Blockchain and Ethics: A Brief Overview of the Emerging Initiatives

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Abstract. Blockchain is a distributed system that stores transactional data in a ledger-like, immutable, consecutive chain of blocks shared across a network of computers. Blockchain and other Distributed Ledger Technologies are believed to have significant impacts on society because they can help to improve transaction efficiency, reduce cost, build trust and improve transparency. These technologies could also be leveraged to build solutions providing individuals with more control over their data. However, these technologies could also have unexpected or even negative impacts. The aim of this paper is to discuss the impacts of blockchains and DLTs and to highlight some of the potential ethical issues that could affect design, implementation or use of the blockchain/DLT-based solutions. In this paper we also provide a non-comprehensive overview of the current initiatives dealing with the ethical context of blockchain and DLTs and we compare two blockchain ethical guidelines.

Keywords: Blockchain, distributed ledger technologies, ethics, ethical design, intentional design.

1 Introduction

Blockchain is a distributed system of digital ledgers which stores data in an ordered and connected chain of blocks, and which utilizes a consensus algorithm and cryptographic and security technologies to maintain the integrity of the system [8]. Although the first notable use case for blockchain has been bitcoin (see [32]), the range of the potential blockchain use cases has extended beyond cryptocurrencies. Gartner predicts that the added value of blockchain will grow to more than $3.1 trillion by 2030 [33]. Blockchain and other Distributed Ledger Technologies (DLTs) have a potential to reshape the existing value chains, transform business models and improve transaction cost efficiency [20]. Blockchain and DLTs provide mechanisms allowing development of systems that would provide individuals with more control over their data. Due to their capabilities to store immutable records of transactions, blockchain and DLTs are also believed to be able to improve transparency, reduce corruption or to help detect tax evasion [20].

Blockchain and DLTs can have significant impacts on society. However, the new possibilities and opportunities go hand in hand with responsibilities of those who

design, build and use the blockchain/DLT-based solutions. The aim of this paper is to discuss the impacts of blockchains and DLTs and to highlight some of the potential ethical issues that could affect design, implementation or use of the blockchain/DLT-based solutions. In this paper we also provide a brief overview of the current initiatives dealing with the ethical perspective of blockchains and DLTs. Among these initiatives there are two ethics guidelines specifically aimed at blockchain (see [3] and [30]). We compare these blockchain ethics guidelines in order to study how they approach the ethical context of blockchain.

The rest of the paper is structured as follows. The second chapter shortly discusses relationships of ethics and technology. The third chapter introduces blockchain, DLTs and their key characteristics. The two following chapters are dedicated to the impacts of blockchain and DLTs and to the current blockchain ethics initiatives respectively. Conclusions are provided at the end of the paper.

2 Ethics and Technology

Kranzberg [28] stated that technology is "*neither good, nor bad; nor is it neutral*" pointing out that technology always interacts with society, different values and institutions and the results of such interactions could be both positive and negative.

In the domain of computing, a discourse on computing and ethics has been going on since the mid-20th century [22]. Based on his analysis of various definitions of computer ethics, cyberethics and information ethics existing in the literature, Hall proposed the following synthesized definition of computing ethics: "*Computing ethics is the interdisciplinary and collaborative efforts of scholars and professionals to methodically study and practically affect the contributions and costs of computing artifacts in global society*" [22].

In 2015, Elon Musk decided to support the Future of Life Institute's artificial intelligence (AI) safety research program[1] with a generous donation [1]. His move helped to attract attention of the global media to the ethical concerns raised by the artificial intelligence and to the initiatives aimed at keeping AI safe and beneficial to humanity, such as the *Research Priorities for Robust and Beneficial Artificial Intelligence* proposed by Russell, Dewey and Tegmark [36]. In order to provide technologist, educators and policy makers with pragmatic recommendations and directions on ethical aspects and non-technical implications of the automated and intelligent systems, the Institute of Electrical and Electronics Engineers (IEEE) launched its Global Initiative on Ethics of Autonomous and Intelligent Systems which recently published the first edition of *Ethically Aligned Design* [24]. Similarly, the European Commission appointed the High-Level Expert Group on Artificial Intelligence[2], which prepared the *Ethics Guidelines for Trustworthy AI* [23].

