

Can Machine Learning and Blockchain Intersect?


Introduction

Blockchain and machine learning are arguably the two most talked about technologies of the past decade. Their potential to transform business models across a variety of industries has led to huge investment in their development, and significant advances have been made in both their capabilities and adoption as a result.

This success, along with the considerable hype around these projects, has led to speculation that machine learning and blockchain could be used together in some capacity.

This is not necessarily, as some may believe, an inevitable consequence of a clickbait culture among technology magazines, desperate as they are to throw together buzzwords in their quest for views. While on the surface they appear to have vastly different technical foundations and practical applications, there are commonalities that suggest there is potential for the two technologies to work in tandem. Blockchain is a distributed immutable database and machine learning is dependant on access to a diverse pool of high quality data - data is central to the existence of both. The potential for intersection should therefore at least be explored.

This e-book will seek to examine the potential for blockchain to be used in conjunction with machine learning, the ways in which it could happen, and the viability of such projects.




Machine Learning and Blockchain: Marketing Gag or Necessary Development?

The hype surrounding both machine learning and blockchain has led to natural scepticism within the technology community about their potential. It is therefore understandable that discussion around the two being used in conjunction might also be met by voices of dissent.

Many prominent voices in the technology communities have dismissed any potential intersection, including respected academics in the machine learning field. When we asked Moritz Hardt, assistant professor of the Department of Electrical Engineering and Computer Sciences at the University of California, Berkeley, about the potential for viable crossover projects, he said:

“Machine learning on the blockchain’ is an intellectually void marketing gag. In particular, I don’t see any way in which the blockchain could currently play a positive role in mitigating algorithmic bias. What the blockchain provides is not what’s needed in this area – neither at a technical level nor within the broader normative debate.”

There are, however, many other academics, developers and investors pushing ahead with the creation of actual products that utilise both machine learning and blockchain technologies. A key example is SingularityNET, which seeks to create a decentralised AI network



marketplace, in which AI services are offered through the medium of smart contracts.

An important consideration to make when examining blockchain's intersection with machine learning is the level of trust in these technologies at an enterprise level. Surveys showed that, even in 2019, there remains a widespread lack of enterprise confidence in the safeguards in place within existing infrastructures to cater for emerging technologies, including blockchain and AI¹

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Machine Learning: Challenges of Centralised Structures

Jorden Woods, Silicon Valley enterprise blockchain expert, outlines several key challenges that are inherent in machine learning and AI, which may offer incentives for solutions to be found in blockchain.

"There are a couple of challenges that we're having with AI and machine learning," he says. "If you look at AI and machine learning, they're typically based on centralised systems, and under centralised systems there are a couple of challenges.

"Because these centralised systems are owned by a single player and they tend to have a lot of records, you get two things happening:

"1: Those records tend to not be safe since there is a lot of valuable data together in one place. You get continuous breaches all over the world every day, and what's being stolen is people's data. You get breaches of these systems because they're kind of like honeypots for hackers.

"2: The centralised players gain a lot of power. Basically, people can start monetizing that data, selling it and derivatives of that data, and they can make a lot of money."

