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***Blockchain 4 AI***

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**In collaboration with**



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# Summary

<b>1. Background .....</b>	<b>9</b>
<b>a. Blockchain .....</b>	<b>9</b>
I. What is Blockchain? .....	9
II. Blockchain 1.0 .....	11
III. Blockchain 2.0.....	13
IV. Blockchain 3.0 .....	15
V. Public vs. Private vs. Consortium.....	16
VI. Market Space .....	20
VII. Business Areas .....	22
<b>b. Artificial Intelligence .....</b>	<b>25</b>
I. What is AI? .....	25
II. AI Technologies .....	27
III. Market space .....	29
IV. Business Areas .....	32
<b>c. Blockchain meets AI .....</b>	<b>36</b>
I. Problem Statement (AI).....	36
II. Problem Statement (Blockchain) .....	36
III. AI 4 Blockchain or Blockchain 4 AI? .....	37
IV. Research questions .....	37
<b>2. Methodological Overview .....</b>	<b>39</b>
<b>a. Systematic Literature overview.....</b>	<b>39</b>
I. Blockchain and AI Literature .....	39
<b>b. Case Study research .....</b>	<b>39</b>
II. Sampling .....	40
III. Triangulation of the information sources .....	42
IV. Cross-case analysis.....	42
<b>3. Case studies.....</b>	<b>43</b>
I. Ocean Protocol.....	43
II. SingularityNET.....	45
III. Doc.AI .....	47
IV. Numerai .....	48
V. DBrain .....	50
VI. Effect.AI .....	52

VII.	ATN.io.....	54
VIII.	Oben.....	57
IX.	DeepMind (Google).....	59
X.	IBM.....	60
XI.	Fetch.AI .....	61
<b>4.</b>	<b>Cross case analysis.....</b>	<b>65</b>
a.	Strategic positioning.....	65
b.	Short List analysis.....	68
c.	Blockchain 4 AI .....	71
I.	ICO and funding.....	71
II.	Create value to join data and algorithms .....	73
III.	AI DAO .....	79

## Indice Figure

Figure 1 Layers in the technology stack of the Bitcoin blockchain (Swan, 2015) .....	11
Figure 2 Cryptocurrencies Ecosystem [3] .....	12
Figure 3 Public vs. Private [19] .....	19
Figure 4 Blockchain Market Size [23].....	20
Figure 5 ICO growth [24] .....	21
Figure 6 Blockchain Market Map [25] .....	22
Figure 7 Blockchain opportunities in Industrial sectors.[27] .....	23
Figure 8 Timeline of the financial services that enter in blockchain market[29] .....	24
Figure 9 AI definitions (Russel & Norvig, 1995).....	25
Figure 10 AI revenues [33] .....	30
Figure 11 AI 100 start-ups 2018 [34] .....	30
Figure 12 USA vs.China [36] .....	31
Figure 13 AI revenues by application[37] .....	32
Figure 14 AI economic value [40].....	35
Figure 15 From the universe set to long list .....	41
Figure 16 Sampling.....	41
Figure 17 Decentralized Data Hub .....	43
Figure 18 Galaxy Pool operations .....	54
Figure 19 Fatch.ai layers.....	63
Figure 20 Shortlist matrix .....	69
Figure 21 Total fund raised (CBInsights, 2018).....	72
Figure 22 Total startups financed (CBInsights, 2018).....	72
Figure 23 VC and ICO funding [62].....	72
Figure 24 Obstacles to data sharing according to the survey results (European Commission, 2018).....	74
Figure 25 Standardization and commoditization in tech. [72].....	79
Figure 26 AI development timeline [75] .....	81
Figure 27 Matrix .....	92
Figure 28 Industries .....	93
Figure 29 DL Ownership .....	94
Figure 30 Underline Infrastructure .....	94
Figure 31 Timeline.....	95

Figure 32 Timeline (2)..... 95

**Indice tabelle**

Table 1 ICO vs. VC documents ..... 73

Table 2 Blockchain mitigation actions (1)..... 77

Table 3 Blockchain mitigation actions (2)..... 77

Table 4 Long List..... 96

# Introduction

The argument of this thesis stems from the fact that, as often happens in the technological world, the advent of a new technology has a disrupting effect on the market in which it bursts. This is exactly what happened with the advent of the blockchain, which was created in 2008 as an underlying Bitcoin infrastructure, and since then it has spread and spread, both in the financial sector and in many other sectors, raising questions that were never been revealed, and proposing solutions that until then were absolutely unthinkable. For example, the idea that intermediaries can be considered as an absolutely superfluous cost, and that there may be a technology that deals with doing the same 'work' automatically, is certainly something shocking and innovative. Or even the idea that a contract is no longer a piece of paper signed by two people, but something digital that allows signing an agreement, without even having ever seen the other party, was something absolutely unthinkable.

But blockchain is such a versatile technology that stereotyping it only as an 'electronic intermediary' or a 'payment infrastructure', so to speak a new generation credit card, would be absolutely reductive. The blockchain is certainly a very important aid to allow other technologies to be based on something real, verifiable and immutable. And it is precisely at this point that the thesis in question is inserted. In fact, it was realized that certain ferment began to exist at the intersection between blockchain and artificial intelligence (AI), another leading technology in the modern scene. The need to investigate the potential that these two innovations allowed together led to the decision to carry out extensive research on the topic.

In the following chapters, there is a focus on the market at the intersection between blockchain and AI. In the first place, to clarify what these two technologies are today, both from the technical point of view and from the point of view of the market, underlying each technology. Then we focused on the market at the intersection of the two, considering it absolutely interesting and strongly increasing. Obviously one of the questions that arose almost immediately is: how one technology influences, optimizes and / or enhances the other? In the end, it was decided to dwell on the contribution that the blockchain is giving to AI and not vice versa, the choice stems from the fact that preliminary researches have shown that this verse was the most interesting, and

with greater growth prospects. After clarifying all the surrounding space, and having aimed the magnifying glass on the intersection market, it was decided to explore who were the main players on this market. Obviously the analysis that was carried out is mainly qualitative, so it was decided that the case study method was the most suitable for the continuation of the analysis. In fact, after having drawn up a 'long list', through the sampling, which characterizes the aforementioned method, we arrived at the 11 companies that make up the short list. The analysis of the 4 archetypal strategic positions has resulted from the in-depth analysis of the offers, projects and newborns and often fragmented business models of the aforementioned companies. Finally, since the sector is profoundly new and often unexplored, the last part of the thesis was certainly the one that leaves more room for the ideas that the author made during the study, at that point the readers entered on the hypothesis space. Trying to gather all the pieces of the puzzle, the last paragraph of the last chapter pulls the strings of all the study, that characterized the thesis itself, and also takes a last step into the void. Moving slightly away from the available literature, we propose a personal and debatable vision of the future that awaits this market, trying to inculcate a real added value to the discussion.



## 1. Background

Before looking at the intersection of Blockchain and AI, it is advisable to concentrate on them separately. In order to clarify the technical features, the practical applications and the market space, which defines these two important technologies, it was decided to insert an introductory paragraph for each, and an additional one that introduces the intersection of these two worlds.

### a. Blockchain

#### I. What is Blockchain?

*“The Blockchain began life in the mind of Satoshi Nakamoto, the brilliant, pseudonymous and so far unidentified creator of bitcoin—a “purely peer-to-peer version of electronic cash”, as he put it in a paper published in 2008. (...) To fulfil Mr Nakamoto’s dream of a decentralised system the avoidance of such abuses had to be achieved without recourse to any trusted third party, such as the banks which stand behind conventional payment systems.” [1]*

Blockchain was born in October 2008 by Satoshi Nakamoto as part of Bitcoin. Using a virtual currency called bitcoin and the blockchain he create a new financial system that is not controlled by a central authority. Bitcoin was the first application of blockchain technology, but the most important invention is exactly the infrastructure, which was created to use a new kind of protocol for a peer-to-peer electronic cash system (Tapscott & Tapscott, Blockchain Revolution , 2016).

In a technical point of view, the blockchain system is a distributed ledger replicated in many identical databases, hosted in computers positioned around the world. When someone changes information in one of those copies, all the other duplicates are updated simultaneously. In this way, all transactions that occur on a blockchain cannot be changed without any evidence in the ledger. For this reason, it is not necessary to have third-party intermediaries to verify or transfer ownership, all transactions take place within a few seconds, in a secure manner and could be easily verified (Harvard University). Intermediaries like lawyers, banker and brokers will no longer be necessary, people and even

organization will be able to operate independently. This is the enormous potential of the blockchain technology (Lakhani & Iansiti, 2017).

The security of the blockchain is guaranteed by a consensus mechanism, merger between mathematic and computational forces. It is called Proof of Work (PoW), and that of Bitcoin is so defined “ *PoW involves scanning for a value that when hashed, such as with SHA-256, the hash begins with a number of zero bits.* ” (Nakamoto, 2008). In the traditional hascash mechanism users must solve a cost function and produce a string that can be used as PoW (Liu, 2007). Nakamoto uses this idea for the validation of the blocks in the chain.

Thanks to this security mechanism, contracts, transactions and registries can be managed automatically and in a verifiable and permanent way. Due to this reason, the potential of blockchain, which was born as a finance application, will be a good solution and will represent a radical change in all sectors (Gupta, 2017).

Blockchain is not a disruptive technology, is a foundational technology; in fact it will create new foundations to economy and social system without attacking traditional business models, on the contrary disruptive technologies are characterized by new business models with a lower cost solution, and that kill the incumbent companies in the short-term. (Lakhani & Iansiti, 2017) Blockchain was created as an instrument that can help people on managing the transactions without the help of middleman, and introducing this solution in their business models, companies can increase the goodness of their offering by reducing the cost of search, coordination and communication. (Tapscott & Tapscott, 2016)

The blockchain revolution is seeing as an essential part in the development of the “Internet of value” [2], in fact the second generation of Internet is focused on value as well as information, and the blockchain is an important aid to transfer value without having to resort to a third trusted part. For example, by creating a better sharing economy, demand and offer could be matched without paying intermediaries fees. (Tapscott & Tapscott, 2016)

The blockchain revolution could be compared to that made by TCP/IP protocol and the subsequent advent of the Internet. (Joichi , Narula , & Robleh, 2017) There are many analogies between the two; in fact, the blockchain creates also an open and public network without central authority for his livelihood. In

parallel the “traditional” telecommunications looked at computing sectors dubiously, and now the financial sector is skeptical about the blockchain development. Finally, the Internet has lowered the cost of connections, in a similar way blockchain aims to reduce the cost of transactions. (Tapscott & Tapscott, Blockchain Revolution , 2016) Knowing all this salient points, it is possible to conclude that, if between the end of 80s and the end of 90s, the number of organizations that created their private networks grew exponentially, it is very probable that in the coming years many companies will use private or public blockchain. (Tapscott & Tapscott, Blockchain Revolution , 2016)

## II. Blockchain 1.0

For long time there has been confusion in the characterization of blockchain technology. For example the word Bitcoin has been used with many different senses, summarized in the figure sotto. The importance of blockchain as a stand-alone technology, was recognized many years later the born of Bitcoin, with the 2.0 and 3.0 blockchain generations.

Cryptocurrency: Bitcoin (BTC), Litecoin, Dogecoin  
Bitcoin protocol and client: Software programs that conduct transactions  
Bitcoin blockchain: Underlying decentralized ledger

**Figure 1 Layers in the technology stack of the Bitcoin blockchain (Swan, 2015)**

After the introduction of the first project, many different cryptocurrencies were born, some using their own infrastructure and some other using the Bitcoin blockchain (some examples are shown in the figure sotto). But in any cases the blockchain was just a tool to create and run cryptocurrencies.

