SUSTAINABLE AI IN FINANCE:
UNDERSTANDING THE PROMISES AND PERILS

May 2018
The banking industry finds itself between two seismic events: it has now moved beyond the immediate aftermath of the financial crisis, but it is still yet to fully embrace the digital revolution.

We have seen a major transformation in banking economics following the ‘tsunami’ of regulation enacted in the wake of the global financial crisis in 2008. Prudential regulatory reforms have resulted in a more liquid and well-capitalised banking sector, but these necessary standards have hit shareholder returns and profitability. In the UK, the four leading banks averaged a return on equity of 5.7% in 2017.\(^1\) Across Europe, the 2019 financial forecast for global systemically significant banks (G-SIBs) indicates that single-figure returns on equity will likely continue. This performance is shy of both banks’ own financial targets and their Wall Street rivals.

The banking sector now faces an inflection point. As a response in part to the industry economics created post-financial crisis, banks are in the midst of fundamental and rapid digital transformation, with this new landscape providing impetus for the Fintech revolution currently at hand. Lloyds Banking Group, for example, allocated £3 billion strategic investment over the next three years to enhance the development of digital banking products and to upskill its staff for the digital age.\(^2\) Each year, Deutsche Bank spends over $4 billion on technology; JP Morgan meanwhile flashes $9.5 billion, 16% of the bank’s total budget, on digital.\(^3\) The aim is to not only stay on the front foot when it comes to digital innovation, but also to weave digital technologies and capabilities through existing business models and processes.

One of the most powerful tools in driving the next phase of this digital transformation is Artificial Intelligence (AI): a category of technologies that use algorithms to identify, predict, and act on patterns in data. To date, AI has proven powerful in automating and improving repetitive and structured decision-making processes. While AI will eventually be applied broadly, today, financial institutions have concentrated on Know Your Customer (KYC), regulatory reporting, anti-money laundering (AML) and Financial Crime (FinCrime) detection.

The exponential rise in computing power and the proliferation of data volume, variety and velocity will continue to broaden AI’s prominence across more facets of financial services, enabling a better understanding of key business drivers while enhancing the accuracy of its predictions.

The power of AI to catalyse productivity in financial services is undeniable, but it brings with it risks at the firm level as well as at the systemic level. At the firm level, key risks include the validation of very complex and opaque models and automated advisory models that could be prone to inadvertent mis-selling. At the systemic level, the Financial Stability Board (FSB) has called out ‘black-box’ algorithms, the high degree of market concentration among AI technology providers, and the rise of unexpected data correlations as potential threats to financial stability.

Protecting and growing the financial market with AI requires a stronger assessment of the technology in view of its risks, including adherence to new protocols on data privacy, conduct risks, and cybersecurity. Financial firms, regulators and technology providers share the responsibility of building a sustainable market for AI. Adequate testing and ‘training’ of tools with unbiased data and feedback mechanisms will be key, backed up by the development of skills in-house to understand and supervise AI and machine learning models.

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\(^1\) 2017 Annual Reports of Lloyds Banking Group, HSBC, Barclays and RBS.
\(^2\) Lloyds Banking Group 2017 annual report.
\(^3\) Bloomberg, JP Morgan’s tech spending should wake up rivals, 5 April 2017.
“It was eight years ago that those robots began showing guests around Santander City, but there is still not a single robot to be found in any of Santander’s 13,697 bank branches,” the Financial Times concluded its recent special report, *AI in banking: the reality behind the hype.*

The sci-fi like scenarios of super-intelligence and the rise of robots may inspire excitement and fear in equal measures. However, the reality of AI in banking needs to be considered in context of the technology’s limitations as well as the industry’s economics and regulatory environment.