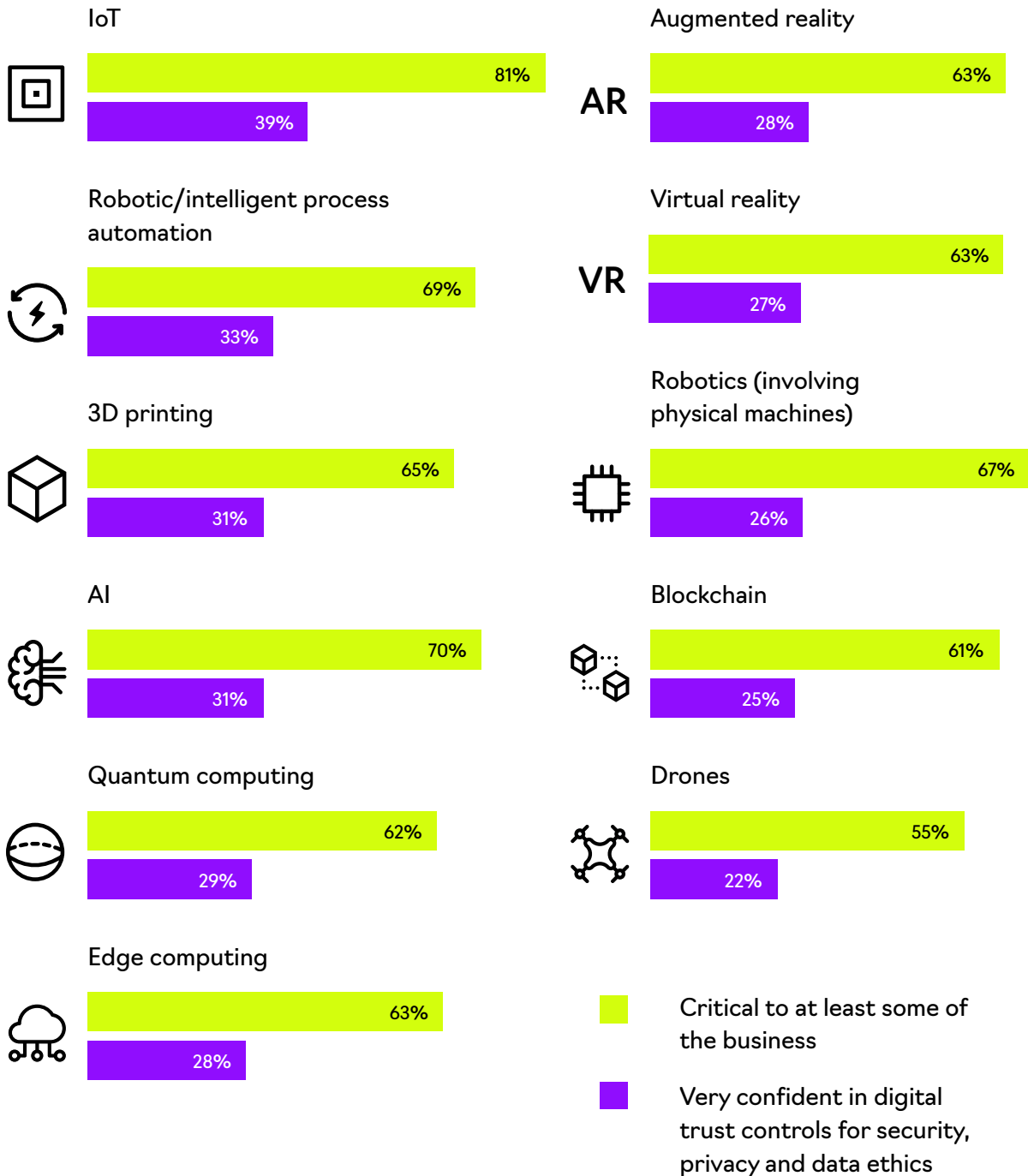
change to: monetising

The allure that these centralised data honeypots present for nefarious characters is a longstanding problem for any business that utilises and stores data. It is not unique to machine learning development. However, the importance of data to machine learning makes it far more susceptible to the negative aspects of centralised systems, with subsequent AI programs becoming fundamentally altered by the effects of restrictive training data.

"The further issue, if we look at it a little bit more, is that when you have centralised systems, and people are monetising this valuable information, they become disincentivised to share the data," Jordan explains. "AI systems and machine learning get better the more data they have. And so if data is not shared, each group only has a partial information set, which is in essence a biased dataset.

"Anything from facial recognition to medical applications are impacted. Consider skin cancer detection, for example. Today most medical datasets only contain information for light-skinned people. If you don't have light skin these AI systems tend to be incorrect in their analysis and assessment, and so you get issues based on race, ethnicity etc. It is also widely recognized that you get issues based on gender. So these AI and ML systems are not as good as they could be and that's because of the siloing of data, and the lack of data sharing, either because people are afraid of breaches or they're afraid of competition."

Most respondents say emerging technologies are critical for business, but fewer are very confident they have sufficient 'digital trust' controls in place



q1010: How important do you expect the following technologies to be to the future success of your business?

q1030: How confident are you that your business is building sufficient 'digital trust' controls into adoption of the following technologies?

Can Blockchain Overcome These Challenges?

Fundamentally, the development of machine learning and AI is heavily reliant on trust in the data being used to train the algorithms. Having siloed datasets does not necessarily mean that they are restrictive and biased, but there is far less transparency, which can negatively influence public faith in the end product.

Blockchain - an immutable and decentralised database - would understandably attract the attention of those seeking to solve the problem of siloed machine learning datasets. Theoretically, blockchain could offer a platform on which data could be shared and accessed by a huge number of people. This would lift the resource restrictions on those with the means to pursue machine learning development. Not only this, but the immutable nature of the platform means datasets could be publicly scrutinised for bias, while at the same time protected from any tampering.

On the surface, these basic blockchain principles offer a promising solution for some of the key issues faced by AI and machine learning development. Jordan understandably takes a measured approach to examining the crossover potential, and is quick to point out that hype surrounding blockchain is never far away.

"There's a lot of buzz around blockchain but it's really not a be all and end all solution for AI and ML by itself," Jordan explains. "It's a specific kind of decentralised technology with promise. Blockchain is really good in terms of creating an immutable ledger, and creating an ultra-secure system and smart contracts, but you've got to put it in combination with decentralised identity and decentralised storage. If you can integrate these different

pieces together, and I think we can, then I think we have a much brighter future for AI and machine learning.”


Could Blockchain Prevent Evil AI?