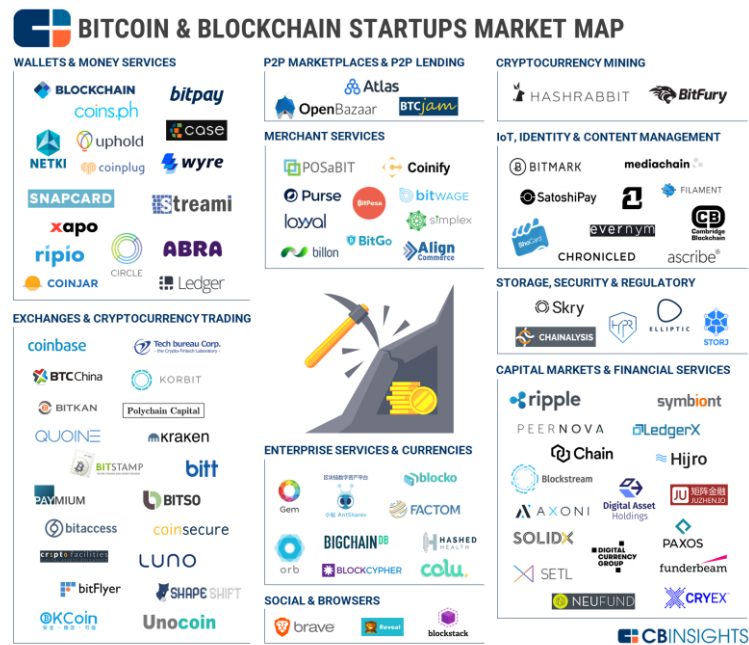


Figure 2 Cryptocurrencies Ecosystem [3]

Until the invention of the blockchain, the money transactions must be controlled by a trusted third party (bank for example), because without a central intermediary, it was impossible to certify that the money has not already been spent (double-spend problem). (University of New South Wales, 2017) The new invention solves this problem by combining a peer-to-peer file sharing technology with cryptography. This revolution is also called “a new kind of trust” [4] because people do not have to trust to the other party to make transaction, they simply have to trust the system: the blockchain protocol software system, [5] which validates all the “blocks” creating an inviolable “chain”.

Analyzing practically the use of a classic blockchain 1.0 platform (for convenience in the example it will be used the Bitcoin characterization, as it is the most widespread and representative). The single user needs: an address, which is the reference that others need to send him bitcoins, a private key that must be used to send bitcoins to the other users and finally a wallet software that is used to manage bitcoins on the computer. Digital cash is connected to the address, if someone has a private key can use the cryptocash from any computer connected to the Internet. For this reason, it is very important to keep the private key secure, because it also represents an identity key for the system.[6]

The biggest advantage is that blockchain is a push technology [7] because users push information to the network to make transactions, as opposed the pull technologies, such as banks or credit cards, in which user information must be pulled every time. Credit cards have not been developed to be secure on Internet, so they can be vulnerable to hackers. On the contrary, blockchain technology has been designed to operate in total security on the Internet. But blockchain is not just a better version of credit cards, currency and payments is only the first step of development, (Swan, 2015) the core functionality is the decentralization of Internet transactions is this the property that led to Blockchain 2.0.

### **III. Blockchain 2.0**

*“Whereas Blockchain 1.0 is for the decentralization of money and payments, Blockchain 2.0 is for the decentralization of markets more generally, and contemplates the transfer of many other kinds of assets beyond currency using the blockchain, from the creation of a unit of value through every time it is transferred or divided.” (Swan, 2015)*

Recalling the analogy with the TCP/IP protocol, Blockchain 2.0 could be compare to all the protocols build on top of it (HTTP for example). The new generation of blockchain exploits the consolidated model of 1.0, being also structured on the same three layers: blockchain, protocol and cryptocurrency. The potential of blockchain brings to reality the utopic idea that it is possible to register, confirm and transfer all kind of contracts and property on Internet. (Wood, 2014) For example, it is possible to register public records like: land and property titles, vehicle registrations, business licenses, and also marriage and death certificates.

The central idea is to give the possibility to register tangible assets as digital, and therefore make online all the transactions that until now have to be done with the help of an intermediary; for example, after the registration, is possible to sell an asset by giving the private key, (known as *smart property*) (BitFury Group, 2016)

The most important “invention” linked to the second generation blockchain is the smart contract, in the following paragraph it will be defined and the main characterization will be analyzed.

### Smart Contract

In the ordinary meaning, contracts are documents that allow two or more parties to do something or not in exchange of something else. In this sense, contracts must be based on trust between the parties, necessary to believe in the agreement. The smart contract simulates the same accord between the parties but overcomes the problem of trust. This can happen only because it is both defined and executed by the code, and everything is done autonomously without discretion. (Kosba, 2016) “Code is law” says that code will be executed in any case (Lessig, 2000), this could be good or bad depending on the scenario, but it is always guaranteed. A real problem is that human and smart contract cannot be managed on the same way, for example in regulation. Human contracts are more flexible because they are at the discretion of human operator. Therefore it is necessary to decide which kind of contracts the society wants to be executed like “code law” and which ones must be executed in a more flexible way. The smart contracts had three core elements: *“Autonomy means that after it is launched and running, a contract and its initiating agent need not be in further contact. Second, smart contracts might be self-sufficient in their ability to marshal resources—that is, raising funds by providing services or issuing equity, and spending them on needed resources, such as processing power or storage. Third, smart contracts are decentralized in that they do not subsist on a single centralized server; they are distributed and self-executing across network nodes.”* (Swan, 2015)

Over time, smart contracts became very complex and autonomous, and now some of them are coded to perform special services:

- Dapps (Decentralized Applications) have three peculiarities. First, the application is open source, it operates autonomously and all its data must be stored in a public blockchain. Second, the application generates tokens according to a standard algorithm and some of them are distributed at the beginning of its operation. Third, all changes and improvements to the app, must be decided by the consent of the majority of users. [8]

- DAO and DAC (decentralized autonomous organization, decentralized autonomous corporations) in these cases a decentralized network of autonomous agents, carrying out tasks, which can be considered in the model of a society that operates without human involvement, using only a set of business rules. (Buterin, 2014)
- DAS (decentralized autonomous societies) the project became a stand-alone entity with some standardized smart contracts, self-bootstrap software to crowd fund itself, receive feedback through blockchain, and eventually dissolve. (Garrod, 2016)

#### IV. Blockchain 3.0

The battle for what will be the emblematic name of the blockchain 3.0 is still fighting, but in any case, the new generation must solve, at least, an important problem of the previous to establish itself as a standard. [9] For example in Bitcoin it is not possible to create two or more blocks at the same time, all the transactions that occur at the same time are stored on the same block; finally, miners (are people who complete the process of adding transaction records to Bitcoin's public ledger of past transactions) [10] compete for validation of the block.

*Definition: "DAG is a directed graph data structure that uses a topological ordering. The sequence can only go from earlier to later. DAG is often applied to problems related to data processing, scheduling, finding the best route in navigation, and data compression."*[11]

In a new concept of blockchain, it is possible to check multiple blocks at the same time. The DAGs create side-chains, which allow having different transactions on different chains simultaneously. For this reason, DAG is very important for the applications that have to confirm thousands of transactions per second. In this case, in fact, the transactions can be approved about instantly.

The DAGs continue to advance, more chains and applications are built every day, thanks to its scalability and transactions in real time, which are remunerated with minimum fees. For this reason, it is possible to send micropayments without having to pay high commissions as in Bitcoin or Ethereum. However, it is not yet possible to say which application will win the race to produce the fastest DAG based blockchain.

In conclusion, the most important features of Blockchain 3.0 are: real-time transactions, scalability, and unlimited decentralized storage. [9]

## **V. Public vs. Private vs. Consortium**

An general distinction is often made between different kind of blockchain: permissionless, permissioned and consortium. Each type of blockchain is defined by some peculiarities, and it is important to know this characterization before choosing the best suited to a particular project or company.[12]

### Permissionless (Public)

In a permissionless blockchain, anyone can access information, view the register of validated transactions and participate in the consensus procedures. Public blockchain usually use PoW or PoS mechanisms and, by following the rules, everyone can be remunerated for their work. The whole system is completely open and transparent, but the identity of each node is protected by strictly privacy, and trust emerges from the game-theoretical incentives. Indeed, the public blockchain is considered totally decentralized. (Mattila, 2016)

### Private (permissioned)

The private blockchain has limited access and permission, in this case, typically a trustworthy agent is required that reaches the consensus, even in blockchain that using the same technology as the public one. In addition all the participants of the network are known.

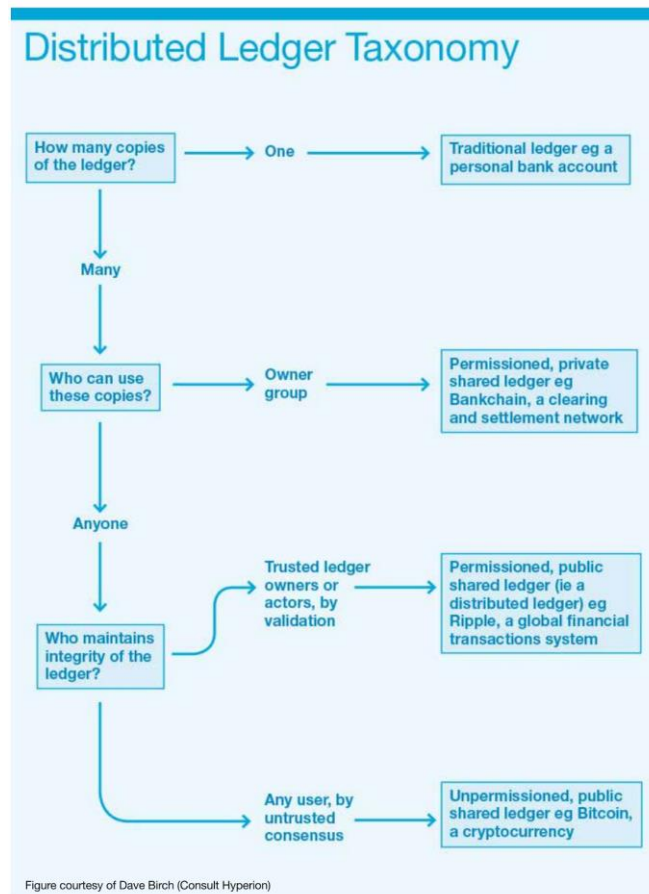
This could be the best solution for companies that introduce blockchain to manage a shared encrypted database. (Mattila, 2016)

### Consortium

This is the solution between the two extremities. In consortium blockchain, the possibility to validate the blocks is only provided to some nodes, but the access to data on the ledger is possible for everyone. [12]

To better understand the differences between these blockchain categories, which are explained in the sotto, it is possible to introduce some examples :





**Figure Distributed Ledger Graph [13]**

**Bitcoin:** The "bitcoin.org" domain name was registered on 18 August 2008. In January 2009 Nakamoto implemented and released the bitcoin software as open source code. The Bitcoin blockchain is a *public* ledger that records the bitcoin transactions (bitcoin is the cryptocurrency connected to the blockchain). It is built as a “chain of blocks”, each of them contains the hash of the antecedent block. The maintenance of Blockchain is performed by many nodes, which communicate with each other using the bitcoin software. Approximately every ten minutes a block, group of approved transactions, is created and joined with the other. (Nakamoto, Bitcoin: A Peer-to-Peer Electronic Cash System, 2009)

**Ethereum:** Ethereum is a *public* blockchain network, the first decentralized platform that manages smart contracts. It works on a big shared and global infrastructure, which allow end even ownership through online transactions. The project was born in August 2014 from the Ethereum Foundation, a Swiss non-profit company, from pre-sale of ether all over the world. Thanks to Ethereum

developers have been able to create all kind of decentralized services, breaking into many different sectors with their applications. (Ethereum White Paper Made Simple)

**NEO:** NEO was founded in 2014 as a non-profit, open source and *public* blockchain project. It digitalizes assets using blockchain technology and digital identity, and it manage them automatically via smart contract. NEO believes that common development should take precedence. It will create a “Smart Economy” with the help of a distributed network [14].