AI is, at its heart, a set of statistical processes whereby data is fed into algorithms to identify and predict patterns. Depending on the form of the data input and the degree of human intervention, AI can be categorised into four types:

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**Figure 1: Types of AI: A Technical Overview**

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
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<tbody>
<tr>
<td>Supervised learning</td>
<td>The algorithm is fed data that contains labels on some data points which allows the algorithm to learn a general rule of classification that it will use to predict the labels for the remaining observations in the data set. For example, this might help it to quickly identify fraudulent information based on the knowledge learned from previous examples.</td>
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<tr>
<td>Unsupervised learning</td>
<td>The algorithm is fed data that does not contain labels. Instead it must detect patterns in the data by identifying clusters and/or anomalies of observations that depend on similar underlying characteristics. For example, securities that have characteristics like an illiquid security that is hard to price. If the algorithm can find an appropriate cluster for the illiquid security, pricing of other securities in the cluster can be used to help price the illiquid security.</td>
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<tr>
<td>Reinforcement learning</td>
<td>This falls in between supervised and unsupervised learning. The algorithm is fed an unlabelled set of data, chooses an action for each data point, and receives feedback (perhaps from a human) that helps the algorithm learn. For instance, reinforcement learning can be used in robotics, game theory, and self-driving cars.</td>
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<tr>
<td>Deep learning</td>
<td>Inspired by the structure and function of the brain, deep learning algorithms, (likened to artificial neural networks), can be used for supervised, unsupervised or reinforcement learning. Deep learning has led to remarkable results in image recognition and natural language processing (NLP).</td>
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The science of AI lends naturally to financial services where data is abundant and the needs for structured problem solving are high. AI’s coming of age is also coinciding with banks’ drive to step up compliance and cost-cutting efforts following the global financial crisis.

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* Financial Times, *AI in banking: the reality behind the hype*, 12 April 2018.
The ‘tsunami’ of regulations initiated to clean up the aftermath of the global financial crisis has shifted banking economics over the past decade. Prudential regulatory reforms have resulted in a more liquid and well-capitalised banking sector, but the compliance costs, regulatory fines and legacy conduct issues have hit shareholder returns and profitability. Across developed markets, global banks’ returns on equity have trailed below their costs of equity – this struggle is also expected to continue in the near future.

The profitability drive underpins the banking industry’s adoption of AI. Risk management and compliance – areas involving complex data, detailed workflows, and significant human involvement in repetitive activities – are particularly fertile ground for AI use. We outline three areas in this report.
1. COMBATTING FINCRIME

FinCrime, especially AML, is a case in point. Money laundering is estimated to cost the global economy up to $2 trillion per year – as much as Italy’s entire GDP – and this sum is growing. Given that the vast majority of those transactions end up funding bad people doing bad things, governments have stepped up their regulatory requirements and oversight while regulators have handed out record fines to banks found guilty of AML breaches. It has been estimated that misconduct fines, including AML, imposed by EU and US regulators are set to top $400 billion by 2020. Global banks are under increasing scrutiny across all jurisdictions. This has caused banks’ compliance costs to grow rapidly – often up to 50% annually – over recent years, burdening bank earnings at a time when they need to fund large-scale transformation programmes to position for the future.

Case study: AI takes a front line in combating money laundering

The complexity and cost of compliance grow with financial institutions’ geographic and product diversity. A G-SIB could easily have an AML investigation team of over 5,000 people and half-a-million risk alerts each month. The business challenge in combating FinCrime and AML is therefore to create operational efficiency while maintaining a keen eye on the institution’s risk profile. A nuanced understanding of features that underpin FinCrime is key to improve signal-to-noise ratio. This is where AI helps.

In a recent project undertaken by AI-pioneer Ayasdi with HSBC, the two organisations sought to develop an intelligent segmentation of customers in order to decrease the number of false positives while enhancing the overall risk profile for the bank.

Ayasdi was able to employ more than ten times the number of features traditionally used by the bank, incorporating transactional data (type, direction, value), customer data (geographical, chronological) and risk data.

With these new features and the application of unsupervised learning, the bank was able to construct fine-grained and evenly-distributed customer groups using behaviours in place of human-coded rules. These groups and their accompanying thresholds reduced false positives by more than 20% while capturing every previously discovered suspicious activity report. This new segmentation also identified behavioural patterns of interest that were previously undetected, enhancing the bank’s risk profile. The result was an AML process that was more efficient as well as more effective.