The fear that AI could become a malevolent force beyond human control arises from not only its raw computational power, but also from the unpredictability and lack of oversight possible when they become able to self-learn.

One of the primary causes of 'evil AI' stems from biased or even deliberately corrupted initial training data, which can damage an AI program's foundations. Many commentators also think that the true danger lies with the creation of a truly intelligent, self-aware AI that understands self-preservation and is sentient enough to practice subterfuge and deception to achieve this. Blockchain, however, could offer a means of making this kind of unchecked AI vastly more difficult to conceal.

Melanie Swan is the founder of the Institute for Blockchain Studies, and a technology theorist in the Philosophy Department at Purdue University. In a paper entitled 'Blockchain Thinking: The Brain as a DAC (Decentralized Autonomous Organization)', she points out the potential for AI's behaviour to be kept in check, thanks to the publically accessible and easily scrutinised ledger of code that blockchain is based on.

“The discussion of blockchain thinkers, smart contracts, and utility functions raises the spectre of Friendly AI: how to develop machine intelligence that is beneficent to humans,” Melanie says. “What is notable



about blockchain technology is that perhaps for the first time, it is a credible model of checks-and-balances by which Friendly AI could be realised.

“First, blockchains are code, which is the language of machines; readily understandable and executable by digital entities. Second, blockchains are not just code as in any AI system, but code in the form of a permanent transparent public record that can be reviewed and inspected by any party at any time; so it is known what the AI is doing.

“Third, not only is it known what blockchain AIs are doing, they will not be changing their behaviour after the fact since ‘code is law’ and cannot be modified once set to run. Smart contracts will run inexorably in the future carrying out whatever has been specified; they are not open for breach or discretionary compliance as are their counterparts, human-based contracts’^{2.}


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Applications of Blockchain in Machine Learning

While the theory behind the use of blockchain in machine learning appears sound, this needs to translate into the real world before it can be taken seriously. Francesco Corea, a tech investor and AI strategist, says developers are already pushing to take the intersection of blockchain and machine learning beyond the conceptualisation stage.

“It is highly viable because it is already happening,” Francesco explains. “Clearly some of the current thoughts are speculations, but there are already examples of this integration. See, for example, what companies like SingularityNet or MatrixAI are doing. Theoretically speaking, blockchain can help making AI more transparent, trustworthy and secure, while AI can make blockchain more efficient, hard to break (especially from cyber-attacks) and scalable.

“So far, the main applications pursued have been in ‘decentralised intelligence’ type of applications, meaning bringing AI to the masses (through peer-to-peer computing power, synthetic datasets, decentralised training, data and talent marketplaces, etc.). Something very interesting coming out of this intersection is the creation of super network of devices/people that can implement parallel computation possibly on personal devices (edge computing) and potentially create a new type of super-interconnected-(living)-computer.”



CASE STUDY: SingularityNET



Singularity Net

The demand for AI solutions is increasing across a broad spectrum of industries, and so is the variety and complexity of the tasks that these programs are expected to perform. Because of this demand, there is often a significant gap between the developers behind these projects and the businesses who are commissioning them.

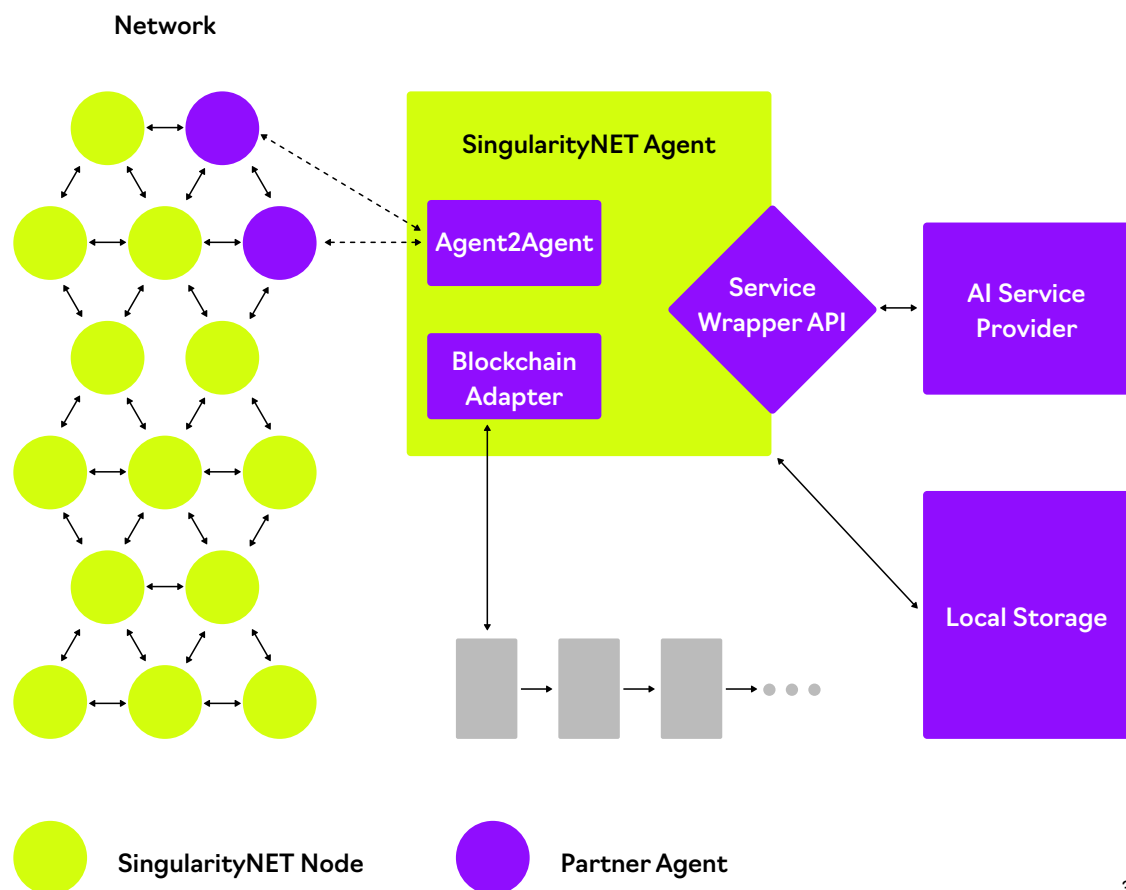
On the enterprise side, there is a need for developers to construct highly customised products that include a greater degree of specialisation than a single AI build can provide. On the research and development side, there is the recurring problem of access to sufficient datasets.

