it appears again that technology-based responses offer suitable solutions to account and more importantly mitigate the possibility of errors in code, evidencing how in the regulation of algorithmic contracts, the law could retain its *ex post* function while technocratic responses could prevent issues from arising in the first place, *ex ante*.

Indeed, in preventing the instance of errors in code altogether, parties could test it extensively before deploying it, or subject it to some form of cross-validation or quality verification/certification. This is already the case in the finance sector which requires that any algorithms used to be thoroughly tested, demonstrate 'best execution' practices and showcase that they are not engaged in market manipulation⁴⁰⁷. Providers are also required to store sequenced records and trading algorithms for at least 5 years⁴⁰⁸.

⁴⁰⁵ See *Frostifresh Corp. v. Reynoso* 274 N.Y.S.2d757

⁴⁰⁶ *Portman Building Society v. Dusangh and others* [2000] EWCA Civ 142

⁴⁰⁷ See MIFID II Market Abuse Manipulation (MAR), 'Market Conduct' (FCA)

<<https://www.handbook.fca.org.uk/handbook/MAR.pdf>> accessed 30 September 2021

⁴⁰⁸ See ESMA, 'Guidelines: Systems and Controls in an Automated Trading Environment' (ESMA) <

https://www.esma.europa.eu/sites/default/files/library/2015/11/esma_2012_122_en.pdf

> accessed 30 September 2021

More broadly, programmers could be subject to guidelines or training⁴⁰⁹ so as to ensure they would be skilled enough in drafting algorithmic contracts.

From a more technocratic view, it may also be envisaged to program algorithmic contracts in a way that they would not operate until ‘approved’ by a designated person altogether. This solution would be particularly useful in the case of smart contracts due to their immutable nature, and would offer the guarantee that the underlying code does not contain mistakes before being used.

In order to respond to cases when an error was already made, parties could respond by creating a new transaction altogether reversing the initial one, or program termination, rescission modification or reformation clauses into the code⁴¹⁰.

In the case of smart contract which rely on the authenticity of the data fed to them by the oracle, solutions to create a third-party-authenticated data feed such as Zhang’s Town Crier⁴¹¹ were also identified to prevent faulty smart contracts from operating.

Overall therefore many solutions can be envisaged to mitigate code-driven challenges, raising the promise of a future of algorithmic contracting, from this perspective, as realistic.

2.2 The role of the Algorithm

As the understandability issues of code have been addressed and it has been established that liability for negligence or voluntary mistakes in code could be attributed to the *programmer* while many ‘technocratic’ solutions could limit the likelihood of issues arising in the first place, it remains to be discussed how liability resulting from the *code* ‘misbehaving’ would be addressed.

Indeed, the unique discretion and responsibility granted to the algorithm in the algorithmic contracting realm only increases the more ‘advanced’ the contracting method is (the algorithm indeed gains in responsibility as it operates in a self-enforcing manner in the case of smart contracts or if it determines contract terms in the case of self-driving ones). It is therefore relevant from a legal perspective to discuss the allocation of liability in the case where ‘things go wrong’ as a result of the ‘algorithmic discretion’ it may exercise in performing its ‘duties’⁴¹².

⁴⁰⁹ Poncibo and DiMatteo (n 404) 129

⁴¹⁰ *ibid* 130

⁴¹¹ See generally Fan Zhang and others, ‘Town Crier: An Authenticated Data Feed for Smart Contracts’ (2016)

⁴¹² Linking to the discussion held in relation to Franken-Algorithms in Chapter 3.

As it was discussed that algorithms are not mere tools, but could instead be akin of agents of the parties in Chapter 2, this dissertation follows the view that agency law would indeed be the most appropriate way to account for this responsibility.

2.2.1 Agency Law as a Solution

Indeed, in accounting for the role of the algorithm in the relationship, scholars have identified that principles of agency law could apply⁴¹³. In such a case therefore, the algorithm would be acting as a constructive agent of the parties, facilitating the operation of the contract between them, much like a human agent would.