**EOS:** EOSIO was developed by the private company block.one, based on the whitepaper distributed in 2017, as open-source software. It is a *public* blockchain protocol that works with EOS, a native cryptocurrency, and smart contracts. The main idea is to decentralize the application through a decentralized autonomous corporation model. The platform is able to validate millions of transactions per second without paying any commission. [15]

**R3’s Corda:** R3 is a *consortium* made up of 200 firms, based on R&D of distributed ledger for implementation in financial systems. They created an open-source distributed ledger called Corda, which handles complex transactions and restricts access to certain types of data. Corda was designed for finance companies but has started to attract the interest of some other industries (health, energy, insurance, etc.) [16]

**Hyperledger:** Hyperledger was started by Linux Foundation and has been supported by many influent companies such as: AT&T, Cisco, Fujitsu, Hitachi, Huawei, IBM, Intel, Microsoft, NEC, Oracle, Qualcomm, Samsung, and VMware. Hyperledger is defined as “an open source collaborative effort created to advance cross-industry blockchain technologies”. (Linux Foundation, 2016) With a global collaboration, including of finance, bank, IoT etc., leaders wants to create a transparent, enduring and interoperable ecosystem of blockchain technologies for commercial adoption. To do so, they have a community of software developers who build blockchain frameworks and platforms. [17]

**JPMorgan Chase’s Quorum:** Quorum is a *private* blockchain based on the Ethereum protocol. Quorum uses a voting based consensus algorithm, and achieves data privacy through the introduction of a new “private” transaction identifier. One of the Quorum’s key goals is to recycle as many existing technologies as possible, minimizing the changes required the Ethereum protocol to reduce efforts for the future releases. (JPMorgan, 2016)

**Digital Asset Platform:** Digital Asset is a software company that develops *private* and distributed ledger technology solutions for the financial services industry. The company uses the blockchain technology to facilitate the agreement between digital and traditional currencies. The software could be used in many different segments such as: securities and foreign exchange. The company has partnership with Accenture, Broadridge, PwC and many others.[18]

In Figure 4, the most important players of the market were divided into four quadrants. A further characterization divides the real platform, where companies could put their tokens, from the software, used as infrastructure to build a permissioned or permissionless blockchain. (Valenta, 2017)

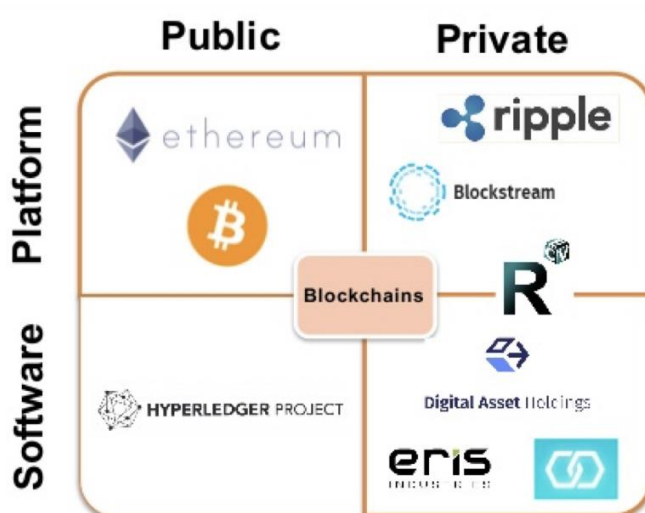


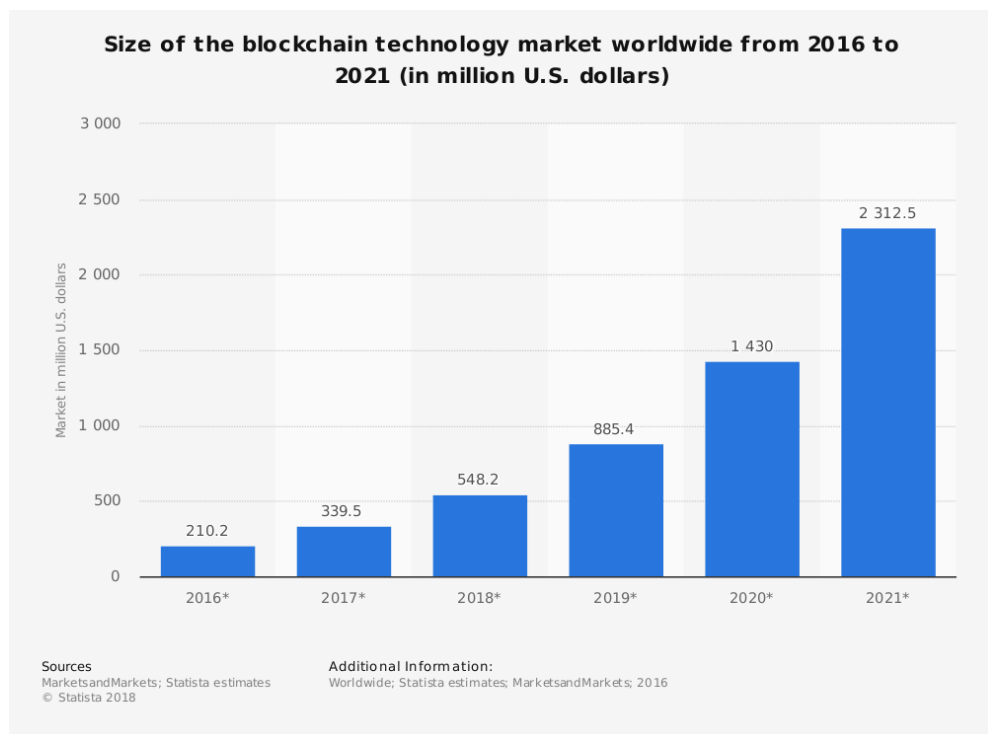
Figure 3 Public vs. Private [19]

## VI. Market Space

The global size of the blockchain technology market is expected to reach USD 2,31 billion by 2021, according to the image sotto, with a CAGR of 79,6% in the forecast period (2017-2022). [20]

The applications considered by the study are:

- Payments
- Exchanges
- Smart contracts
- Documentation
- Digital identity
- Supply chain management
- Governance, risk and compliance management



**Figure 4 Blockchain Market Size [23]**

The growing demand for this technology is visible in various industries: financial services, technology media and telecom, healthcare, transportation and also the public sector. [20]

The growing demand for solutions based on blockchain technology is justified in terms of security, speed and autonomy in transactions. In addition, the increase in confidence in digitization also plays a dominant role in the enormous demand recorded. (Infosys, 2017)

The public blockchain will be the segment with the most important growth (CAGR 39,2%). This part of the market is still in the development phase, due to the continued entry of new progress and of its integration.[21]

Some of the most important vendors in the market are: Digital Asset Holdings; IBM corporation; Linux Foundation; R3, Microsoft and Ripple. On the other end the most important public ecosystems are: Ethereum, EOS and Bitcoin.[22]

### Trends 2018

*ICO* (Initial Coin Offering): The researchers affirm that in 2018 the number of ICO will increase substantially from 2017,[24] because of the goodness of the solution a fundraising for blockchain projects, (the figure show the growth of the last year)



Figure 5 ICO growth [24]

*Ecosystems*: If 2017 was the year of Ethereum, in fact the most part of ICOs happened there, in 2018 it must compete with two new player: EOS (where it is possible to create proprietary currency with C++), and NEO. In 2018 and in the years that will follow, the dominant position of Ethereum may be reduced as ICO platform. [24]



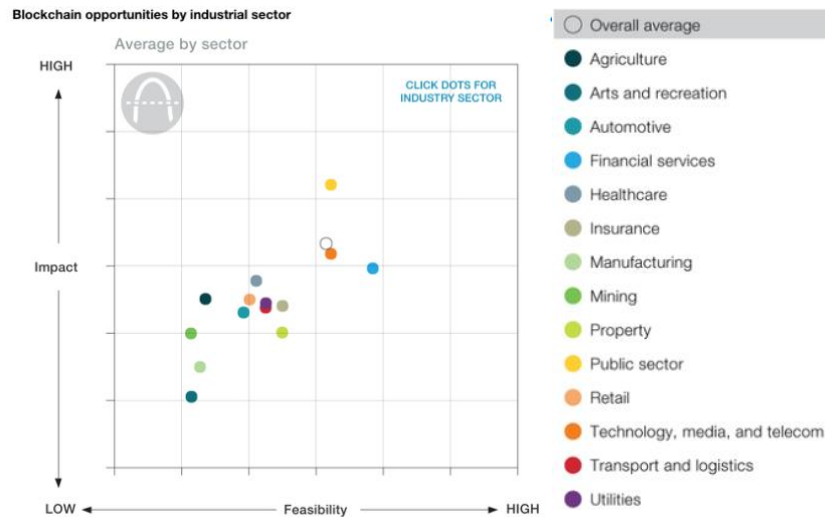


Figure 7 Blockchain opportunities in Industrial sectors.[27]

### Financial services

Blockchain is widely used in the financial sector, due to some features that make it perfectly suited to many different applications.

- International payments: This kind of payments are traditionally very expensive, using the blockchain technology can reduce the costs associated with them, avoiding the action of manual settlement of transactions.
- Trade finance: The estimated value for this market is \$10 trillion a year [28]. Traditional methods of trade financing are very slow and this is a big problem for the companies, because of the difficulty of managing liquidity. But it could be overcome with the help of blockchain; in fact it is possible to do the same job that would require a week in just 4 hours with the help of the new technology.
- Insurance: Probably the most important application is the use of smart contracts, which can handle claims with transparency and security. All contracts are registered in the infrastructure and automatically validated, eliminating the possibility of invalid claims [28].

Many different companies have recognized the importance of integrating the blockchain in their value proposition. In the figure sotto it is possible to see which were the first movers and which followed them in the adoption of the technology.