SingularityNET seeks to bring together machine learning and blockchain by constructing a decentralised protocol for AI developers and customers to interact and do business. Fundamentally, it is an AI-as-a-service marketplace, which facilitates tailored solutions for complex AI projects.

Transactions are kept simple by providing APIs to incorporate standard AI services, such as image processing. To facilitate other types of services, smart contracts are also used to help matchmake suitable buyers and

sellers, and also to power voting for governance issues (DSOC democracy is used for said governance model).

SingularityNET is also taking development beyond this user-driven marketplace, into an autonomous network fully driven by AI. If successful, 'AI Agents' will seek each other out based on each other's specific expertise to perform tasks. If three Agents team up to perform a task, each one updates their own AI with the network information gained from their cooperating Agent. In this way, the collective AI of the entire system grows and develops at a much quicker rate than it would with isolated Agents working autonomously.



The marketplace is also tokenised. Developers can exchange their services for the SingularityNET AGI token, thereby establishing a whole new set of price points in the field.

Their ICO garnered a great deal of attention in December 2017 by raising a reported \$36 million in just 60 seconds. In addition to this, the SingularityNET team reported that crowdfunding was capped after receiving \$361 million from more than 20,000 whitelisted investors, under full compliance with KYC/AML regulations.


Because of the wide range of applications intended to be developed and facilitated through SingularityNET's marketplace, there has been a dedicated drive to establish partnerships with other companies within the AI community. A few examples include:

Ocean Protocol: A decentralised data exchange network that lets people share and monetise data for use in training AI models

Hacken: A decentralised cybersecurity ecosystem focusing on bug bounty research, penetration testing and vulnerability assessment. It is also using its own cybersecurity utility token

Dbrain: Ecosystem that sources workers from emerging workers to label and validate AI data, then rewards them instantly with cryptocurrency payments

Shivom: A decentralised platform that helps sequence and securely store patient genome data for use by pharmaceutical companies, insurance companies and support groups, with the goal of creating personalised medical analytics



Nexus: A partnership was reached in January 2018 with Nexus to build a 3D blockchain to help facilitate this ambitious intersection. Nexus is designed to be quantum resistant by using three consensus protocols, which theoretically would make the blockchain network resistant to centralised mining pools, and would aid in on-chain scaling.

The construction of a 3D blockchain utilises three separate consensus channels:

Prime Channel: Resistant to ASIC mining, and work can be done on CPUs


Hashing Channel: Utilises Hashcash-style proof-of-work that is GPU compatible, and features a quantum resistant hashing algorithm

Proof of Holdings Channel: Representative of the proof-of-stake model, with participants who stake their coins through their wallets and continuously use them being subsequently rewarded with newly minted coins

Three mining channels are able to work together on blocks, with no one channel gaining more influence than another. Mining pools are therefore not needed, and each channel can scale independently.

The Case for Decentralised AI Marketplaces


SingularityNET has received a great deal of attention for its tangible intersection of blockchain and AI. The accelerating growth of AI R&D in the past five years, coupled with the more recent legislative pushback



concerning enterprise access to user data, has led to uncertainty and even concern that the resources necessary for unrestricted AI growth are insufficient. Francesco Corea describes how using the decentralised foundation of blockchain for AI development, as seen in offerings like SingularityNET, can help address these points.