Following the view that algorithmic contracts are not mere tools, but rather agents of the parties⁴¹⁴ in so much that they have been delegated responsibility to fulfil their contractual intentions, the use of agency law principles appears therefore justified⁴¹⁵ and could provide much needed clarity and framework as regards the allocation of liability in the case things go wrong.

While this dissertation takes the stance that such use of agency law is not necessary in the ‘plain’ algorithmic contract realm considering that the algorithm has limited *agency* at that level which mainly uses code as a contracting language, accounting for that agency in the smart and self-driving contract world where the algorithm takes on a role of initiating and performing a transaction or drafting it, appears more purposeful. More importantly, it would allow to allocate liability accordingly in the case where things go wrong, or should the algorithm bring its own meaning to the exchange and depart from what the parties initially intended as per the ‘Franken-Algorithm’ discussion held earlier. Indeed, in the case of a ‘breach of trust’ or ‘breach of fiduciary duties’⁴¹⁶ by the algorithm, the principal will bear the liability. In contracting via algorithmic means therefore, it would be up to the principal in the relationship to decide whether to accept the risk of being held liable for algorithms’ possible lateral thinking considering that this discretion of the algorithm cannot be excluded *ex ante*.

Interestingly in the smart contract realm, in which parties are often anonymous/pseudonymous to each other, deriving from the peculiarities of the blockchain platform on which they operate, the situation would arguably be more akin to a *partially disclosed agency* to the extent that the

⁴¹³ See generally Scholz, ‘Algorithmic Contracts’ (n 71)

⁴¹⁴ *ibid*

⁴¹⁵ *ibid*

⁴¹⁶ Taking the stance that these doctrines could apply in the first place.

third party to the agreement knows that the transaction will be facilitated via an agent (i.e. the smart contract) yet does not necessarily know the identity of the principal.

Providing a framework for allocating liability for algorithmic behaviour nevertheless appears purposeful in extending the reach of the law to novel features of algorithmic contracts, promoting some form of legal certainty as a result.

From a more legislative perspective, this use of algorithms as agents would also seem to align with various international frameworks: The Uniform Electronic Transactions Act (UETA) and the Uniform Computer Information Transactions Act (UCITA), both US frameworks, already recognise the validity and enforceability of electronic agents⁴¹⁷. (The UETA which recognises the agency of electronic contracts (including possibly therefore plain algorithmic contracts) would however not extend to smart contracts for now: it only does so when said agents act *automatically* but not *autonomously*, drawing the line therefore at fully autonomous algorithmic contracting⁴¹⁸).

Similarly, Article 12 of the UN Convention on the Use of Electronic Communications in International Contracts, operating at an international level, also considers that automated contracts should not be considered as unenforceable or invalid simply on the basis of a lack of human intervention in the process⁴¹⁹. Suggesting that a legislative recognition of electronic agents and by extension algorithms acting as agents to the parties is already present in other jurisdictions, it would seem possible to extend the current reach of agency law in the UK to account specifically for the use of algorithmic agents in contracting.

By doing so, English Law could arguably set a global algorithmic-contract targeted precedent, showcasing its flexibility and capability to regulate new technologies. Setting such a precedent could in turn could pave the way for a globalised and harmonised recognition of algorithms as agents of their parties. Considering that the position on smart contracts is still nuanced at an international level, with some jurisdictions not recognizing them as enforceable altogether, while other such as the US adopting a ‘fragmented’ approach to the extent that they are recognized (or not) at state level⁴²⁰, proposing a clear framework could indeed allow to move towards a global recognition of algorithmic contracts. For the purposes of this discussion on the future of contracting, such an approach would therefore be purposeful in allowing algorithmic contracts to scale internationally.