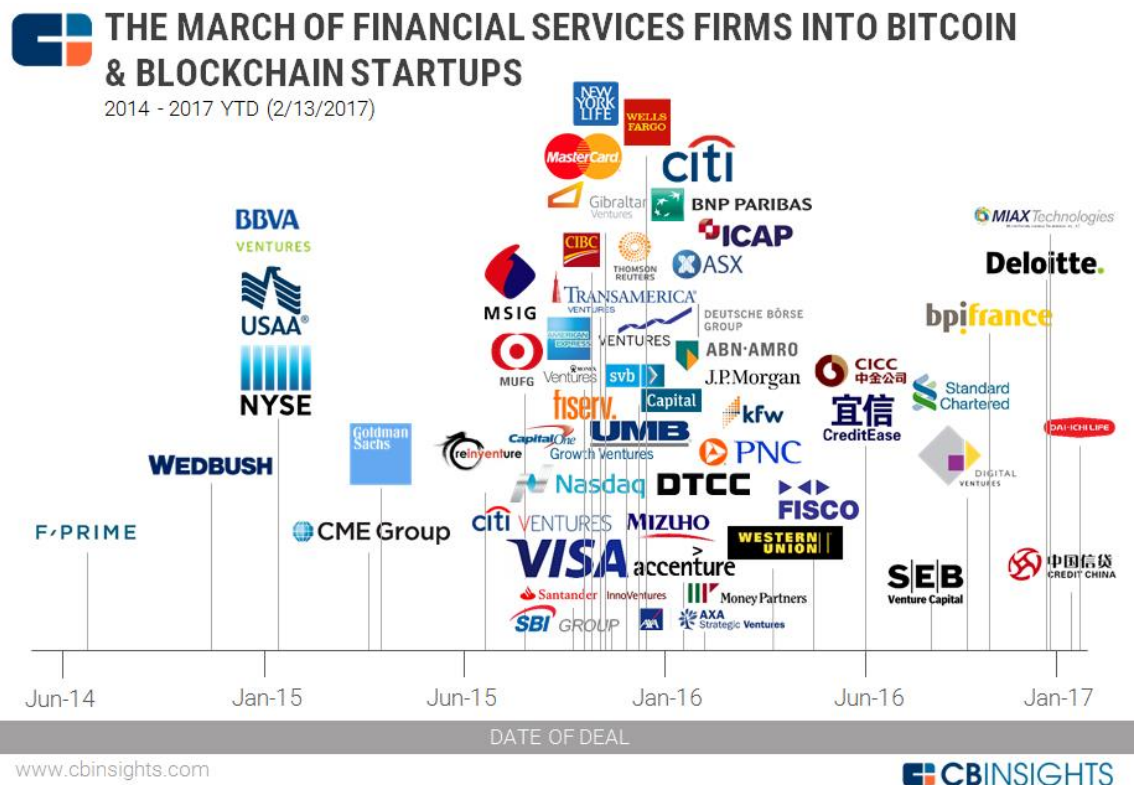


Figure 8 Timeline of the financial services that enter in blockchain market[29]

### Public Sector

When it comes to public sector, it is really important to be able to verify the security and the clarity of the actions carried out. Many blockchain applications could help public institutions to guarantee this property. (Weiss & Corsi, 2018)

- Record Management: Personal data of citizen must be stored in a responsible manner, maintaining their privacy. In some cases it may be really difficult do this, because this data is saved in paper form. Blockchain technology can simplify the storage and make them more secure.[27]
- Voting: Some characteristics of blockchain could perfectly serve the voting system. Information written on the blockchain cannot be changed, is not possible to hack it, and all transactions can be tracked. For these reasons, the use of blockchain in voting systems could be really useful to increase the validity of the vote, and at the same time, to increase the confidence in the system. [27]
- Property transactions: Right now, if someone wants to sell an asset, he needs a trusted third party that validates a contract. Using blockchain this



type of transactions could be done automatically, in a faster and cheaper way.

## **b. Artificial Intelligence**

### **I. What is AI?**

*“We call ourselves Homo sapiens—man the wise—because our intelligence is so important to us. For thousands of years, we have tried to understand how we think; that is, how a mere handful of matter can perceive, understand, predict, and manipulate a world far larger and more complicated than itself. The field of artificial intelligence, or AI, goes further still: it attempts not just to understand but also to build intelligent entities.” (Russel & Norvig, 1995)*

People who study Artificial Intelligence (AI) want to know how this kind of technology can change the world and the reality of human life. According to the quote the question is: could the machine think and feel emotions like humans or not?

A lot of scientists have studied to answer this question, and there are different ideas on solving this problem. For this reason, with the passing of the years, many different definitions about AI were born. In the figure sotto it is possible to find some of them.

<b>Thinking Humanly</b> “The exciting new effort to make computers think . . . <i>machines with minds</i> , in the full and literal sense.” (Haugeland, 1985) “[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning . . .” (Bellman, 1978)	<b>Thinking Rationally</b> “The study of mental faculties through the use of computational models.” (Charniak and McDermott, 1985) “The study of the computations that make it possible to perceive, reason, and act.” (Winston, 1992)
<b>Acting Humanly</b> “The art of creating machines that perform functions that require intelligence when performed by people.” (Kurzweil, 1990) “The study of how to make computers do things at which, at the moment, people are better.” (Rich and Knight, 1991)	<b>Acting Rationally</b> “Computational Intelligence is the study of the design of intelligent agents.” (Poole <i>et al.</i> , 1998) “AI . . . is concerned with intelligent behavior in artifacts.” (Nilsson, 1998)

**Figure 9 AI definitions (Russel & Norvig, 1995)**

There are two different approaches that could be used to divide these eight definitions (Russel & Norvig, 1995). On top the central idea is reasoning, instead on bottom the theme is behavior. On the left the definitions are based on the measurement of proximity with human performance, on the other side it is possible to find those that establish the degree of rationality. (A system is rational if it does the “right thing,” given what it knows).

**Thinking Humanly:** When this type of research began scientists must understand how humans think. They had three possibilities to comprehend this; through introspection, trying to catch people thoughts as they go by; through psychological experiments, observing people in action; and through brain imaging, observing the brain in action. These intangible actions are really difficult to study, and they were helped by the cognitive science to do it. After those analyses they wrote algorithms that could reflect the human thought in computer science. An example of this approach is the project of Allen Newell and Herbert Simon who developed GPS (General Problem Solver), they were not satisfied if their computer only found answers to tangible problems. They want to compare all the phases executed by the computer and by the humans to solve the same problems.

**Thinking Rationally:** This kind of analysis begins in the ancient Greece with Aristotle who was the first to try to codify ‘right thinking’. He defines the syllogism, is a sentence that begins with an evidence and ends with another, though some logical steps. The syllogism and the other studies of Aristotle are the foundation of the modern logic. In the 19<sup>th</sup> century, people (logicians) start to use these studies to connect all kinds of objects and the relationships among them. By 1965 there existed jet programs that could, in principle, solve any solvable problem described in logical notation. This represents one of the first steps towards AI. A problem of this approach is that it is not always easy to make informal knowledge in the formal terms, and on the other hand often solving a problem in theory and in practice is not exactly the same.

**Acting Humanly:** The first to use this kind of approach to define AI was Alan Turing. Even today his Turing Test (or Imitation Game) is used by scientists to test the goodness of an AI implementation.

The Turing Test is defined as follow: *“The test is for a program to have a conversation (via online typed messages) with an interrogator for five minutes. The interrogator then has to guess if the conversation is with a program or a person; the program passes the test if it fools the interrogator 30% of the time.”* (Russel & Norvig, 1995)

He hypothesized that by 2000 computers will be so powerful as to pass the test, but it was wrong, until now no computer has passed it.

So far this is the only test that could say, objectively, whether a machine is intelligent or not.

**Acting Rationally:** This kind of analysis is also called the rational agent approach. A computer agent operates autonomously, perceives their environment, persists over a prolonged time period, adapts to change, and creates and pursues goals. In addition, a rational agent is in grade of conclude the best result. This method is linked to the first one that was presented, because to act logically first of all it is necessary to reason in a logical way. For this reason, making correct inferences is part of being a rational agent.

This procedure has two main advantages in comparison to the others. First, it is more general than the “laws of thought”, because correct inference is just a part of the method and not the main principle of the method like in thinking humanity. Second, scientific developers are better disposed to it than methods based on human behavior or human thought.

## II. AI Technologies

### Machine Learning

*Definition: “Field of study that gives computers the ability to learn without being explicitly programmed.” (Samuel, 1959)*

Machine Learning (ML) was born at the intersection of Computer Science and Statistics. If Computer Science is based on how to program computers manually, ML focuses on how computers could program themselves. While Statistics want

to understand what conclusions they can infer from data, ML wonders how the algorithms can be used to optimally manage these data. (Mitchell, 2006)

The most important algorithms in the ML space are, deep neural networks (treated in the dedicated paragraph sotto).

The most important implementations of ML are: computer vision (from face recognition systems, to system that could classify microscope images) bio-surveillance (for example in tracking epidemic), robot control, medical research (an example could be the automatic learn models of gene expression in the cell, from high throughput data). ML is used in these applications because the resulting systems are more precise than handmade programs.

Definitely ML is used when the applications are too complicated to manually plan, or when huge databases need be to be used, and for this reason it plays a very important role in computer science.

### Deep Learning

*Definition: “Deep learning allows computational models that are composed of multiple processing layers to learn representations of data with multiple levels of abstraction. These methods have dramatically improved the state-of-the-art in speech recognition, visual object recognition, object detection and many other domains such as drug discovery and genomics”. (LeCun, Bengio, & Hinton, 2015)*

Deep learning software tries to simulate the actions of neurons in the neocortex, where the thought take shape. This kind of software assimilates digital representations of many different data such as sounds and images.

The core idea is to build a “neural network” capable of simulating the actions performed by neurons in the brain. The notion of deep learning arose tens of years ago, but only now computer scientists, due to the advancement in mathematical formulas and more powerful computers, can model multiple levels of virtual neurons. And after years of research, AI experts can say that this technology is ready to leave computer science books. (Hof, 2013)

In a technical view, programmers want to instruct the neural network with millions of different images and sounds that represent the same pattern, and, if the network does not recognize it, an algorithm adjusts the weights. They take advantage of the same approach using by child to learn about the world.

Early software (1970) could simulate only a small number of neurons and can identify simple patterns. Then (2006), Hinton developed a more efficient way to teach individual layers of neurons. (Hof, 2013) The first layer learns the primitive characteristics, after it has recognized them with precision it is possible to move to the next layer, which learns more difficult features of the first one. The process is repeated in successive layers until the computer is familiar to the object. [30]

### Natural Language Processing

*Definition: “Natural Language Processing is a theoretically motivated range of computational techniques for analyzing and representing naturally occurring texts at one or more levels of linguistic analysis for the purpose of achieving human-like language processing for a range of tasks or applications”. (Liddy, 2001)*

Natural Language Processing (NLP) is integrated in lots of technological product and services, used by people in daily life. An example is the suggestion of words made by smartphones when composing a text message, voice assistants like Siri, Amazon Alexa and Google Assistant are some other examples.

NLP works by identifying words in a sentence, and to do so it follows a rigid scheme of actions.