“I believe that two of the biggest issues are still (training) data and lack of talent,” he says. “What marketplaces enable is a common standard for data sharing (and possibly new forms of data monetisation for individuals and small businesses) and above all a network of talents that can read and analyse the data.

“This also means that, in general, and if all that happens, we might end up with lower moats and barriers to entry for startups, because the big defensive strategy today is collecting as much data as possible and clearly you can't compete with the Facebook or Google of any sector. However, if everything is accessible and shared, anything can be started more easily - think about the increase in the number of companies created thanks to the introduction of cloud computing (AWS) less than a decade ago.”



Obstacles to Overcome

Hesitancy from the Machine Learning and Blockchain Communities

There is a vast variety of projects in machine learning and blockchain, and the level of personal and professional investment tied to them is huge. It would, then, be naive to expect the idea of an intersection between the two technologies to escape severe scrutiny. As a frequent speaker at blockchain and artificial intelligence conferences, Jordan Woods has seen firsthand the reaction to a cross-platform intersection from the respective communities themselves.

“You get this at the beginning of a lot of movements,” he says.

“Everybody’s like ‘Oh we need to have rights to our data and we need to have all these good things that come from decentralisation,’ and so in the blockchain community everybody’s pretty positive. But I’ve gone to conferences where I’m speaking about blockchain, but it’s really an AI conference. It’s a totally different crowd - it’s the people that are in Web 2.0 and this decentralisation concept in the centralised world is something people don’t understand at first. They say ‘Well why would you do that?’ And then if you talk about these challenges to people, they’ll downplay it, and say ‘Oh it’s not really an issue and these centralised systems, they’re so powerful, we’ve been able to do so many great things.’

“It’s kind of visceral with people that are currently in the community. They’re just really happy with the way things are and they don’t really want anybody to change it. I’m not saying it’s across the board, but most

people don't think about it. So when you kind of put a different paradigm out there, they just want to shoot it down because it's what they're not accustomed to, and that's just human nature. I would say the majority of people who are in this space who I've spoken to don't think this is a good idea."

Public Opinion and Consumer Adoption

Enterprise handling of user data has been an area of great concern for consumers for a number of years now.

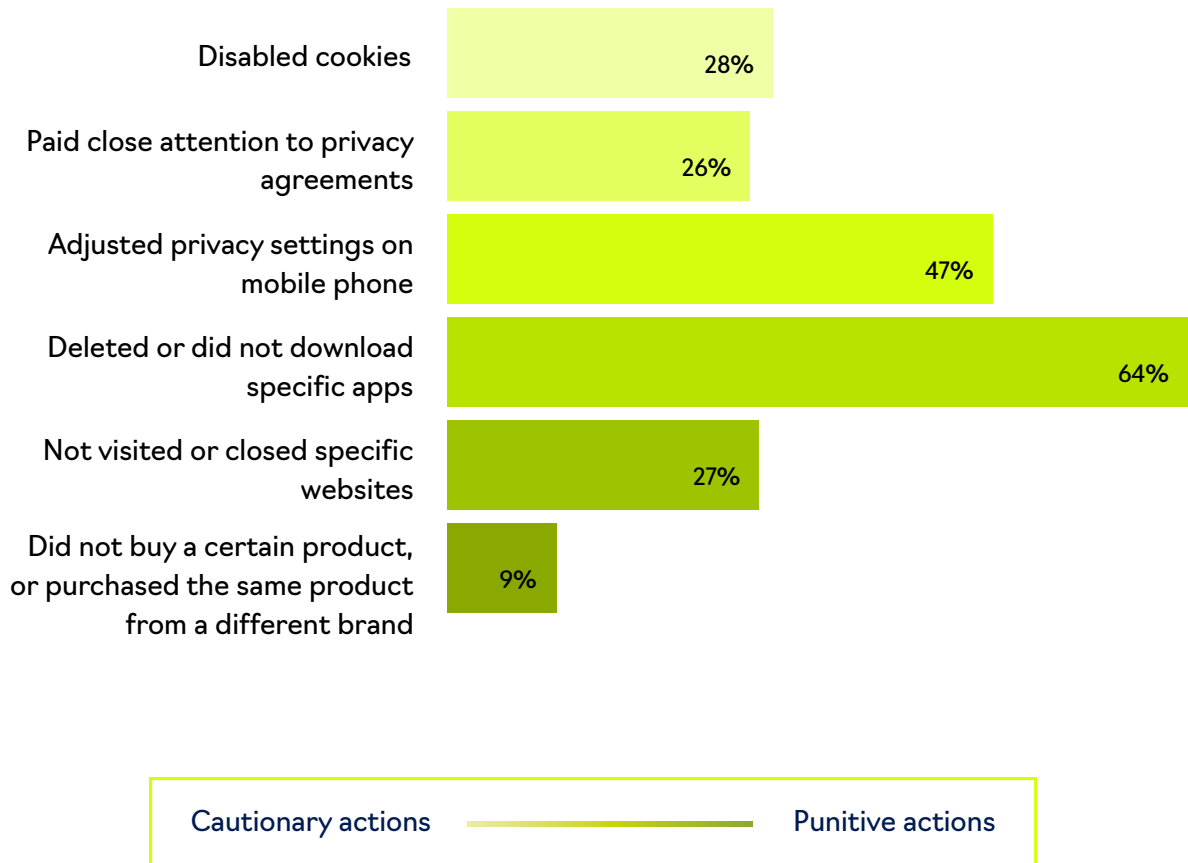
This public distrust in data use is important to consider. The theoretical applications of an intersection between machine learning and blockchain may well go beyond the confines of their two respective development communities, eventually breaking into the consumer sphere. Any emerging projects that incorporate a meeting of the technologies will likely be built on a foundation of strong access to, and ease of sharing, data. The treatment of data itself is an area that legislation is adapting to cater for.