⁴¹⁷ See generally Uniform Electronic Transactions Act (UETA) <<http://euro.ecom.cmu.edu/program/law/08-732/Transactions/ueta.pdf>> accessed 30 September 2021

⁴¹⁸ *ibid*

⁴¹⁹ Article 12 UN Convention on the Use of Electronic Communications in International Contracts

⁴²⁰ See how they are recognized in States such as Arizona or Tennessee but not in others.

In the case of self-driving contracts more specifically, it could also be said that they could have a fiduciary duty to the parties, essentially acting in their best interests and ensuring best outcomes overall. Self-driving contracts would essentially act as ‘utility maximisers’, ensuring that the best, most appropriate, and arguably most likely to yield financial benefit, courses of actions are being followed. In such a case, relevant legal recourses could be applicable to an extent.

2.2.2 Separate Legal Personality

In accounting for this ‘responsibility’ of the algorithm, other propositions have been made in the relevant literature on the subject, such as the use of some form of separate legal personality. Akin to the separate legal personality granted to limited companies, this proposition would see parties able to ‘hide’ behind the separate legal personality of algorithms and avoid personal liability, should things essentially go wrong. Contracting with the safety that they will not be personally held liable in the case the situation goes awry, yet accounting for the risks of algorithmic contracting discussed earlier⁴²¹, this solution could offer some ‘safety’ to the parties and could encourage them to experiment with the technology.

This view would be in line with that adopted by famous legal scholar Gunther Teubner, as he identified that personifying non-humans is ‘social reality today and necessity for the future’⁴²², in which case the ongoing challenge with emerging technologies will lie in aligning the law with the agency and discretion that will arguably be increasingly delegated to technologies in the future, accounting for the increased levels of responsibility they already enjoy as per the examples of the uses of AI in medicine or finance for instance. As a result of this thinking, granting algorithms some form of ‘personality’ would only be a timely development in the law. Yet from a practical perspective, it remains to be determined to what extent this solution would be *desirable*⁴²³: parties could ‘hide’ behind the legal personality of the algorithm to avoid personal liability, but this could only further fuel uncertainty in the process, much like parties hiding pseudonymously behind the blockchain smart contract. It is therefore not a solution that would promote more complex algorithmic contracts for arguably ‘legitimate’ transactions.

⁴²¹ In relation to franken-algorithms and the risks of them performing something fraudulent, illegal or unethical due to a lack of ability to distinguish those from more legitimate undertakings.

⁴²² Gunther Teubner, ‘Rights of non-humans?’ (2006) 497

⁴²³ Simon Chesterman, ‘Artificial Intelligence and the Limits of Legal Personality’ (2020) 825-826

Second, it remains more importantly to be determined to what extent this solution could be *actionable* in practice: unlike a company or corporation which can be fined or have its property seized, or for whom forms of criminal punishment would apply to deter future ‘bad’ behaviour, there is little possibility or scope to punish an algorithm. The algorithm has nothing to ‘lose’, limiting therefore the *usefulness* of a separate personality. If the operation of the contracts goes awry, it is likely that parties will want *actionable* and *practical* recourses instead, in which case this solution appears ill-suited.

In the case of self-driving contracts, and in light of the development of AI and its applicability in society, a similar solution may also seem purposeful. But for similar reasons that punitive measure cannot purposely be applied to the AI, and that it could only result in parties using it to achieve undesirable means while ‘hiding’ behind its separate legal personality, this solution is similarly inherently limited from a practical perspective.

The need for legal protection of the parties remains nevertheless important, especially considering that the more intelligent or capable an entity is, the less predictable or controllable it will be⁴²⁴. As such, the use of agency laws or other doctrines that would allocate liability to human parties, the use of restitution-based remedies or ones that would reverse transactions would appear more purposeful in ensuring *practicable legal certainty*. They also do not prevent parties from allocating liability issues themselves and undertaking specific pre-contractual considerations in relation to that.