The above-mentioned initiatives show that researchers, practitioners and policy makers are aware of the potential impacts of the autonomous and intelligent systems and they also highlight the importance of the intentional design through which the

[1] https://futureoflife.org/ai-safety-research/

[2] https://ec.europa.eu/digital-single-market/en/high-level-expert-group-artificial-intelligence

contributions and costs of such computing artifacts could be affected. We will show later in this paper that this approach is not unique to the domain of autonomous systems and artificial intelligence, but that a similar approach has been proposed to deal with the potential impacts of blockchain and DLTs.

3 Blockchain and Distributed Ledger Technologies

While the principle of blockchain comes from the original bitcoin paper, the word blockchain has not been mentioned in the paper [32]. The phrase "block chain" was probably first used in a crypto forum in November 2008 when discussing the original paper [4].

The principle of blockchain combines an undeniable chain of consecutive data blocks and a consensus algorithm, i.e. an algorithm of distributed social agreement on which last block is accredited and valid.

The chain of data blocks is realized by applying cryptographic hash function on a block of data, and then adding the resulting hash data into the following block. Thus, the content of any previous data block can't be questioned.

As the distributed agreement, the original bitcoin paper [32] states the so-called proof of work algorithm (PoW). This algorithm is performance-intensive, therefore other algorithms such as proof-of-stake were designed thereafter (see for example [39]). The principle of PoW is to choose the one block, of which hash meets specific requirements, which are difficult to meet. Then the subject, who aspire to create the next block in the chain, the miner, needs to spend some computing resources to "prove the work". As the hash is a one-way function, the hash of the new block must be created by guessing the (meaningless) part of the data, the so called nonce. By changing the nonce the miners generate numbers of hashes until one of them meets the agreed criteria. Thus, according to the rules, the entire society agrees which block is the next one. Other parts of the algorithm (beyond this paper) adjust the difficulty, frequency of blocks and the conflict resolution.

Originally, the consecutive data was chained in a linear sequel, but this is not strictly necessary. The data can be chained in more complex structures such as graphs. Therefore, a broader term Distributed Ledger Technology (DLT), of which the blockchain is a specific case, is used to denote technologies that enable development of distributed systems for storing undeniable records of data (see [9]).

The term ledger is used due the fact that the content of the block is usually a set of transactions representing transfers of cryptocurrency or other crypto-tokens from one address to another. The character of the data is thus similar to an accounting ledger. The data of the transaction is public. Every subject participating on the blockchain network can read and verify the validity of the blocks and all transactions, as long as the cryptographic hash function is safe (it is extremely unlikely to find a block with different content but the same hash).

The technology behind the transactions is based on a code processing, i.e. a cryptocurrency on specified address can be spend by subject, who can successfully execute a script code started on this address. The code can be executed only if the subject

knows a private key that corresponds to the address. Bitcoin, as blockchain has been originally intended for cryptocurrencies, has intentionally limited the script as not Turing-complete [2]. But achieving the Turing completeness (in the sense of [37]) is not only possible, but it has already been implemented e.g. by Ethereum. With the Turing-complete scripts the blockchain creates fully programmable virtual machine (EVM in the case of Ethereum) [10]. The programs running the EVM are called Smart Contracts. Such programs enable creating decentralized autonomous organizations (DAO) [11].

4 Blockchain Impacts and The Ethical Context

Blockchain is believed to have disruptive potential, yet Risius and Spohrer pointed out that research investigations "*into consequences of different technological variations, into the business value of blockchain systems, and into their management and organization are fairly scarce*" [35]. In this section we do not intent to provide a comprehensive overview of the potential blockchain impacts because this is one of the current research challenges, but we rather provide examples of the impacts of the technology in order to show that there is an ethical context of blockchain and its impacts.