GDPR has been a major force in altering the treatment of user data, while raising awareness in the public over how theirs is used. With projects like SingularityNet seeking to use blockchain technology to create an open, monetised market that utilises data, could the technology behind this win public support by giving consumers control of their data, and the opportunity to profit from it?

remove this

~~Figure 4. Consumers are unforgiving when it comes to data breaches~~

Percentage of US respondents who agreed that they have taken action in last 12 months «due to concerns over data privacy» ← change arrows to speech marks: “



Sample size: 1,538.

Source: Deloitte/SSI 2016 consumer survey.

Deloitte University Press | dupress.deloitte.com

~~Figure 3. Consumers' attitudes and behaviors toward data privacy and security~~



Source: Consumer responses from the consumer product consumer and executive survey on data privacy and security, Deloitte LLP, August 2014.

Graphic: Deloitte University Press | DUPress.com

“With GDPR and the right to be forgotten, you can download your data, everything that belongs to you from a centralised service and you can take it somewhere else,” Jordan says. “Well these days you can just take it to another centralised service - you’re kind of going from one centralised service to another. But if you have a decentralised system, you’re given another choice where you upload your information but you still control it, and then they help you via a marketplace to monetise it.

“Now there’s a big incentive to actually use GDPR and use this mechanism of the right to be forgotten to gather up all our data and move to a system that we can control. And so GDPR actually can facilitate the move to a decentralised world, but these decentralised systems have to then be very good at marketing to the general public.”

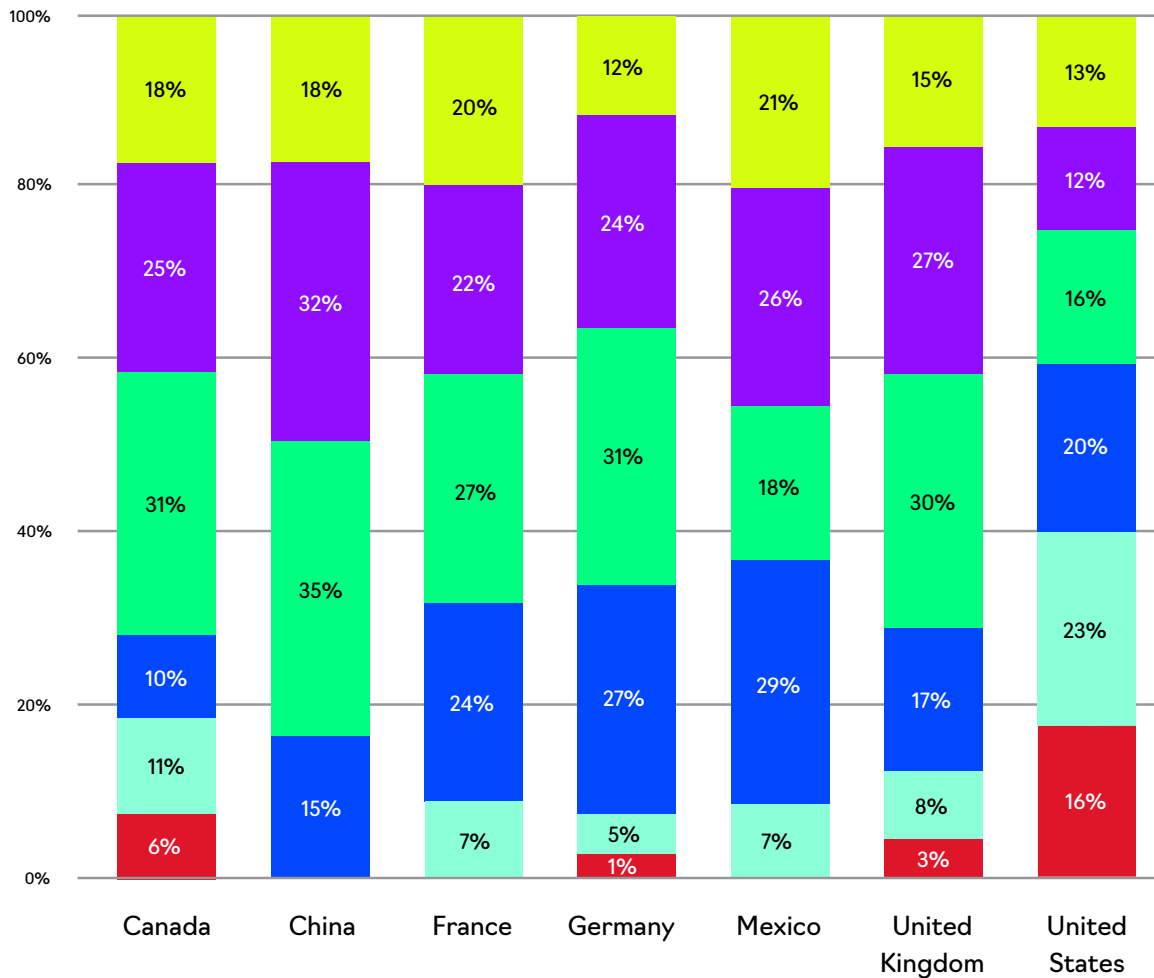
Will the Intersection Become a Scalable Reality?