2.3 Ex ante, ex durante, ex post?

As extensively discussed throughout this paper, this shift towards algorithmic contracts also appears to entail a shift in contracting paradigm altogether: while ‘plain’ algorithmic contracts retain the *ex post* remedial function of contract law as possible, in the case of smart contracts this paradigm shifts to an *ex ante* one where every aspect of the contractual agreement has to be dealt with *before* the agreement unfolds, and as it is transcribed into code.

More interestingly, self-driving contracts which draft terms in real-time as the situation evolves shift it towards a unique *ex durante* one. This shift in contracting paradigm is not without raising legal challenges.

2.3.1 Ex ante Smart Contracts

⁴²⁴ See generally Roman Yampolskiy, ‘On Controllability of AI’ (2020)

Indeed, in relation to the *ex ante* shift implied by smart contract, it not only places the burden on the parties to get everything right before the operation of the agreement, but also challenges the key remedial function of contract law⁴²⁵. Indeed, some scholars argue that contract law cannot accommodate their self-enforcing nature to the extent that deeming terms unenforceable *ex post* may have no practical effect on what has already been performed⁴²⁶. Doctrines of variation or frustration would not be actionable in the immutable smart contract realm⁴²⁷ while key remedies such as termination or rescission or doctrines such as efficient breach are unavailable for the same reasons⁴²⁸. The legal focus will therefore have to be shifted towards a restitution-based approach⁴²⁹ with doctrines such as unjust enrichment gaining in importance in such a context, while the possibility to *reverse* the contract would similarly gain in relevance, in light of the *fait accompli*⁴³⁰ lens created by smart contract.

Parties may also have to rely more on *ex ante* mechanisms which may require to shift the regulatory approach, including the applicability of remedies and other forms of legal recourse to be taken in the case of smart contracts to a similar *ex ante* lens:

Indeed, some scholars have for instance called for the inclusion of dispute resolution mechanisms in the code itself with an ambition anticipate disputes which would be remediated in an automated manner⁴³¹. In light of the impossibility of the law to remediate these issues *ex post* as it usually would, incorporating dispute resolution clauses into the code would be a suitable technocratic response to an identified smart contract shortcoming. Similarly, it has been envisaged to code doctrines such as rescission into the smart contract code so as to allow the parties to reverse or amend their agreement as they wish⁴³². This is of course only possible to the extent that parties have not suffered a loss that is irremediable in which case the use such mechanisms will be of little recourse. It also remains to be determined how possible this would be from a technological point of view.

⁴²⁵ Werbach and Cornell (n 220) 318

⁴²⁶ *ibid* 373

⁴²⁷ Durovic and Janssen (n 168) 73

⁴²⁸ For the same reason that the immutability of smart contracts would not allow to terminate the agreement early.

⁴²⁹ Larry A DiMatteo and others, 'Smart Contracts and Contract Law' in Larry A DiMatteo and others (eds), *The Cambridge Handbook of Smart Contracts, Blockchain Technology and Digital Platforms* (Cambridge University Press 2019) 10. The courts would have to focus on disgorgement or restitutionary damages in response to the automated performance of the contract.

⁴³⁰ *Fait accompli* would evidence that the smart contract is irreversible. See definition at Merriam-Webster Dictionary <<https://www.merriam-webster.com/dictionary/fait%20accompli>> accessed 30 September 2021

⁴³¹ See generally Koulu (n 201)

⁴³² Bill Marino and Ari Juels, *Setting Standards for Altering and Undoing Smart Contracts, Rule Technologies: Research, Tools, and Applications* (Springer 2016) 152

In the smart contract realm still, notions of illegality and fraud, which would arguably fall within the applicability of the law are also rendered more difficult to remediate *ex post* to the extent that parties cannot go back on their agreement: if it performs something illegal, they will not be able to stop it. While the law will not allow these kinds of behaviours just because they operate in a different contracting paradigm enabled by smart contracts, it remains to be seen how it will intervene in such a case from a practical view point: it may not be able to reverse something that has already been performed. A technocratic response in the form of hybrid structures that allow the enforcement by traditional legal methods⁴³³ could appear useful:

Indeed, calling for some form of *ex ante* proactive regulatory input, provisions could for instance be made to prohibit the integration of certain terms or clauses into smart contract code altogether. Scholars have indeed called for the incorporation of court decisions into the smart contract so as prevent the execution of illegal smart contracts (although it remains to be determined how that would work in practice). It would also require parties to agree to it and would need to be included from the outset⁴³⁴.

