Editor's Note

Towards Blockchain Intelligence

In 2008, Satoshi Nakamoto introduced the Bitcoin [1], the first cryptocurrency that had a significant impact in the financial scene. This currency relied on some technological innovations, including a cryptographic mining system and a distributed database with interesting properties, deemed "the Blockchain".

At its core, Blockchain is a database able to store a list of entries, implementing some cryptographic mechanisms that prevents stakeholders from being able to tamper its contents. This is achieved by storing data in blocks, which are summarized using a hash function and linked to each other (therefore the term "Blockchain"). Additionally, Blockchain is often presented in a decentralized and distributed implementation, which can be public. Therefore, it can be used as a digital ledger to record transactions across several (potentially many) computers, so that these transactions cannot be altered, at least without needing to tamper all subsequent blocks (therefore, producing a massive alteration that could be easily detected).

Although initially engineered to support the development of a cryptocurrency, throughout the last decade Blockchain has found its way through many different fields of application, both inside and outside the financial world, where the need for immutability and security has thrusted its deployment. Recently, several literature reviews have been published describing some of these fields of application [2], [3], [4], [5], [6].

Additionally, with the introduction of the Ethereum Platform in 2014 [7], the concept of "Smart contracts" arose, as a method of automatically enforcing the execution of the terms of a contract when its conditions are fulfilled by transactions executed in the blockchain.

With the integration of smart contracts, Blockchain technology has enabled companies to consolidate multiple repositories of customer and supplier information into a single data warehouse. Since it uses algorithms to ensure that transactions are valid and authentic, it can help improve processes involving multiple parties. Also, it contains the complete history of all the transactions that have been carried out on the network, along with their time stamp. Therefore, this record can be accessed at any time knowing that this information is fully updated [8].

In any case, although the theoretical foundations of the blockchain are well known, the technology is recent enough as to remain in the peak of innovation, where many new applications of it are being discovered and presented every day. Blockchain improves processes (both in cost and time) as well as allowing hitherto unimaginable scenarios. For the industry, the blockchain enables an improvement in the efficiency and effectiveness of the supply chain. This provides up-to-date and easily accessible documentation on how materials are obtained, purchased, recorded, and used [9].

Due to the origins of the technology, the financial services sector is probably the one that will be able to benefit more quickly from the use of blockchain, by allowing financial transactions between two participants in a safe, reliable and irreversible way. One of the main advantages would come from the supply side, by being able to improve the service catalog. Many of the processes that are currently manual could be automated and speeded up, so new products and services that are currently unfeasible or unmanageable can be offered. Blockchain is a tool that simplifies relationships between large companies and their suppliers, assigning them digital identities that save time and effort by eliminating all the paperwork involved in starting a collaboration between entities, and the introduction of smart contracts can simplify the bureaucratic processes.

In summary, the advantages of the Blockchain technology for the financial sector can be specified in the following aspects:

- Efficiency: Savings in transaction costs, which makes information reconciliation processes more efficient.
- Security: Distributed records allow to verify transactions and collaboration on different nodes ensures their authenticity.
- Transparency: The identities of blockchain users can be cryptographically protected, allowing the system to be completely transparent.
- Accessibility: Can be implemented as a public platform, so any authorized user can obtain a copy of the registry.

In the public administration sector, the possibilities of blockchain technology are enormous. Those responsible for public institutions could ask the following question: How can you create a government on the web that brings institutions closer to citizens? The Blockchain-based public administration model would lead to a decentralized government in which one could even think about the possibility that the vote in an election was done electronically. But to get to this point, it is necessary to implement a series of measures that will compel the citizen to become part of that digital society.

In the real estate field, the possibilities unveiled by the Blockchain have also proven its usefulness by accelerating disruptive processes and rethinking business models. How can a real estate developer use this technology? Two concepts are the key to its implementation: efficiency and elimination of unnecessary intermediaries. If we want to sell a building to a foreign investor, the process is usually very opaque, with many intermediaries, and we do not know the buyer until the last steps of the process. One opportunity is to tokenize assets (with a token being a unit of value issued privately). Each home would then be a token that can be shown to investors so that they have all the information available about the status of the project at all times.

The legal sector is also making progress in taking profit from Blockchain. A particular and original example that can be cited is that of a company in the sector that has resorted to issuing tokens, which in this case are nothing more than hours of legal advice. These tokens are channeled to a foundation that is in charge of working with disadvantaged groups. Subscribers can choose to which wallet they send the tokens and these are destined to the projects of the foundation. In this way, traceability, transparency and visibility of when and how the funds designed to support different projects with social content are used.