Similar approaches can be applied to credit scoring to speed up lending decisions while reducing credit risk. Lenders are turning to additional, unstructured and semi-structured data sources, including social media activity, mobile phone use and text message activity, to capture a more nuanced view of creditworthiness, simultaneously improving the rating accuracy of loans.

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5 United Nations Office on Drugs and Crime website, 2 May 2018.
2. AUTOMATING INTERACTION

The benefits of AI extend beyond improving the effectiveness of AML and FinCrime detection. Client-facing chatbots, or employee-enabling ‘virtual assistants’, are being rolled out by leading banks to help customers and employees transact or solve problems. These automated programmes use NLP to interact with clients in natural language (by text or voice) and use machine learning algorithms to improve their ‘human-ness’ over time. Examples of this include customer-facing Cora (Natwest) and Erica (Bank of America), and virtual assistant COIN (Contract Intelligence) that helps JP Morgan employees processing commercial credit agreements.

BNY Mellon went a step further with the roll-out of AI across the organisation and putting the bank on ‘bots’. With over 220 bots handling repetitive tasks such as “data requests from external auditors” and “correct formatting and data mistakes in requests for dollar funds transfers”, this AI initiative enabled BNY Mellon to achieve an 88% improvement in overall processing time and a 66% improvement in trade entry turnaround time. For example, the time required for AI to complete a failed trade is a quarter of a second, compared with 5-10 minutes by a human.7

3. SHIFTING MANAGEMENT LENS

Forward-looking financial institutions are also incorporating AI to change the ways they optimise capital, model risks, and manage their businesses. Particularly as the regulatory focus moves from maintenance of financial stability in terms of assets held under the Basel III requirements, calculations for forecasting and classifying necessary levels of regulatory capital are quickly becoming the target of AI algorithms and artificial neural networks. Accordingly, the technology can be used for back-testing of internal risk models.

For instance, one global corporate and investment bank is using unsupervised learning algorithms in model validation. Its equity derivatives business has used this type of machine learning to detect anomalous projections generated by its stress testing models. Each night, these models produce over three million computations to inform regulatory and internal capital allocations, as well as limit monitoring.8
MANAGING THE RISKS ASSOCIATED WITH AI: REALISING THE PROMISES, AVOIDING THE PERILS

Developments around the generation, storage and management of data would enable cheaper access to AI tools and the development of a market for AI as a service (AIaaS). At the same time, continued improvement in hardware, such as processing chips and quantum computing, will allow for a wider range of more powerful AI applications. For example, they could make more real-time insights possible on large, unstructured data sets, such as online user behaviour or internet-of-things (IoT) sensors located around the world.

All of these developments warrant further attention from financial services companies both to realise the opportunities of AI and to mitigate its risk implications. The overwhelming focus of the latter, to date, has been on AI’s threats to job security. A more pressing concern for the financial industry, however, relates to the financial stability implications of AI use.

Institutional interdependencies and risk correlations are central to financial crises and market crashes. The 2010 Flash Crash was an example: triggered by an automated algorithmic trade, US stocks and futures markets saw a 10% fall in market value in a matter of minutes, only to recover hours later. The market crash witnessed in February 2018 in which the Dow Jones collapsed by 1,000 points in 11 minutes – the biggest points fall in the Dow’s history – was a fresh reminder. Proprietary algorithms that can perform thousands of trades a second is now a reality for global markets. And the prospect for these to cause market volatility or to crash markets has become far more significant.

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**Dow Jones crashing in February 2018**

![Dow Jones crashing in February 2018](source: CNN Money, 2018.)