Similarly, machine intelligence could be used to scan code and detect unlawful material, much like AI algorithms already scan social media to report or remove prohibited content. In such a scenario, the use of technocratic mechanisms therefore appears purposeful in addressing the limitations of a law-based only regulatory response, while arguably being within the capabilities of existing technologies.

2.3.2 *Ex Durante* Self-Driving Contracts

As the regulatory challenges raised by *ex ante* nature of smart contracts have been discussed, it emerges that the novel *ex durante* paradigm that could result out of the creation of self-driving contracts would raise issues of its own.

Indeed, it may raise issues regarding doctrines of meeting of the mind, mutual assent or definitiveness: The parties essentially agree to a broad objective of the contract *ex ante*, but not to the exact terms that may lead to achieving it, as they were not yet laid out at the time of agreement. While it may be argued that the criteria for meeting of the mind or mutual assent could be satisfied to the extent that parties indeed have to agree to an objective and feed it into the algorithm for it to propose terms, the notion of definitiveness would however be challenged

⁴³³ Christopher Clack and others, 'Smart Contract Templates: Essential Requirements and Design Options' (2016) 3

⁴³⁴ Durovic and Janssen (n 168) 74

due to a lack of actually agreed contract terms. A more extensive legal discussion would therefore be warranted in determining whether such established legal principles would be reconcilable with the novel paradigm entailed by self-driving contracts or not.

Similarly, this unique operating mode could also end up blurring the important line between complete and incomplete contracts.

Indeed, as extensively discussed throughout this paper, self-driving contracts would be incomplete at the time of signing, only based on a broad contractual objective whose specific terms will only be determined by the algorithm, afterwards having regards to the evolving environment and the parties' intentions. It remains therefore to be determined how the law would respond in such a scenario where the contract is 'empty' at the time of signing, especially should the AI technology draft the entirety of the agreement rather than just a few clauses.

While scholars in the field, looking at the innovativeness behind the concept have considered this inherent 'incompleteness' of self-driving contracts to allow for the most complete contracts by economic standards, enabling the consideration of *every* possible contingency and state of events, from a legal perspective, the law has usually shown that it will not enforce incomplete contracts, especially if *essential terms* are missing.

This would arguably be the case in the self-driving contract realm as these essential terms would be the ones delegated to the AI to draft so as to achieve the outcome sought by the parties.

As per *Foley v Classique Coaches Ltd*, for instance, 'unless all the material terms of a contract are agreed, there is no binding obligation'⁴³⁵. While it could be argued that the parties indeed agree on the contractual objective, it may be that at the time of signing they would not have agreed to the actual *material terms* to achieve it. In such a case therefore, and following that logic, self-driving contracts would not be binding contractual agreements.

This feature of self-driving contracts may therefore be one that could require the law to review its position the most, in a process that would seriously hinder the viability of the concept for mainstream application. It would also warrant a more thorough legal analysis than is possible in this dissertation.

As regards the 'future of contracting' discussion held in this dissertation therefore, the difficulty of reconciling the concept behind self-driving contract with arguably key legal principles could seriously restrict its future promise.

2.4 Other Legal Considerations

⁴³⁵ *Foley v Classique Coaches Ltd* [1934] 2 KB 1 (Maugham LJ)

As what are deemed to be the most important challenges raised by algorithmic contracts have been discussed, this part of the chapter will look at other issues that arise out of the practice:

2.4.1 Pseudonymity

While discussed as a feature that enables a ‘shift from trusting people to trusting math’⁴³⁶, it emerges that the anonymity/pseudonymity feature of smart contracts raises some issues as regards enforcement and capacity.