Voice-based systems translate words that listen into text, usually using Hidden Markov Models system (HMM), the other systems skip this first action. Subsequently every NLP system, using different techniques, tries to detach each word and isolate it from the rest of the speech. This could happen using series of coded grammar rules that can help to determine the context of the statement. The end finding is the capacity to categorize what is said.[31]

### **III. Market space**

The Artificial Intelligence is one of the most important trends of innovation of this century. Many specialists affirm that the growth of AI in the next years will be fabulous.[32]

According to these opinions experts estimate the revenues for the market, explained in the figure sotto:

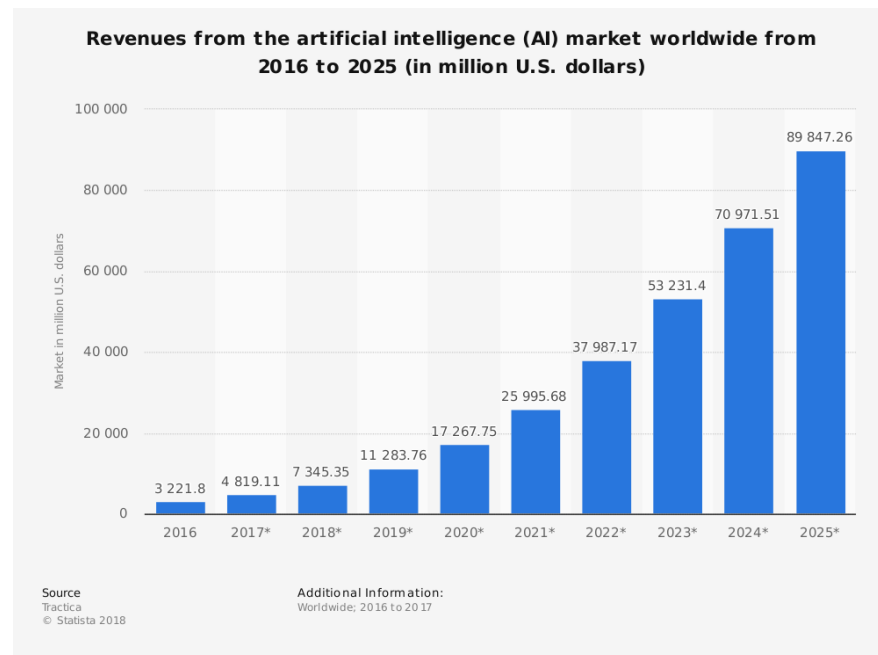


Figure 10 AI revenues [33]

The estimations say that in about 10 years the market will become 30 times bigger[33], and for this reason is normal that lots of big company invest in this area, and also many start-ups are born with an AI project (overview in the figure sotto)



Figure 11 AI 100 start-ups 2018 [34]

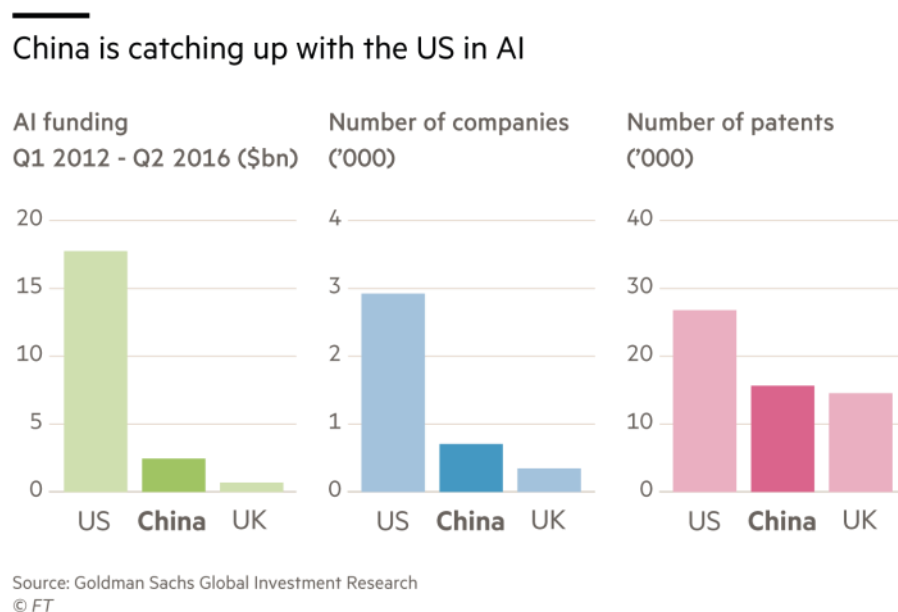
The global AI market is expected to reach \$35,870.0 million by 2025 from its direct revenue sources, growing at a CAGR of 57.2% from 2017 to 2025.[35]

This enormous growth is pushed by emerging AI technologies and by greater use of big data.

For long time, USA was the place where AI flourished, in fact there were the hugest number of start-ups in the industry, the largest number of researchers and also the greatest investments.

Now the Chinese government is promoting a futuristic AI plan, which will involve several sectors (logistics, military, agriculture etc....). For this reason, the number of investments in AI is increasing vertiginously and the Chinese president declared that by 2030 they would be the undisputed leader on that technology. In this moment the market is divided between USA and China: “If you look globally, it is a two-horse race in AI,” says Michael Chui, a McKinsey partner. [36]

In the battle for supremacy in the market, China has some important advantages.[36] First AI is founded on Big Data and a country with 1,7 billion people has a large amount of data to use. Secondly, China’s privacy rules are more tolerant than in Occidental world, now it is going to become more stringent, but the regulations are still million miles from laws such as the European GDPR. Finally, in China collaboration between public and private sectors is normal, and this pushes research into technology. The figure sotto is the economic representation of all these advantages:



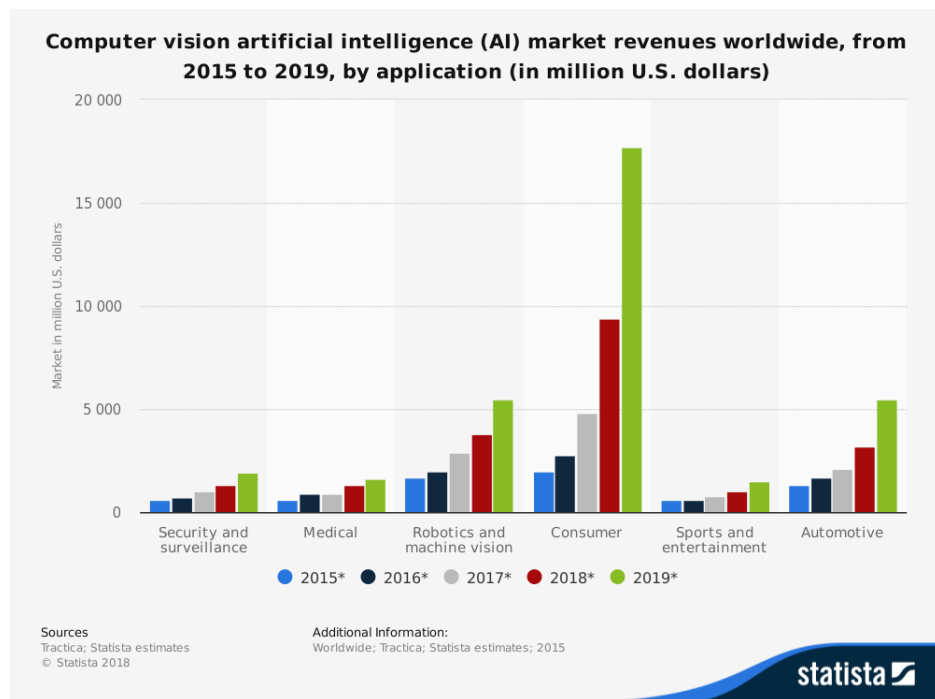
**Figure 12 USA vs.China [36]**

But some specialists of the sector say that the USA has still a clear lead, thanks to: the most advanced algorithms, specialized computing hardware and a good

supply of the raw material that machine learning systems depend on (data). Indeed, all the companies that collect a huge mass of data came from USA such as Amazon, Google, Facebook , and it is clear that the number of people that are in contact to these companies is bigger than the population of China.

In conclusion, it is possible to state that USA and China will be the most important players in the AI world. But in many cases the most important AI inventions are result of collaboration, for this reason is possible that will be some agreements between the two countries.

After the geographical overview, is very important to know which are the areas where AI applications are more profitable:



**Figure 13 AI revenues by application[37]**

Figure 13 underlines a great surge between 2018 and 2019 in all areas of application. Consumer is the most profitable application, and is also the one that has the most important growth between 2015 to 2018 (from 2000 to 17700). Then is possible to see that robotics and automotive are on the same level of revenues (on 2018 around 3500). Finally medical, security and surveillance and sports and entertainment follow with about 1000 of revenues.

#### **IV. Business Areas**

To better understand why some applications are more profitable than others, it is important to make a small overview of the areas where AI is most used.



## Healthcare

The key to innovation in healthcare is the use of patient information and data. With the help of AI it is possible to transform these inputs into algorithms, and so computer can use them for real problems and pathologies. *“Using consensus algorithms from experts in the field, along with the data that oncologists enter into a medical record a computer can review dozens, sometimes hundreds, of established treatment alternatives and recommend the most appropriate combination of chemotherapy drugs for a patient.”* [38]

An other big problem that AI could contain concerns the “false positive”. The studies affirm that 50% to 63% of US women who do mammograms in the space of 10 years will receive one of these. This happens because the same studies estimate that one third of the time radiologist looking the same exam can disagree. The recognition software is evaluated to be 5% to 10% more accurate than physical radiologists. [38]

In many cases the difference between good and bad doctors is not their level of intelligence, but is related to: how they approach patient problems and the health system that support them. The combine of these two variables could develop millions of different results; in this vision AI could be a good ally for the medical system. Two AI approaches could radically improve human performance.

Natural language processing that helps computers understand and interpret human speech and writing. The second method involves using computers to watch doctors at work, and learn from them. [38]

The biggest limitation of AI in healthcare is the medical culture; many doctors want their independence in diagnosis and do not like to be told what to do. At the same time people who have a job related to medical area are scared, because the real truth is that if technology is going to improve quality and lower costs in healthcare, some jobs will disappear. This is the price to pay for the progress; the physician’s role will change in the future, and medicine will be more related to AI. Fortunately for doctors, computers could not give empathy and compassion like humans, and for this reason millions of patients’ needs to a real doctor.

## Finance

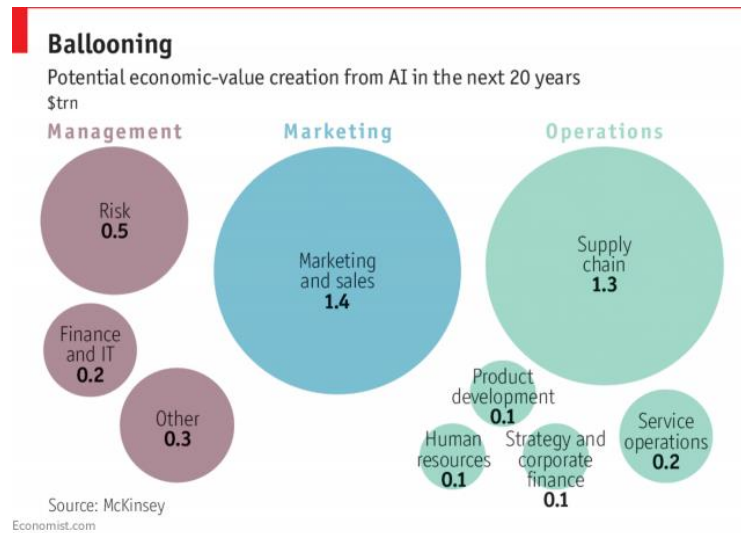
*“In January, CB Insights reported that 2016 was a record year for AI venture funding deals with 550 companies using AI in their products raising \$5 billion. In July, CB Insights announced a list of 250 companies that are poised to redefine the financial services industry. At the 2016 Annual Technology Innovation Summit, hosted by Bank of America and Merrill-Lynch in Silicon Valley, AI, robotics, and VR were named as the most interesting area in technology for the coming year.”[39]*

In line with this extract, it is possible to affirm that the future of finance will be robustly influenced by application of AI technology and by new fintech companies. AI will be used to increase the revenues and at the same time decrease the risks, maximizing the use of resources.

Some tangible examples:

- Accounts payable/receivable processing: there are some software applications that using simple workflows can issue invoices in a short time and can also learn the most appropriate accounting code for each type of invoice.
- Supplier onboarding: machines could check the debit and the tax information in a short time to choose the best supplier, without the aid of humans. Then the computers set up them in systems automatically.
- Expense management: Is an action time consuming for the accounting team, a computer can collect all the information to do this kind of review in a really short time. Then if there are some problems or infraction the machine could send an alert.