The origins of the ethical context of blockchain could be traced back to the worldwide Cryptoanarchy movement started by May [31] (which [34] dates back to the year 1978) with the Crypto Anarchist Manifesto and also to the work of Diffie and Hellman [7], who introduced the public key cryptosystem. It addresses the basic need for privacy by a cryptosystem enabling message encryption, and it also states the right of people to use cryptography to ensure their privacy.

We can see that even the Nakamoto's original paper [32] tries to address an ethical issue. Nakamoto discusses the inherent weaknesses of the trust-based model of electronic payments via traditional financial institutions. He describes the possible frauds resulting from the impossibility of having complete irreversible transactions. This makes the subjects of the transactions, especially the sellers, vulnerable to mediating disputes. The blockchain shifts the trust from the financial institutions or from the recipient of the payment to the cryptographic technology.

The transaction irreversibility may be taken as a basic attribute of blockchain, as well as the main aspect which ensures that the society can trust the transactions. While the original blockchain keeps its irreversibility, the example of another important cryptocurrency, Ethereum, shows that the certainty secured by the technology, in the end, still depends on the people. Due to an error made in the design of a code of a DAO created by startup slock.it [40], hackers were able to steal currency valued about 150 mil. USD from 11,000 investors. Due to the huge impact, the community, by the votes of the majority, decided to roll back the blockchain to the block before the DAO was launched. However, a part of the community didn't agree and thus a fork occurred. From then, two separate blockchains exist, Ethereum and Ethereum Classic. The decision, which was itself ethically motivated, had also a huge moral impact, because it questioned the main principles of the blockchain technology and

undermined the trust of stakeholders in the code and made them dependent on the volatility of the voting majority. The technological consequences brought other ethical issues as well. The already spent coins were unspent and the original receivers lost funds they already received. The fork enabled future double spend frauds resulting from the fact that contracts before the fork are now executable in two branches. Wong and Kar [40] consider the situation as a moral hazard of bailout.

There is also an ethical context of the blockchain use cases and of the impacts resulting from the use of the technology. For instance, as a moral issue related to the possible widespread expansion of cryptocurrencies, Guttmann [21] predicts, that early adopters of Bitcoin or its successor cryptocurrencies could eventually become very rich, while the possible collapse of the traditional FIAT currencies would cause the majority to lose their assets. According to Dabrowski and Janikowski [6] cryptocurrencies will not challenge the major currencies in the near future; however, they admit that advances in technologies might make the cryptocurrencies more attractive and thus more competitive.

Kewell, Adams and Parry [27] propose the concept of "blockchain for good" and they view blockchain and DLTs as technologies that can contribute to the sustainable development agenda. On the other hand, there are concerns about the environmental impacts of blockchains using the energy-intensive PoW consensus algorithm [29].

From the perspective of the Hall's definition of the computing ethics, the design of Bitcoin could be seen as motivated to provide a solution capable of reducing some cost incurred by society. The other examples illustrate that the features of blockchain, such as the immutability, as well as the blockchain use cases could raise new ethical concerns.

5 A Brief Overview of The Blockchain Ethics Initiatives

5.1 Institutions and Projects

The European Commission has launched several initiatives to promote and support blockchain and DLTs [16], e.g. the European Blockchain Partnership [18], or the European Blockchain Observatory and Forum (EUBOF) [12]. The EUBOF has already published a set of thematic reports[3], and even though none of them has ethics as its main topic, some of them are relevant to the ethical context of blockchain. For instance, reports addressing privacy in the context of the General data protection regulation (GDPR) [14] or digital identities [13] have been published. In the *Blockchain Innovation in Europe* report [15] the authors argue that blockchain is not just a technology but that it brings a new mindset as well. They also point out that blockchain can be an enabler of a real-time electronic voting which could facilitate direct democracy. However, they add that direct democracy might be associated with the risk of the tyranny of the masses and they emphasize the importance of the checks and balances as the key element of the modern democracies. The authors also point out that

[3] https://www.eublockchainforum.eu/reports

as an enabler of decentralization and disintermediation, blockchain might "*catalyse a re-thinking of the role of middlemen in many industries and contexts, forcing a re-pricing of their services*" [15]. In the context of e-government, blockchain could also add to the debate about the extent to which the public services should be digital [15].