Indeed, it is possible for one party to deceive the other by pretending to be someone else, or one party could be inadvertently contracting with a minor or with someone who could otherwise not have the capacity to enter into contracts⁴³⁷. A legal response accounting for these possibilities seems therefore warranted.

Similarly, this same feature may also make it difficult to sue because parties won’t necessarily know who the other party is⁴³⁸. A way for the parties to eventually know one another in the case where ‘things go wrong’ is therefore warranted.

Answers to these questions may be found in jurisdictions such as that of Spain or the US where parties may act on a pseudonymous basis provided that there is a link off the blockchain to evidence their identity (or be identifiable by an agent or a proxy)⁴³⁹. Arguably a similar response in UK law could offer that level of certainty as well.

2.4.2 Technological Considerations

As regards cybersecurity issues arising out of the ‘connected’ nature of algorithmic contracts (to the extent that they require computer data to operate), parties would also have to determine whether any failure of code, hack... would give rise to breach of contract.

Similarly, considerations of cybersecurity and data privacy would also apply to any data linked to the algorithm. Clarification as to the applicability of international legal doctrines on the use of algorithmic contracts and the data they contain (such as the GDPR in Europe, the CCPR in the US...) would seem warranted.

⁴³⁶ Antonopoulos (n 176)

⁴³⁷ Giancaspro (n 231) 6-7

⁴³⁸ Durovic and Janssen (n 168) 72

⁴³⁹ Chamber of Digital Commerce, ‘Smart Contracts: Is the Law Ready?’ (2018) 19

Similarly, consideration of database rights, cryptography to preserve data confidentiality..., evidence the additional layer of pre-contractual considerations that parties must bear in mind when contracting via algorithmic means. They do not however challenge existing legal principles to the extent that frameworks dealing with these data-related matters are already in place.

Finally, and as already discussed to a great extent, questions also arise regarding who should be tasked with the drafting: with plain algorithmic, computable or smart contracts, the drafting is delegated to a 3rd party programmer (already raising issues in some jurisdictions where laymen cannot perform legal tasks), but with self-driving contracts this drafting is delegated to an AI algorithm. It therefore raises again the question as to whether it is appropriate to delegate such a key legal task to a machine, and whether the law, whether English Law or that of other jurisdictions would recognise non-lawyers/machines to be able to draft enforceable contracts. As such, this would be an area where legal clarification would be warranted, otherwise placing breaks on the development of algorithmic contracts as the future of contracting altogether.

3. The Promise of Regulating Algorithmic Contracts.

As discussed earlier, the purpose of regulation in relation to algorithmic contracts is twofold: it is about (1) mitigating any risks they pose, as discussed throughout this chapter which outlined solutions to mitigate said risks. It is also (2) about promoting innovation. For the purposes of this dissertation which seeks to position algorithmic contracts as the future of contracting, achieving these objectives proactively is possible considering that we are still in the early stages of algorithmic contract development which remains primarily applicable within the confines of simple and deterministic financial transactions for now. Addressing these risks proactively could therefore result in creating environment in which parties are encouraged to safely experiment with innovation, enabling it to develop.

From an economic viewpoint, there is already a clear objective to set English law as a leading legal system that attracts and boosts investment in innovation⁴⁴⁰. The UK government for instance sees AI as a key driver for competitiveness and productivity of the UK economy⁴⁴¹,

⁴⁴⁰ As evidenced by various laws/regulations/regulatory sandboxes that aim to encourage innovation yet in a safe environment.