The key point is that, in this case is really important the cooperation between machines and humans, each one have to contribute in areas they are best skilled at. Machines are efficient in analyzing data and information; people could leave these monotonous tasks and do that one they are better suited of; for example consultations or professional services.



**Figure 14 AI economic value [40]**

### Supply chain

*“McKinsey estimates that firms will derive between \$1.3trn and \$2trn a year in economic value from using AI in supply chains and manufacturing.” [40]*

Integrating AI in supply chain will have the greatest economic impact compared to all the other markets.

One of the most boring work is paying suppliers, AI could do, this important but unglamorous action, automatically just using a Microsoft’s Excel spreadsheet as input. Using computers the back-office routine could become more efficient and less risky.

A further important application of AI in supply chain is the ability of managing computationally a warehouse (for instance Amazon uses these algorithms to store a huge number of different products to sell all around the world). It is possible to predict the fail of the equipment, and this could be really valuable information to be known to large company that must plan maintenance.

Finally, the integration of AI into the supply chain is essential to track the movement of goods; most companies in the global navigation industry will use this type of software to provide an increasingly efficient tracking service to their customers.

Experts predict that the AI will reduce logistics costs by at least 5%, which could generates additional profits of around \$25 billion within ten years. [40]

### **c. Blockchain meets AI**

#### **I. Problem Statement (AI)**

Despite AI is very useful, there are some problems that must be solved before introducing it into everyday life. The greatest number of problems concerns the AI R&D. It is possible to classify these problems into three different areas:

Data processing: Intelligent applications perform tasks that traditionally require human feedback. These applications are trained on large data sets, but obtaining them requires a lot of time and resources.

Diverging Task: An impediment, when developing a complex algorithm, is the need to cooperate with parts of the world outside the present domain.

Computational Costs: Developing and training AI systems is, in most cases, a computational intensive and expensive task. It requires a technical infrastructure capable of processing big data sets and coordinating the results.

#### Solution

A decentralized ledger like the blockchain provides a direct link between supply and demand, which can greatly mitigate these problems. The transparency that blockchain offers, fosters collaboration and data sharing between agents. It also makes AI more affordable by sharing costs. (Eisses, 2018)

#### **II. Problem Statement (Blockchain)**

Blockchain was a great invention, but like all the new technologies with great potential, it comes with huge problems to be solved. The main problems are two:

Energy costs: Estimated cost connected to blockchain implementation, including energy-spent mining for coins amount around \$600 million a year.

Managing by humans: Blockchain was born as an autonomous and decentralized connection between two or more parties, but at the end of the chain there is already a big component of human work (an example is the Bitcoin hash method that uses the “brute force”). This could be a problem for the achievement of the mission proposed by the investors. [41]

### Solution

AI could help to optimize calculation to decrease miner weight and on the same time doing faster transactions.

The AI could handle tasks smarter; in fact a ML-based mining algorithm (which has a lifetime to become an expert) could almost instantly models its fields, if the training is done with quality data.

[42]

### **III. AI 4 Blockchain or Blockchain 4 AI?**

After the presentation of the problems and solutions that both technologies could serve to the other, the question is: which of the two technologies would have the greatest benefit in meeting the other?

To solve this question it is going to highlight two key points:

Storage and usage of personal data: Blockchain is ideal for storing sensitive data that are necessary to AI development in some industries. Through the help of the Blockchain AI can involve for example smart healthcare or that could push more accurate diagnoses.

Understanding AI decisions: Sometimes, for humans, it is hard to understand decisions made by AI, such as in financial brokerage. But if decisions will be recorded on a blockchain it will be possible to recall the actions and understand better the decisions, with the guarantee given by the immutability of the blockchain.

In conclusion, the meeting of these two technologies will be so disruptive for the habitual life, the changes and benefits will be so huge, that the business world will be very different, and probably even better.

### **IV. Research questions**

After making an introduction into the state of the art, it is possible to conclude that the intersection between blockchain and AI will be really interesting in the coming years, probably because it will be an important part of the optimization of some applications in the technological field. An important topic, which will be analyzed in the continuation of the thesis, is the management of personal and business data. This topic is crucial for many different sectors and the search for

improvement actions could be interesting for the global market, in this area the potentialities generated by the considered intersection are perfectly placed.

Finally, big technology companies such as Google, IBM and Cisco have placed their attention on this market, starting various projects: for example, to improve intelligent databases (supply chain) or to manage clinical data used for research (healthcare) .

In conclusion, to better understand this new business and tech space, the research questions that this thesis proposes to solve are:

1. Which is the strategic positioning of the most important company in this market?
2. Why Blockchain will be so important for the development of the AI?

## **2. Methodological Overview**

This thesis, unlike pure scientific research, which is based on the quantitative analysis of the phenomena studied to make the treatment as objective as possible, was written using qualitative analysis. Due to the predominance of innovative subjects, which in many cases are in a development phase. For this reason, in order to better study the topics discussed, it was decided to adopt the interpretative paradigm that is peculiar to the qualitative approach. (Cohen, Manion , & Morrison, 2005)

### **a. Systematic Literature overview**

In the sequel of the dissertation, the two pillars of this thesis have been studied together: blockchain and AI. The analysis was made to answer the first research question in a direct, and also to respond the second indirectly, knowing which types of solution are already into the market space. (Answers will be presented in detail in chapters 3 and 4).

#### **I. Blockchain and AI Literature**

To better understand the world of blockchain and AI, lots of papers and books were analyzed (many of these are included in the first chapter and are used to analyze the state of the art). The peculiarities of the two technologies have been examined in depth, to better understand the point of contact of the two worlds, before the analysis of all the projects at the intersection between them.

### **b. Case Study research**

In line with the case study practice adopted by ISMB in business-related consulting activities, see (Osella, 2013). Due to the innovation and immaturity of the projects that are at the intersection between blockchain and AI, the case study approach was chosen to conduct a comprehensive exploratory study upon this market.

There are several reasons that led to this choice:

First, case studies are considered most appropriate as tools in the critical, early phases of a new theory, when key variables and their relationships are being explored (Yin, 1994). It is clear that all the projects that were born at the intersection between blockchain and AI are in a critical and early phase, and at the same time, the join of these two technologies is a new theory whose goodness is to be tested with this thesis.

Second, the absence of data could be a problem on using other research methods, in the case study approach the importance is focused on the study the phenomena in their context without extrapolating them from it. (Pettigrew, 1973) In the space of blockchain projects are really often do not find a lot of quantitative data, and in the join, with AI this problem becomes more acute.

The complex nature of blockchain and AI market space calls for exploratory case studies due to the absence of rich and consolidated literary theories and also because there are not key variables that define the goodness of their convergence (Tellis, 1997). Each unit of analysis is a company whose core business is centered on blockchain and AI, regardless of the industry it belongs to. The case design is based on a "multiple case design" logic (Yin, 1994) in which the presence of several contexts under examination is oriented towards heterogeneity rather than replication.

## **II. Sampling**

The methodology analysis adopted for the case study approach is divided into three steps:

- Identification of a long list of cases for the analysis
- Selection of a short list of cases with objective criteria
- Analysis of the case study with a predefined template

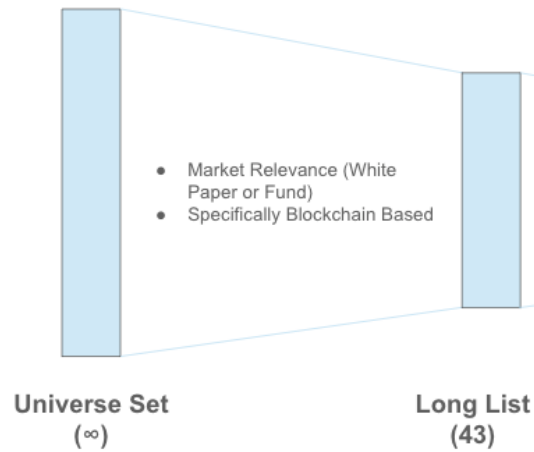
The sources used to analyze the universe of companies that have projects on the intersection between blockchain and AI are essential: CBInsight, Crunchbase, and Owler.

Using some filters that CBInsights and Cruchbase dispose of for the researchers, the universe of the firms that are on the intersections was defined, after that Owler was used to examine the competitors of the firms that are already into the universe set, to understand if some of them could enter into the market space or not.

But the universe was very enormous, hundreds of companies, from many different industries, with a very varied project and stage of development was identified. To reduce this huge set has defined some filter to create a long list of firms:

- Market relevance, underlined with the existence of a white paper for the project or presence of funds
- AI projects specifically blockchain based





**Figure 15 From the universe set to long list**

After the identification of the characteristics, which define a project an object of the research made with this thesis. The study of all the information that is fund, was used to create the long list repository (Appendix 1), that summarize the most important characteristics of the projects and the companies.

After that, the projects that are part of the short list are identified using the following characteristics for the theoretical sampling application:

- Development or Execution Phase
- Budget allocation
- Use Smart contract

But with these discriminates the number of companies is too big, for this reason, it was used also an empirical sampling, that considerate the market relevance of the company or of the project, and the possibilities of development.



**Figure 16 Sampling**

### **III. Triangulation of the information sources**

The most important sources from which the information are taken to implement the case study could be divided into three groups: (Ferro & Osella)

- Whitepaper of the projects
- Website of the company
- Scientific articles (Medium, Forbes, Financial Times etc.)

All the whitepaper and the website of the companies are collect in Appendix 2.

The most important role to find information is played by the whitepaper, but in some cases they were not sufficient to understand the project of the company, for this reason, to better analyze these aspects, the other sources were used.

Moreover, in two cases (Accenture and Poolecy projects) has been conducted interviews with people that work in the first line of these projects. It was really interesting to better understand the market space, but the answer could not be inserted in this thesis to keep the industrial secret.

### **IV. Cross-case analysis**

In order to elaborate the information gathered from the case studies and extract the strategical position, taken by the archetypal actors, the cross-case analysis approach is adopted. The archetypal positioning has been identified and described.

### 3. Case studies

To write this chapter the most important sources are the whitepaper and the website of each company, where is not differently declared the source of the information is the single whitepaper (Appendix 2).

#### I. Ocean Protocol

##### History

The Ocean Protocol is a non-profit foundation; the promoters are DEX Pte Ltd and BigchainDB GmbH. The foundation has to ensure open access to the protocol and the platform, provide long-term governance, and finally be a custodian of funds raised. The main goal of the company is to incentivize AI data & services.

##### Solution

The Ocean network is composed of data assets and services. Assets are in the form of data and algorithms. Services are processing and persistence which leverage assets. All the assets are available on the Internet, in this optic the company connect a client with data and software providers. For this reason, the Ocean Protocol is defined as Decentralized Data Hub.

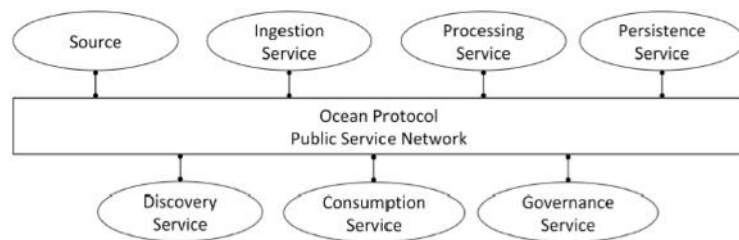


Figure 17 Decentralized Data Hub

They think that create an ecosystem where data are secure and affordable could be a good way to incentivize AI developers.

Practically Ocean Protocol is an ecosystem for sharing and monetizing data, with the help of a tokenized service layer.