The European Commission also helped the industry to set up the International Association for Trusted Blockchain Applications (INATBA) [17, 25]. INATBA's aim is to "*bring together all those stakeholders committed to a shared vision that through continued collaboration and openness they can promote interoperability, transparent governance, legal certainty and trust in services enabled by blockchain and distributed ledger technologies (DLT), ultimately leading to high levels of sustainable economic growth*" [26]. This aim can be viewed as a collaborative effort to study and affect the contributions of blockchain and DLTs to society. INATBA has not published any outcomes yet, as it has only been established recently. However, given the aim of the association, its outcomes might be relevant to the ethical context of blockchain in the future.

Blockchain and DLTs can contribute to the sustainable development agenda [27]. Funded under the Horizon 2020 program, the European Commission has launched the *Blockchains for Social Good* Horizon Prize in order to support development of the blockchain/DLT-based solutions that would help to deal with local or global sustainability challenges [19].

Under the United Nations World Food Programme (WFP) the *Building Blocks* pilot is running [41]. Building Blocks uses blockchain for authentication and registering of transactions of the WFP beneficiaries. For example, thanks to the technology refugees in two camps in Jordan can redeem their allowances with an iris-scan instead of the easily lost food vouchers [41].

Climate Chain Coalition is an open global initiative that aims at using blockchain, DLTs and other technologies such as Internet of Things and Big Data to enhance measurement, reporting and verification of the climate actions, and to mobilize climate finance [5]. Besides these contributions the climate action, according to the United Nations Climate Change secretariat blockchain and DLTs could improve its transparency, traceability and cost-effectiveness, they could help to build trust among the involved actors and make the climate action incentives accessible to the poorest as well [38].

5.2 Blockchain Ethics Guidelines

Blockchain Code of Ethics. The *Blockchain Code of Ethics* is an initiative that attempts to create a code of conduct for ethical blockchain companies [3]. According to the *Declaration of Blockchain Code of Ethics* such companies should be accountable to values such as humanity, individuals' data, the planet, transparency or freedom [3]. Even though this initiative does not provide any comprehensive guidelines for the ethical blockchain companies yet, it tries to formulate a set of principles such companies should follow.

Blockchain Ethical Design Framework. The *Blockchain Ethical Design Framework* [29, 30] goes beyond principles as it tries to provide an actionable framework for design and use of the blockchain/DLT-based solutions that aims to address both positive and negative social impacts of such solutions. The authors emphasize that intentional design is important in general, but they consider it to be a crucial element of the solutions leveraging blockchain or DLTs because of the significant impacts they might have on society.

The first phase of the framework consists of five steps at which the problem and the desired outcome should be defined, the ethical approach identified, the outcomes assessed, and the design philosophy determined [30]. The objective of the last step is to determine if blockchain is an appropriate technology. The framework provides the decision makers with a set of questions that could serve as a supportive tool when making the choice about the technology.

The second phase of the framework is dedicated to the design and implementation of the solution. According to the framework, the following root issues for ethical consideration should be analyzed: governance, identity, verification and authentication, access, ownership of data, and security [30]. For each of the issues an overarching question is formulated, and definition of the corresponding concept is provided together with the key design and assessment considerations.

During the third phase of the framework, the maintenance phase, steps from the previous stages should be periodically revised and repeated [30].