⁴⁴¹ Department for Business, Energy and Industrial Strategy, 'Professional & Business Services Sector', 11 <https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/866329/professional-business-services-sector-growth-outside-london.pdf> accessed 1 October 2021

and aims to put the UK at the forefront of the data revolution⁴⁴². This was also the impetus behind the UK LawTech Delivery Panel's Statement on Cryptoassets and Smart Contracts, a first across numerous jurisdictions which recognised smart contracts as capable as being enforceable contracts⁴⁴³, and which aimed to position the technology as one that could drive economic competitiveness in the UK. The objective through this statement was to promote English Law as a suitable legal framework that is able to deal with smart-contract and cryptocurrency-related issues⁴⁴⁴, linking therefore to the economic benefits of being the first to regulate promising innovation such as smart contracts, and harnessing resulting economic benefits thereof. While this legal statement did not aim to be the basis of actual legal reform in so much as it voiced the importance of regulating them appropriately and proactively to reap economic benefits and provide more certainty for legal, commercial and technological stakeholders involved, it represents nonetheless an important first step in the development of smart (and algorithmic) contract technologies in the UK.

As pointed out by the UKJT, English Common law is one of the systems most able to deal with the development of new technologies, being inherently flexible in its approach⁴⁴⁵, it may therefore follow that a regulation of more advanced versions of algorithmic contracts may fall within its capabilities. Adopting a similar view, the Law Commission also recognised the imperative of reviewing the existing English Law framework on smart contracts if it aims to remain a competitive option from a business perspective⁴⁴⁶. In light of an identified competition between countries to become AI leader⁴⁴⁷, the proactive regulatory objective behind algorithmic contracts to promote innovation within the UK is made even clearer.

As it appears therefore, the UK has already evidenced its willingness to proactively regulate innovation so as to be the first to benefit from it. The legal analysis undertaken in this chapter, while limited in scope and warranting a specific and more thorough exploration, could therefore form part of a wider trend that sees regulation as a key component of innovation, and could be purposeful in paving the way for a facilitated development of algorithmic contracting technologies.

⁴⁴² HM Government, 'Industrial Strategy: Building a Britain fit for the future' (n 262) 10

⁴⁴³ See generally UKJT (n 67)

⁴⁴⁴ *ibid*

⁴⁴⁵ *ibid*

⁴⁴⁶ Law Commission, '13th Programme of Law Reform' (2017) <<https://www.lawcom.gov.uk/project/13th-programme-of-law-reform/>> accessed 30 September 2021

⁴⁴⁷ Charlotte Walker-Osborne, 'Artificial Intelligence, Automation and the Law' (2018)

The promise of algorithmic contracts as the future of contracting would therefore depend on the regulatory input that effectively addresses the challenges they may raise, hereby creating a suitable environment for them to develop.

4. Conclusion

As this chapter summarized and discussed the key legal challenges that arise out of practice of algorithmic contracting, it emerges that the mix of regulatory-instrumentalist and technocratic approaches discussed in Chapter 6 is to a great extent capable of addressing issues to the extent that both would act in a complementary manner: legal rules could provide *ex post* recourse while technology-driven solutions would aim to avoid issues *ex ante*. As we may be moving towards new forms of contracting it indeed appears fitting to move towards new forms of regulating innovation too, maintaining to some extent the promise of ‘code as law’⁴⁴⁸ in regulating algorithmic contracts.

In discussing the regulation of algorithmic contracts, it also emerged that there is a clear governmental and legislative impetus to enable technologies to take off, and position English Law as leader in regulating novel concepts. As such, the possibility to address challenges of algorithmic contracts in the future through some form of regulatory input is not to be ruled out. In light of the interesting promises and advantages they offer discussed throughout this dissertation, this regulatory input could very well be foreseeable.

⁴⁴⁸ See generally Lessig (n 247). This promise of ‘Code as Law’ sees the use of code as a form of regulation in itself as private parties would embed their values directly onto the algorithm. For the purposes of this paper, it recognises indeed the possibility for code to be a regulatory modality in its own right.