Actors who have data and want to monetize its put them into the network for a price, and after the usage of Data Consumers, they receive the price through tokens return.

### Use of Blockchain

They build a proprietary blockchain that is necessary to avoid that someone became a gatekeeper of a huge mass of data.

After that, they use the blockchain and a private token to incentivize the sharing of data and plan rules and behaviors that must be followed into the network. In this way, they want to maintain a good quality of data and at the same time and equal payments for all the participants. Furthermore, to guarantee the privacy, the data sets are prepared to ML and AI analysis without showing raw data

### AI

In Ocean Protocol, the main objective is to encourage the AI development by providing high-quality data. But because Ocean is a decentralized system, they cannot create a central committee that controls the quality of data, on the contrary, they use people, with domain expertise, to do so. Any expert can participate as a Data Curator and will be paid through a token. They put a number of tokens at stakes to signal that a certain dataset is of good quality and every time is verified they are remunerated with a newly mined token.

### Smart contract characterization

The smart contracts are used to automatically manage some actions done by the client and the data provider, explained below:

Contract Setup: When a client asks for a service and block some token to the contract when the conditions are respected the resources are allocated and the contract is signed and deployed on the chain.

Access Control and Consumption: The client and the provider are in contact and after a successful authorization by the system the client has access to data.

Verification and Statement: The client verifies that data are compliant to his request, the contract goes into the settlement and the funds are transferred from client to provider.

### Utility Token

The Ocean Token is a "crypto asset" used as a commodity to incentivize the coordination of resources and scales the network. With the help of the property,

token Ocean can chase his mission: incentivizing actors to develop AI with the help of secure and quality datasets.

### Funding

\$44.2M collects with an ICO and a Funding Round in March 2018

### Industrial synergies

One of the most important investors of the company is Outlier Ventures, with the help of Ocean Protocol and other projects they want to build a Convergence Ecosystem Stack. [43]

### Timeline

March 2018: Ocean pre-launch token distribution; Singapore lead Costumer Advisors.

## **II. SingularityNET**

### History

SingularityNET is a Swiss company based in the Netherlands that raised his entire fund in ICO in about a minute. The company is owned by Hanson Robotics Limited, a Hong Kong company that was founded in 2013, and that specializes in creating human-like robots and is known for having created Sophia. In 2017 the company created SingularityNET along with its Chief Scientist, Ben Goertzel.

### Solution

Is defined as a sharing-economy marketplace for AI, which encourages and pushes the development of software to create a democratic access to the benefit of AI technology. For this reason is thought as an open network, where developers could put their work and sell them. Anyone can insert an AI Agent if correspond to the company's rules, in privacy and according to the payment logic. In computer science terms, SingularityNET is a distributed computing architecture to facilitate market interactions with AI and ML tools.

### Use of blockchain

SingularityNET initial implementation is on Ethereum, with a smart contract designed to minimize gas cost, use this decentralized ledger to automatically execute prices of logic that run on the blockchain. The smart contract contains some if-then logic and executes payment when the conditions are written on top of it happen. However SingularityNET is not simply an Ethereum app, it was designed for the implementation with various different cryptocurrencies or blockchain technologies.

### AI

Development of AI is the mission of SingularityNET, in a space where the scientists could be incentivized on developing new algorithms, without the control of big tech companies, in a safe and practical way.

### Smart contract characterization

At this moment SingularityNET implements the traditional Ethereum smart contracts, which work with PoW or PoS mechanisms to pay the developers when the right condition happen. In the future, the idea is to implement Proof of Reputation, which combines different factors: stake, overall activity in the network specific rating aspects, rating levels above specific thresholds etc. ML can be used to find the optimal combination of all these factors.

### Utility Token

The AGI token is a utility token with the main objective of remunerating the scientists that develop AI software in SingularityNET platform. But the choice of creating a native token is not a coincidence, in fact, after a careful analysis, the specialists of the companies decree that only a native token could follow the three main objectives of the company at the same time: to create an AI market that makes transactions smooth, to guarantee international access, and to incentive network growth.

### Funding

\$36M collect with ICO in December 2017

### Industrial synergies

SingularityNET has many partnerships with important actors of the market like Nexus, FundRequest, Bitspace, DeepBrain Chain, Ocean Protocol, DBrain etc.

## Timeline

Platform pre-launch

### **III. Doc.AI**

#### History

Doc.ai is an AI and Blockchain company oriented on health; it was born in August 2016 with the mission of transforming the prevention in health in a continuous function, and not a discrete one.

#### Solution

Neuron is the main project of the company, that want to create a complex brain that eventually binds all AI into one, and with the help of organizations and individuals data will develop new studies and help the advancement of medicine. They give an economic incentive to everyone who wants to participate, with data or with algorithms, using Neuron tokens to pay them. Neuron will provide a suite of distributive, AI tools accessible to everyone with step-by-step instructions.

#### Use of Blockchain

Neuron is an Ethereum based blockchain used to a decentralizing AI, using the smart contract to create the network infrastructure it needs to increase developers, users researchers etc. through the use of a token.

#### AI

Learning consists of a model being broadcast to the clients that in three phases administer data to the AI network:

The ***proposal phase***: the curriculum or dataset available for training are inserted on the network when the server determines that there are enough peers with a particular curriculum, it starts a proposal. The server selects users or peers and undergoes an initial teaching. It is very important that at this stage users are present throughout the learning and that the data sets are fixed.

The ***initial training***: the server transfers the parameters to the first client that will be used for the task. This action will be repeated many times by different users asynchronously until the dataset is fully learned.

The ***synchronization*** is the moment when the server collects all the leanings done and calculate a new model to provide to the network.

#### Smart contract characterization

n.a.

#### Utility Token

Tokens are used to remunerate people dealing with data delivery to the neural network. Through a series of tasks that can be accepted individually by users. Tokens will be returned at the end of the training phase or when the research organization decides to end the learning process.

#### Funding

\$12.3M with ICO in October 2017

#### Industrial synergies

Doc.ai did an important partnership with Anthem

#### Timeline

n.a.

### **IV. Numerai**

#### History

Richard Craib wants to transform Wall Street from a cutthroat competition into a harmonious collaboration. the 29-year-old South African technologist and his unorthodox hedge fund, Numerai, started issuing a new digital currency. Craib's idea is to create a new kind of hedge fund on the Internet, that work with a nativity token. Craib and company believe Numerai can become even more successful if it can align the incentives of everyone involved.[46]

#### Solution

The company wants to create an AI meta-model to trade long or short equity hedge fund, to realize this idea Numeric uses crowdsources machine learning problems powered by a competition, in which the scientists could demonstrate how much they believe on their model. [44]



Numerai holds a weekly data science competition where, any user can submit predictions of their hedge fund performance for the coming week, and a weekly prize is paid out to the top performing users in form of a native token (Numeraire).

Numerai do not need a collection of back tests that work well on historical data, they want to build a great model that could work well on new data.[45]

#### Use of Blockchain

Blockchain is used by the company as an instrument to remunerate the participants of the project. For this reason, Numerai creates a native token (Numeraire) that is an Ethereum ERC20 token created in June 2017. They use Ethereum as infrastructure where his token can run.

#### Use of AI

Numerai is a new kind of hedge fund that use AI to create the predictions. For the first time, data scientists could enter into a network that understands the importance of their work also in Finance. The scientists, for the first time, can express the confidence on their models' performances, and their expression of confidence could help the company on finding the right model and improve the performances of all project.

The predictions did by the scientists with their algorithms on data sets prepared by the company, are uploaded on Numerai to be evaluated. Once Numerai evaluates the predictions, the API activate the smart contract and the scientists are remunerated. The Numerai's back-tests have many parameters to evaluate the goodness of scientists' work, for example: how it is possible to combine models together, to optimize the portfolio and to estimate trading costs.[48]

#### Smart contract characterization

The smart contracts work as follow:

When data scientists are confident of the predictions they have made, they send Numeraire to the Numeraire Ethereum smart contract. After a time  $t$  Numerai will send a message to the contract with information on which data scientists' predictions performed well or not.

If the answer is positive the data scientists earn dollars based on the auction mechanism, and their Numeraire is returned. On the contrary, if the answer the scientist's Numeraire were destroyed.

### Utility Token

Numeraire is not really a currency, it is a token to access the staking tournament on Numerai.

In the staking tournament, data scientists stake Numeraire on their predictions to express their confidence that their model will perform well on live data. [47]

Numerai did not sell his tokens in an ICO because of they are the real invitation for the scientist that want to join to the network, and for this reason, the company has not the interest on giving their token to the speculators, which have no intention on using it.

A big reason for this usage is that Numerai did not sell its token in an ICO to speculators with no intention of using it.

### Funding

\$7.5M collect by venture capitalist traditional methods in 2016

### Industrial synergies

n.a.

### Timeline

n.a.

## **V. DBrain**

### History

Dbrain was founded in the summer of 2017, after that it secured \$2.5 million in seed funding and reached a significant milestone by releasing the Alpha version of its platform. [49]

### Solution

Dbrain is an open blockchain platform that links crowd workers and data scientists enabling them to transform raw data into real-world AI solutions. Crowdworkers do simple tasks of data labeling and validation and are paid instantly in cryptocurrency for their work. Data scientists use the resulting

datasets to train Neural Networks (NN) and build AI apps. Dbrain automates AI production and data workflow by providing efficient tools to all parties.

Dbrain aims to provide a secure, unified infrastructure to supercharge businesses through accessible, high-quality AI products.

#### Use of Blockchain

Using the blockchain technology, they can manage high-quality data labeling, security concerns, intellectual property rights, and micropayments.

The Dbrain platform works on the Ethereum network and relies on its smart contracts. They are going to build a permissioned blockchain on the Ethereum network. Their solution can process thousands of transactions per second which all involved parties can verify independently.

#### Use of AI

To guarantee the quality of data sets the company use two AI algorithms that organize and validate the data: SPOCK and PICARD protocol

The SPOCK protocol validates data label quality, ensuring the most accurate datasets possible. The PICARD protocol ensures the security of confidential data and automatically manages relations and fair revenue distribution between stakeholders.

**SPOCK:** Dbrain strives to guarantees quality of datasets without any work duplication. To align the incentives for crowd workers, validators, AI developers, and data owners, Dbrain implements the Subjective Proof of Crowdwork Protocol (SPOCK), which validates data quality automatically.

**PICARD:** Dbrain protects data owners' interests and seeks to prevent leaks at all stages of AI app development. The Protocol for Indirect Controlled Access to Repository Data (PICARD) protects datasets and AI apps hosted on the platform. The protocol seeks to guarantees security and trust in the Dbrain community with regards to data access control and reward distribution.

#### Smart contract characterization

n.a.

### Utility Token

Dbrainncoin (DBR) is an ERC-20 cryptocurrency used to remunerate the work on the platform. The entire number of Draincoins is fixed, and they are used as the lubricant on the Dbrain platform.

### Funding

\$8.2M collect with ICO, seed round and equity crowdfunding in 2018

### Industrial synergies

Dbrain did a partnership with SingularityNET and Zippie OS

### Timeline

## **VI. Effect.AI**

### History

Effect.AI is an Amsterdam based company that is working on a blockchain-powered, decentralized platform for Artificial Intelligence development and AI related services.[50]

### Solution

Effect.AI will become an open, decentralized network, that provides services in the AI market.

To do so, the founders create a project that is divided into three layers, which run on the NEO blockchain and are fuelled by a network token called EFX.

**The first platform** is a marketplace for tasks that require human intelligence. It allows anyone in the world to perform tasks for a fair payment and gives businesses access to a large workforce of human intelligence.