Comparison of the Identified Blockchain Ethics Guidelines. Table 1 briefly summarizes the concept of the *Blockchain Code of Ethics* and the *Blockchain Ethical Design Framework* and it compares the guidelines with regards to their structure and to the concerns they aim to address.

The *Blockchain Code of Ethics* [3] has a form of a code of conduct structured into a preamble which lists the values ethical blockchain companies should be accountable to, and a decree which states the rules these companies should follow. The rules are brief, pointing out the key principles rather than trying to provide specific guidelines as to what actions the companies and the involved individuals should take.

Authors of the *Blockchain Ethical Design Framework* [30] took a different approach and focused on the lifecycle of a blockchain-based solution which they decomposed into phases and steps. For each of the root issues for ethical consideration the framework provides an overarching question, a definition, and a set of key design and assessment considerations. For each of the root issues there is also a set of additional questions provided that should be answered during the design and implementation of the blockchain-based solution.

Table 1. Comparison of the blockchain ethics guidelines, source: based on [3] and [30]

Attribute	The Blockchain Code of Ethics	The Blockchain Ethical Design Framework
Authors	Blockchain for Good	Cara LaPointe and Lara Fishbane of the Beeck Center for Social Impact + Innovation at Georgetown University
Concept in brief	Code of conduct for ethical blockchain companies intended to hold organizations accountable to a set of values	A framework for an intentional design of blockchain-based solutions aimed at addressing root issues for ethical consideration
Structure	Preamble and decree	A blockchain-based solution lifecycle consisting of phases and steps
Concerns addressed	Values: • Humanity • Individuals data • Stakeholders • Value creators • The planet • The economy • Diversity • Transparency • Freedom • Future technologies • Community • Integrity	Root issues for ethical consideration: • Governance • Identity • Verification and authentication • Access • Ownership of data • Security

Both of the identified blockchain ethics guidelines differ in their concept, i.e. they try to address the ethical context of blockchain from different perspectives. The *Blockchain Code of Ethics* emphasizes a certain set of values the blockchain companies should honor, whereas the *Blockchain Ethical Design Framework* stresses the need for the design of the blockchain-based solutions to be intentional, and it provides those involved in design and implementation of the blockchain-based solutions with guidelines that should help them to determine if blockchain is an appropriate technology and to understand the effects of the root issues for ethical consideration. However, we view these blockchain ethical guidelines as complementary rather than competing approaches to the blockchain ethical context because the values honored by the *Blockchain Code of Ethics* could serve as the starting point when defining the desired outcomes of some blockchain/DLT-based solution or when identifying the ethical approach as recommended by the *Blockchain Ethical Design Framework*.

6 Conclusions

Blockchain and DLTs have received a lot of attention recently and the discussion of their potential use cases results in great expectations. However, as any other technology, blockchain and DLTs are non-neutral and the outcomes of their use can be both positive and negative. These technologies, and the systems leveraging them, could be a contribution to society, as well as they can result in economic, societal or environmental cost.

In this paper we illustrated the ethical context of blockchain with several examples. The motivation behind the first notable application of blockchain, Bitcoin, was to address an ethical issue, however the presented examples also show that the attributes of blockchain such as immutability could also raise new ethical issues. With regards to the use of the technology some authors warn against the potential negative impacts of blockchain and DLTs such as the codification of negative social impacts or the risk of transparent and immutable personal data [30]. In order to promote the use of the technology to deliver outcomes beneficial to the sustainable development agenda, Kewell et al. proposed the concept of "blockchain for good".

Because the use of blockchain and DLTs could have ethical consequences, there is a need for blockchain ethical guidelines that would help the stakeholders to understand these consequences and the impacts of their design decisions. We also agree with Risius and Spohrer [35] that more research on the value creation and management of the blockchain/DLT-based solutions is needed. The expectations are high, so the future research should focus on identifying the application areas where the technology delivers the real value. The ethical context should not be omitted, i.e. contribution and cost of the technology should not be analyzed just from the economic or business perspective, but the wider societal and environmental impacts should be considered as well.

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