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9 The Economist, One big, bad trade, 1 October 2010.
10 CNN Money, How the Dow fell 800 points in 10 minutes, 5 February 2018.
In a recent report examining the risk implications of AI, the Financial Stability Board (FSB) highlighted that the lack of transparency and auditability of AI algorithms in trading poses macro-level risks. Applications of AI could result in new and unexpected forms of interconnectedness between financial markets, for instance, based on the use of previously unrelated data sources in designing trading and hedging strategies.11

The use of AI and machine learning also risks the creation of ‘black-boxes’ in decision-making. In particular, it may be difficult for human users at financial institutions – and for regulators – to grasp how decisions, such as those for trading and investment, have been formulated. Moreover, the communication mechanism used by such tools may be incomprehensible to humans, posing monitoring challenges for the human operators of AI solutions. Financial institutions applying AI and machine learning to their businesses need to establish well-designed governance frameworks and maintain audit trails.

Another challenge posed by AI relates to new sources of market concentration in financial services, especially with regards to third-party relationships. Access to big data could be a source of systemic importance, especially if provider firms are able to leverage this to obtain substantial economies of scope. A strong network effect and first-mover advantage common in the technology sector also reinforces a winner-takes-all dynamic. ‘Word of mouth’ and scalability of new technologies could cause the provision of AI to concentrate among a small number of advanced third-party providers, hence increasing market concentration among some functions in the financial system. As the FSB noted, this may lead to “the emergence of new systemically important players that could fall outside the regulatory perimeter” and trigger systemic risks if a large technology provider were to face a major disruption or insolvency. Indeed, this has caused the UK’s Financial Conduct Authority (FCA) to heighten supervisory efforts on third-party dependencies and supply chain risks in the banking industry over the coming year.

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11 Financial Stability Board, Artificial Intelligence and machine learning in financial services, 1 November 2017.
Building a Sustainable Financial Industry with AI

Protecting and growing the financial market with AI requires a strong and innovative assessment of AI and machine learning in view of their risks, including adherence to new protocols on data privacy, conduct risks, and cybersecurity.

The validation of models that ‘self-build’ (e.g. genetic applications for credit scoring), predictive analytic models that are opaque (e.g. neural networks) and automated advisory models that could be prone to inadvertent mis-selling, would all benefit from best practice principles and guidelines to reduce ambiguity. Adequate testing and ‘training’ of tools with unbiased data and feedback mechanisms will be key, and so will the build-up of skills in-house and among regulators to understand and supervise AI and machine learning models.

The responsible use of AI is a part of the future for sustainable digital finance. The financial industry itself stands at an inflection point of change. With the regulatory tide post-financial crisis now settling, the industry is anticipating a wave of rapid and fundamental digital transformation. In the next era of finance, business focus will be shifting from compliance to performance; regulatory focus will tilt from the prudent management of capital to the prudent management of data.

In managing this transition successfully, financial institutions, regulators and technology providers share the responsibility of building a sustainable market for both AI and for digital finance. A new mindset is required, so are new ways of working between financial institutions and the regulatory community. We suggest three principles for effective collaboration to future-proof the financial industry.

1. Increase technology-specificity in regulation

Regulations in the banking sector have been technology-neutral, understandably. This allows for flexibility, but introduces ambiguity in interpretation when it comes to the adoption and use of new technologies. To prepare the industry for the more rapid and fundamental digital transformation ahead, financial regulators need more robust guidance to foster continued commitment to FinTech adoption. Three principles will be key to governing the application of technologies in finance: explainability, auditability, and reproducibility.

Equally, clearer communication of regulatory expectations is critical in ensuring the sustainable adoption of AI. Regulators need to specify their ‘red lines’ based on the nature and key characteristics of this new technology. Detailed guidelines related to the adoption of new technologies may also be required to support regulated firms.
2. ESTABLISH A MORE EFFICIENT REGULATORY COMPLIANCE INFRASTRUCTURE

Updating regulatory infrastructure in a digital age requires not only the regulation of technology, but also the technology of regulation (RegTech). Key use cases include real-time reporting, conduct risk analytics, and macro trade surveillance technologies. Alongside the adoption of RegTech, regulators’ operating models also need to change to reflect the diversity of innovation in the industry.

The industry and its regulators should collaborate to broaden the use of technologies in improving the operational efficiency of regulatory activities, and in particular when it comes to the use of AI. Regulators therefore need to have a clear understanding of the benefits of artificial intelligence in improving the design and operation of their activities. Further evolving the use of ‘tried and tested’ tools, like the FCA’s FinTech Sandbox could also prove effective in deepening regulatory innovation, particularly among firms who do not already hold FCA authorisation.