Although some of the Blockchain's underlying capabilities provide data confidentiality, standards need to be adopted for organizations using Blockchain in order to protect their organizations from external attacks. In any case, Blockchain technology can be used to protect systems and devices from attacks and improve cybersecurity across industries. Additionally, with a distributed Blockchain, there is no longer a centralized authority controlling the network and verifying the data going through it.

As a result, it should be noted that Blockchain is a technology with enormous possibilities. However, because of it being relatively recent, the regulatory factor has not yet been consolidated. An example of a legal issue that can be formulated regarding the Blockchain is how to make the right to be forgotten compatible with

a distributed registration technology in which information lives in innumerable nodes? Problems as this arise that may be incompatible with data protection regulations.

More importantly, data stored in Blockchains might constitute a priceless resource for numerous data analysis and intelligence applications. In a scene where machine intelligence relies more and more in huge amounts of data, we cannot underestimate the importance of this information. In some cases, even the Blockchain can be designed so that its inner workings be used to empower an artificial intelligence system [10].

In this special issue, we want to gather some innovative applications that are currently pushing forward the research on Blockchain technologies. In particular, we are interested also in those applications that put the focus on the data, enabling new processes that are able to leverage relevant knowledge from the data.

As stated before, the earliest and most well-known field of application of Blockchain is finance. In this context, it is reasonable to expect that there are some proposals that suggest the hybridization of Blockchain technologies and banking. In this issue, Arjun and Suprabha study the literature to conclude some of the most relevant innovations of Blockchain in banking, as well as the biggest challenges up to date.

Another field of application with a huge potential is healthcare, but it is crucial to put the focus on security and privacy when it comes to storing health-related data from patients. In this issue, Jennath et al. propose a solution based on Blockchain to store health records while addressing privacy concerns, finally outlining the potential of building artificial intelligence models over the e-Health data.

Of course, Blockchain turns out to be a great alternative for those applications requiring to store lots of data that are generated as a result of business-to-business interactions and where some rules must be executed based on certain transactions. This is the case of affiliate systems, where certain fees or deals must take place as a result of established agreements, and the promise of an immutable ledger brings trust to the ecosystem. In this issue, Baldominos et al. present Blockverse, a platform relying on a cloud stored Blockchain that allows tracking in affiliate systems, allowing the computation of advanced analytics and proposing some lines for the construction of intelligent systems relying on the data recorded.

Additionally, Blockchain can also be used to enhance integrity and efficiency on the cloud when it comes to data storage. In particular, this is proved by El Ghazouani et al., who present a cloud storage solution implementing deduplication and auditing mechanisms, while relying in a Blockchain implementation.

But Blockchain is also called to revolutionize other professional fields, such as journalism. In particular, the work by Jurado et al. proposes mechanisms for guaranteeing the traceability of news from their origin, analyzing their evolution and easing fact checking. This work has a potential impact towards improving transparency in the media.

The wideness of application of Blockchain extend even to the countryside, where it can be used to support a pest management system. This use case is described by Lopez et al. in a paper gathered in this special issue, where the architecture of a system for intensive farming is presented, including the ability to detect environmental conditions that might lead to the appearance of pests.

The potential of cross-fertilization of Blockchain and artificial intelligence can also have a direct impact in the security of small and medium enterprises. Such a system is proposed by Lopez et al. in their work, where a platform relying on Blockchain technologies would be in charge of detecting cyberattacks and, if necessary, containing the attack and easing the recovery after the attack takes place.

But Blockchain can also be used beyond banking, enterprises and particulars. As Triana et al. illustrate in their paper, Blockchain along with smart contracts are an extremely useful resource to enhance trust and transparency in the public sector, reducing or preventing corruption and improving efficiency in many bureaucratic procedures.

This special issue will be successful if readers gain a better understanding on how Blockchain can be applied to very diverse areas, and might even be interested in designing, implementing and deploying an innovative solution to a completely different field of knowledge. In such case, the final paper of this SI, published by García-Sáez, can be of special relevance to the avid readers. In this paper, the author put a critical lens on top of Blockchain development and argues the challenges for startups when running a Blockchain solution, posing strategical recommendations to enhance the chance of success.

We hope this Special Issue can provide a better understanding and key insights to readers on how Blockchain and artificial intelligence are cross-fertilizing to revolutionize many aspects in our societies.

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