Machine learning and blockchain are rapidly evolving in their applicable uses. The breadth of businesses investing in them, or at least undertaking research to determine if their adoption is prudent, is increasing.

Realistically, it is impossible to say at this point in the two technologies’ ongoing development whether or not there can be an intersection that is scalable in the long term. Unfortunately, the hype that these technologies attract begets more hype over their potential applications and their future market caps. This leads to a great deal of scepticism towards the legitimacy of these predictions, not just from the public at large, but also from key members of the technology community.

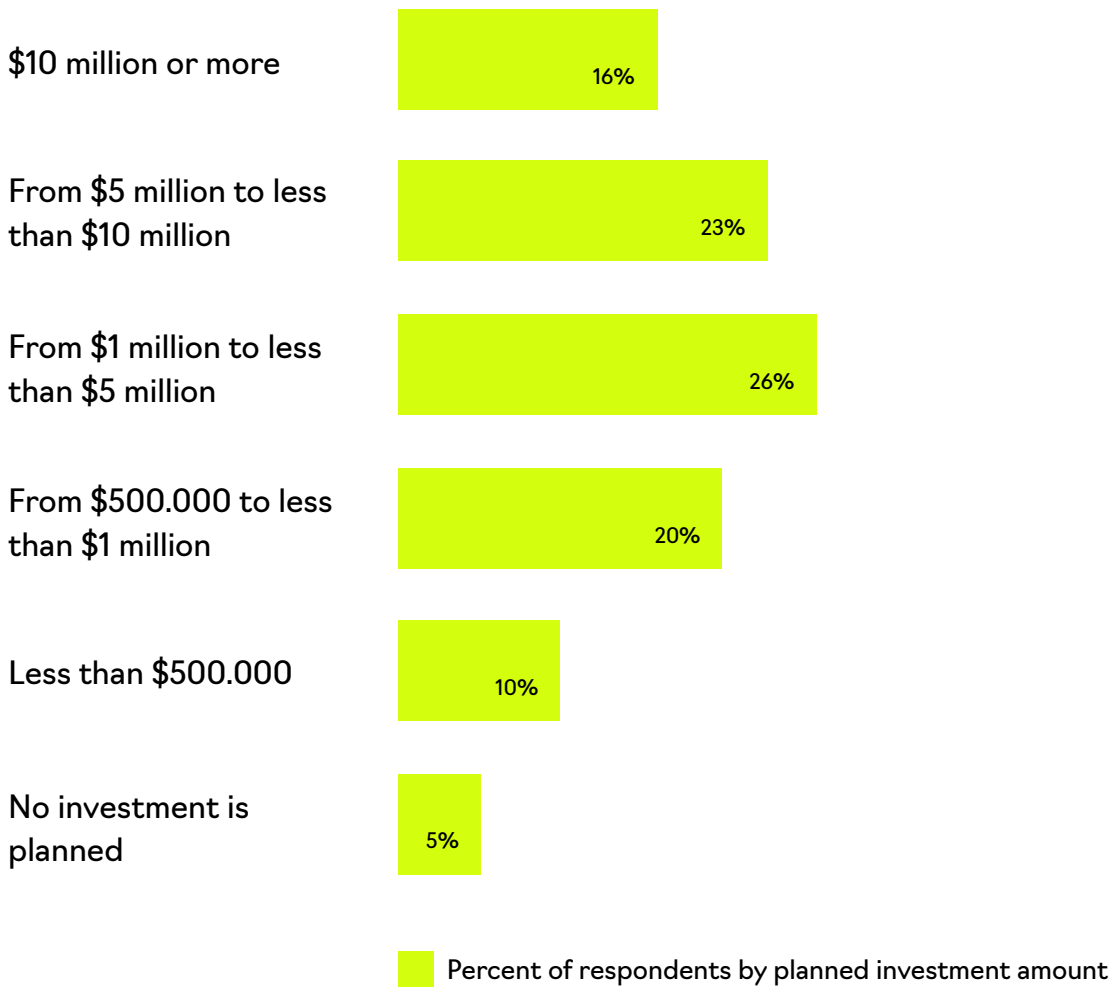
Approximate blockchain investment that organisations will make in the next calendar year