3. MAINTAIN REGULATORY COHESION ON AN INTERNATIONAL LEVEL

Macro-level standards and international regulations on AI will be integral to guide its responsible adoption and usage. These are particularly important for firms operating across multiple jurisdictions - the greater the geographic coherence of regulation the easier it will be for banks to realise the potential of their investments.

Making this happen requires the maintenance of regulatory equivalence and sustained international links with policymakers and technical standard setters. This is pertinent in the context of Brexit: the EU Digital Single Market is focused on co-ordinating digital regulation across the EU28 and will be an increasingly important stakeholder for the UK banking industry and regulators to maintain links with after Brexit. UK banks should also remain close to the European Commission’s Task Force on Financial Technology (TFFT) to accelerate capital market reforms and the planned European Parliament’s policy paper on the EU regulatory regime for FinTech.
Conclusion

As the use of AI proliferates in financial services, the transformative power of this technology will become even more visible. Today we have seen the promise of AI in automating processes, improving customer interactions and re-wiring business operations. The continued development in data storage and handling, as well as the advancement in hardware, will make AI a more integral part of decision-making and market-making.

At the heart of the power of AI lies its ability to comprehend, learn and act upon data at a volume and a variety not previously possible. But drawing correlations and insights from an unprecedented amount of data calls for ever greater human guidance and oversight. As we have seen, if AI is not properly understood, unexpected market jitters may in turn lead to bigger shocks to wider macro-financial stability. Artificial intelligence can only be as beneficial as the supervisory systems in place allow it to be.

To encourage commitment to AI adoption and ensure that this benefits the financial industry both now and in the long-term, regulators across the globe need to provide clear-cut definitions of the allowed reach of this technology and avoid regulatory balkanisation for both AI and FinTech overall.

Ultimately, protecting and growing the financial market with AI requires a stronger assessment of the technology in view of its risks, including adherence to new protocols on data privacy, conduct risk, and cybersecurity. This involves a closer coordination across all three lines of defence of financial institutions in order to apply a risk lens in the design of AI algorithms and to ensure an audit trail of AI to comply with new regulatory expectations. To ensure a sustainable future for AI in finance, the risk management and internal audit teams need to assume a much more active role in being both the user of AI and the custodian of it.

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Gurjeet Singh is Ayasdi's CEO and co-founder. He leads a technology movement that emphasizes the importance of extracting insight from data, not just storing and organizing it.

Gurjeet developed key mathematical and machine learning algorithms for Topological Data Analysis (TDA) and their applications during his tenure as a graduate student in Stanford's Mathematics Department where he was advised by Ayasdi cofounder Prof. Gunnar Carlsson.

Gurjeet is the author of numerous patents and has published in a variety of top mathematics and computer science journals. Before starting Ayasdi, he worked at Google and Texas Instruments.

Dr. Singh serves on the Technology Advisory Board at HSBC and was named to the Silicon Valley Business Journal’s “40 Under 40” list in 2015.

Gurjeet holds a B.Tech. from Delhi University, and a Ph.D. in Computational Mathematics from Stanford University.
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SUSTAINABLE FINANCIAL SERVICES IN THE DIGITAL AGE

May 2018

This joint report by UK Finance, an industry group representing nearly 300 of the largest financial firms in the UK, and Parker Fitzgerald focuses on three key technologies in finance: artificial intelligence, the Cloud and Distributed Ledger Technology. It discusses how the advent of the digital economy, financial regulation and the emerging risks for firms are transforming the financial services landscape.

SAFEGUARDING DIGITAL TRANSFORMATION

December 2017

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October 2017

FinTech adds to London’s Brexit-proof appeal. Technology will be the dominant driver of change in global financial services, as well as that of new systemic and firm-level risks. The City of London is in the prime position to address these risks and reap the potential benefits of a digital financial marketplace.
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