CONCLUSION

Algorithmic contracts have generated strong scholarly and professional interest, stemming from the novel contracting experience they propose. The possibility to automate transactions, rendering them self-executing and self-enforcing, benefit from the security and immutability of the blockchain or even incorporate machine intelligence to automate contract drafting are indeed attributes that would align contracting practices with the demands and capabilities of our digital economy.

As extensively discussed throughout Part I of this paper, we indeed find ourselves in an increasingly technology-driven economic landscape to the extent that technologies now play a central role in various industries, including the legal sector, and are trusted with sometimes high-stake work. As such, the promise of algorithmic contracts was identified as a fitting one. In light of the various commercial contract shortcomings discussed in Chapter 2, this promise was rendered even more relevant.

As such, Part II moved on to outline various forms through which algorithmic contracts could take shape, beginning on the ‘simpler’ end of the concept in the form of algorithmic contracts incorporating a foundation of computer code to automate the exchange. It then discussed the more elaborate concept of smart contracts, operating on the blockchain, and benefitting from more advanced features of immutability and security, but also from the possibility of creating both self-enforcing and self-executing contracts able to connect with data-gathering devices and operate in real-time. Finally, this second part of the dissertation explored the novel yet speculative concept of self-driving contracts, able to use a foundation of AI to draft terms that would reflect accurately and precisely the parties’ intentions, justifying a unique role of ‘contract-optimisers’.

Acknowledging the potential offered by these concepts, the analysis undertaken in relation to these novel forms of contracting also outlined the various risks they pose, and the ways in which they challenge what is currently known as contracting from both a ‘social’ perspective, but also and more importantly from a legal one. It also evidenced the technical challenges that may place breaks on the development of the technology.

Nevertheless, and based on the possibility that the advantages offered by algorithmic contracts may outweigh the challenges they raise at present, especially in the case of ‘simple’ transactions, this paper moved on to discuss how the challenges they raise could be addressed through regulatory input.

Recognising the difficulty of regulating innovation, it went on to discuss how the appropriate regulatory input could take shape, drawing from various challenges raised in the relevant strand of literature linking technology and law. As such it emerged that the right approach would be proactive, flexible and able to adapt to change, recognising the disruptive nature of algorithmic contracts. From a practical perspective, this paper suggested that the right approach would take the form of one mixing legal input through the creation of new laws and the adaptation of existing ones, with ‘technocratic’ solutions, recognising the nature of code as a regulatory modality in its own right.

In light of these insights, the final chapter of this paper went on to propose ways in which key challenges identified throughout could be resolved. While it emerged that some of the challenges raised by algorithmic contracts could indeed be resolved by extending existing doctrines or principles, applying foreign ones or through the use of technology-driven solutions, others were identified as needing to be resolved by novel means. Overall, it was deemed that the *ex post* remedial function of the law combined with the possibility to avoid issues *ex ante* through technocratic means rendered addressing challenges to a great extent possible. It is more importantly desirable, should the UK aim to harness any potential economic benefits that may derive out of the practice.

How this regulation will actually take shape in real-life remains however to be seen as this discussion was very much speculative in scope. Nevertheless, this possibility to account for the novel challenges raised by algorithmic contracts reinforces the view that they *may* have a place within the future of contracting.

As a possible regulation of algorithmic contracts is foreseeable, suggesting their possible place within the future of contracting, it is worth acknowledging that real-life will development of the practice will also depend on the various commercial, technical and social factors that make up the architecture of algorithmic contracts, and therefore on the extent to which they are deemed ‘commercially’ and ‘technically’ viable, and reconcilable with more relational contractual endeavours.

While aligning to some extent with the view adopted by scholar Jeffrey Lipshaw as he forecasts that ‘dumb’ contracts will persist, and agreeing that smart or otherwise code-based contracts will not replace ‘traditional’ contracts, should all the architectural components of algorithmic contracts ‘align’, the promise of algorithmic contracts as the future of contracting could indeed become true.

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