Blockchain is a priority investment for many companies, with 39% of respondents reporting that their organisations will invest \$5 million or more in blockchain technology in the coming year.



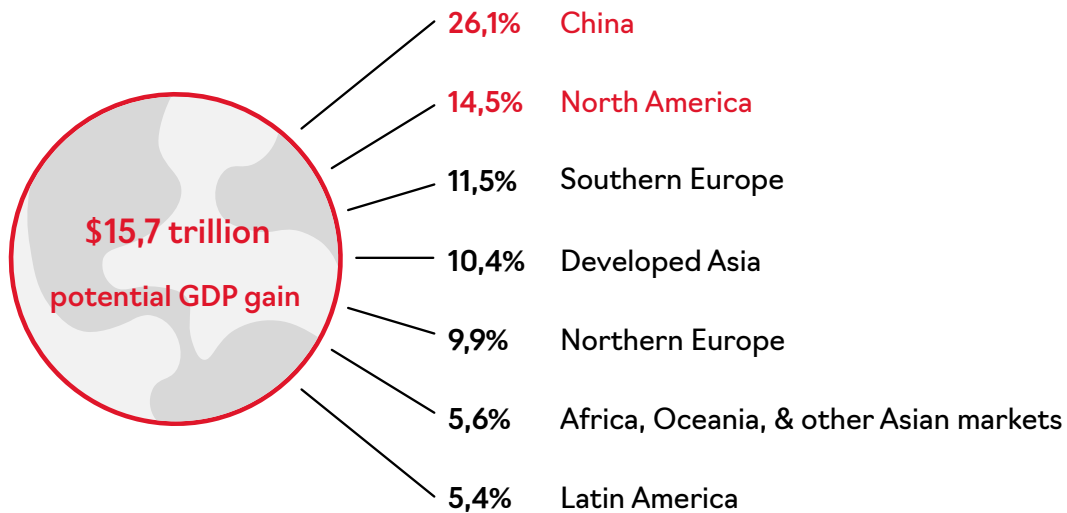
- No investment
- \$1 million to less than \$5 million
- Less than \$500,000
- \$5 million to less than \$10 million
- \$500,000 to less than \$1 million
- \$10 million or more

Q: Thinking specifically of blockchain technology, what is the approximate investment your organization will make in the next calendar year in this area?



Where AI gains will be realised

AI's impact on GDP by 2030



Source: PwC Global Artificial Intelligence Study, 2017

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Hilary Mason, founder of the machine learning intelligence company Fast Forward Labs, is one of many industry leaders who express disdain towards gratuitous marketing of cross-platform collaborations.



Hilary Mason ✓
@hmason

Follow

The depth and quality you can expect from an event has an inverse correlation with the number of trendy topics that even covers.

For example:

AI - maybe awesome, probably cool

AI & Blockchain - meh

AI & Blockchain & VR - umm no

2:51 PM - 14 May 2018

54 Retweets 214 Likes




8

15 54 214

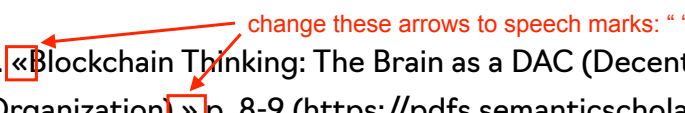
Separating the marketing hype from tangible products is difficult, and fatigue from this hype frequently sets in, even with dedicated members of the technology communities, as displayed in the above tweet.

The possibility of achieving machine learning intersection with blockchain exists, as companies like SingularityNET are demonstrating. Achieving a cohesive roadmap for meaningful intersection is likely to be made easier by their aforementioned formation of partnerships. With the creation of a cross-company ecosystem, there is a much wider depth of technical knowledge available to the venture, as well as other logistical aids, such as increased access to various streams of training data. Knowing whether or not it is a fundamentally scalable is another matter, and will require close monitoring of these companies and their progress.

Fundamentally, the intersection concept relies on the meeting of internal ambition with outside investment. If crowdfunding and VC commitment holds, companies will continue to push into this currently untested market.



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