**The second platform** is a decentralized registry of AI services described by a rich ontology. On this platform, any algorithm can be accessed as a service in a unified manner and has a convenient way to receive payment.

**The last platform** provides a decentralized, distributed computational platform that can run popular deep learning frameworks.

Users in the Effect Network are rewarded for the amount of effort and work they do. This could allow malevolent users to gain wealth by submitting large quantities of work with poor quality. Users that put in the good effort will get a higher Effect.AI Reputation Score (ERS), and users that put in the poor effort

will get a lower ERS. Workers with a higher ERS will be able to apply for higher rewarding tasks. Furthermore, workers with a higher ERS will pay lower commissions for their jobs.

#### Use of Blockchain

Effect.AI uses NEO blockchain to remunerates the actors of the platform. NEO is a blockchain that uses Delegate Byzantine Fault Tolerance (dBFT) consensus and features Turing-complete SCs. In NEO there are two native tokens, that are used in different situations.

GAS is a utility token used for paying network fees. These are fees associated with deploying and executing smart contracts. NEO acts like a share in the platform. In this setup, the company should hold a combination of EFX, NEO, and GAS to function correctly. The NEO issued to pay-out workers at a stable exchange rate, but, because of, NEO is indivisible the rate should be defined in EFXNEO. The GAS is used to pay any network fees to users of the network, and it is also used to deploy new smart contracts and amend existing smart contracts.

#### Use of AI

The core idea is to create, in the end, an AIaaS platform, but at this moment the platform is used as an exchange platform between the workers and someone that ask for a work.

#### Smart contract characterization

Effect.AI Service Contract (ESC) is the smart contracts that process the transactions of tasks and the service registry. This protects the platform from external manipulation and keeps exchange rates stable for all agents in the network.

For the second platform they will use an upgraded smart contract that will work as follow: the caller of the contract will have to transfer the required funds to the owner of the contract to get an authorization token that allows him or her to interact with the application.

#### Utility Token

To maintain the liquidity of EFX the Effect.AI Network (Effect Network) will build a central pool of tokens, which will encourage adoption and stabilize network fees. This pool is called the Effect.AI Galaxy Pool (EGP) and consists

of a mix of EFX and native tokens. The Galaxy Pool's mechanism is summarized in the figure sotto:

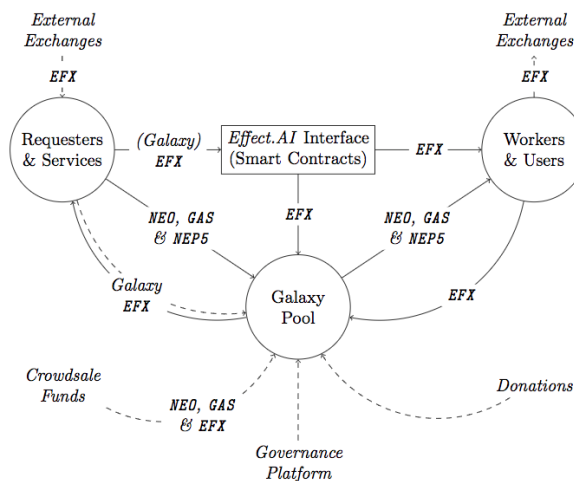


Figure 18 Galaxy Pool operations

The pool is not suitable for day traders, as only Galaxy-EFXtokens (G-EFX) can be bought. Any G-EFX bought from the EGP cannot be sold back to the EGP. AG-EFX is washed (converted to a regular EFX token) by spending it through an Effect.AI Service Contract (ESC).

### Funding

\$11M collected in 2018 with an ICO.

### Industrial synergies

Effect.AI did partnerships with Civic and Trueblocks.

### Timeline

Releases tests outside the company.

## VII. ATN.io

### History

ATN.io is a Chinese company that was born in 2016, with the mission: *"ATN is a global artificial intelligence API marketplace where developers, technology suppliers, and buyers come together to access and develop new and innovative forms of A.I. technology, effectively building the next generation of artificial intelligence in a trusted and collaborative environment."*[51]

### Solution

ATN is a decentralized, permission-less, customizable AI service and open interface blockchain platform.

ATN is an AIaaS marketplace where developers, technology suppliers, and buyers come together to access and develop new and innovative forms of A.I., the mission is to build the next generation of artificial intelligence in a trusted and collaborative environment.

ATN can also solve the problem of integration between fragmented AI services. ATN through DApps will provide network accessible to everyone, solving the problem of cooperation between AI participants. ATN provides an AI ecosystem with a payment network and smart contracts that create an economic infrastructure.

### Use of Blockchain

ATN is built on a smart-contract enabled next-generation blockchain that gives DApps quick and secure access to AI capabilities and service through a DBot/DApp ecosystem that will be created by ATN.

With blockchain technology, ATN uses encryption to protect data sets and AI algorithms, to allow for rapid commercialization and adoption. Developers will be able to share their work in the marketplace with the knowledge that their technology is secured and that they will be remunerated for their work. The first step in developing the ATN platform is to build a blockchain service that connects different AI services together to create a blockchain smart contract ecosystem for the benefit of users.

### Use of AI

Development and sharing of AIaaS projects is the core idea of ATN.io, for this reason, the entire platform is built to put AIaaS on the center.

### Smart contract characterization

In order to use AI services on different blockchains, ATN will implement a DApp in the Ethereum environment and subsequently DApps in other smart contract environments. Different DApps in different blockchains will need to support ATN's base blockchain interoperable smart contracts.

The blockchain execution of the smart contract is deterministic, which means that if you execute a smart contract with the same parameters, it will always return the same answer and then it will update the blockchain records. The introduction of DBot will solve this issue. Communication between smart contracts and DBots are asynchronous. When a smart contract wants to access an AI service, it will trigger an event. The DBot node will receive it and communicate with the AI service according to the parameters and the strategy chosen in the smart contract. Then it will receive the result and send it back to the blockchain smart-contract. The ATN DBot platform can carry out communications between interoperable smart-contract platforms which exist in different blockchain networks, the only condition being a smart contract compatible form.

#### Utility Token

An ERC-20 token contract will also be provided and tokens will be used as “gas” for the use of these AI services. ATN’s second step will be the creation of an independent ATN blockchain with a native token which will be interoperable with other blockchains to enable an ecosystem of interoperable smart contracts to access AI services through ATN’s DBot platform. ATN tokens can be used to pay for fees and "gas" by users to access AI services or can be a reward for a Dbot user account, which provides an AI service. When the ATN tokens will be used also to the governance system the company will become a DAO  
Even if different blockchains can possess ATN tokens, the overall total number of tokens will be constant.

#### Funding

In 2018 with a corporate Round ANT.io collect \$10M

#### Industrial synergies

ATN.io have a partnership with Gico Inc. and Contractium

#### Timeline

Private chain deployment



## VIII. Oben

### History

Founded in 2014, ObEN is a K11, Tencent, Softbank Ventures Korea, and HTC Vive X portfolio company and is located at Idealab in Pasadena, California.

ObEN is an artificial intelligence company that is building a decentralized AI platform for Personal AI (PAI), intelligent 3D avatars that look, sound, and behave like the individual user.

<https://oben.me/>

### Solution

The solution powered by Oben is projected PAI. A person's PAI is a network-verified 3D AI avatar that looks like the owner, speaks in the voice of the owner, and represents the owner when acting on his or her behalf, the project believes that every person in the world has the right to create, own, manage, and use their own PAI as per their Right to Publicity. To fulfill that mission, Project PAI proposes a blockchain protocol designed to give people trackable ownership and management rights (e.g., portability, limited sharing, and interoperability) to their intelligent personal data profiles.

### Use of Blockchain

The PAI Blockchain Protocol incorporates decentralized artificial intelligence development into the blockchain, in addition to typical transaction and management rights that cryptocurrencies such as Bitcoin and Ethereum contain. However layering artificial intelligence into the blockchain, and building around AI as a core component of the blockchain requires additional work and specialization to create an entirely independent protocol with functionalities custom-designed for AI usage. They believe that a separate blockchain, built independently for AI, will encourage faster adoption by AI developers and maintain a focused domain around PAI-centric applications.

PAI blockchain uses a Proof of Identification: Fake profiles are not possible on the network through data verification performed by Authenticators (Anyone who offers human labor to verify and confirm changes that have taken place within

the PAI Network.). In this way, the user is still able to track the PAI activities to ensure their PAI is not misused for malicious behavior.

The identity of the PAI can be verified for trust through the blockchain protocol. The data and experiences created, developed, and submitted by people or developers can also be verified for trust through the blockchain protocol. Anyone who helps verify through the blockchain is compensated with PAI Coins.

#### Use of AI

The protocol serves as the foundation of a new AI economy, where AI is decentralized, personal data is securely associated with a person's PAI, and people are fairly compensated for their contributions.

#### Smart contract characterization

Decentralized applications (PAI App) built upon the PAI Network. These applications span across the personal information economy, social networking, healthcare, education, and other personalized products and services.

#### Utility Token

Users on the PAI Network transact with PAI coins. The reward system for goods and services such as compensation for providing computational power or payment for using an application all operate with PAI coins as the standard currency.

#### Funding

\$27.3M collected with traditional venture capitalists mechanisms

#### Industrial synergies

Oben has a partnership with Tencent

#### Timeline

Release prototypes

## **IX. DeepMind (Google)**

### History

DeepMind Technologies is a British artificial intelligence company founded in September 2010, currently owned by Alphabet Inc. The company is based in London but has research centers in California and Canada.

Acquired by Google in 2014, the company has created a neural network that learns how to play video games in a fashion similar to that of humans, as well as a Neural Turing machine, or a neural network that may be able to access an external memory like a conventional Turing machine, resulting in a computer that mimics the short-term memory of the human brain. [53]

### Solution

Over the course of this year, they are going to build a Verifiable Data Audit for DeepMind Health, their effort to provide the health service with technology that can help clinicians predict, diagnose and prevent serious illnesses (a key part of DeepMind's mission to deploy technology for social benefit).

DeepMind wants to create machine learning services, that can identify diseases and illness in medical scans and other health records. For such a system to work hospitals will need to share their records with the Google Lab, but Google will need to reassure the world that it respects patient privacy.[52]

### Use of Blockchain

DeepMind's system will record and later verify everything that happens to a piece of data. Just as the blockchain works to track every event related to a personal stash of bitcoin, DeepMind's system will track every event related to hospital health data.

### Use of AI

They declare that will use AI algorithms to recognize the symptoms of an illness, but it is not clear how they will work.

### Smart contract characterization

n.a.

### Utility Token

n.a.

### Funding

The fund comes from Google

### Industrial synergies

Google is the main partner of the project because they have bought DeepMind.

### Timeline

Whitepaper

## **X. IBM**

### History

International Business Machines Corporation (IBM) is an American multinational information technology company headquartered in Armonk, New York, United States, with operations in over 170 countries. The company began in 1911 as the Computing-Tabulating-Recording Company (CTR) and was renamed "International Business Machines" in 1924.[54]

### Solution

IBM enter in the blockchain and AI market with a project connected to the supply chain of the perishable goods. It is possible to use these instrument to track environmental conditions for a food safety supply chain, refrigerated medical supplies, garden plant shipments, or any perishable shipment that are sensitive to the temperature, humidity, vibration, or time. [55]

### Use of Blockchain

The Hyperledger blockchain can be used to record immutable transactions as the shipment progresses through its delivery journey.

The Internet of Things allows devices to send data to private blockchain ledgers for inclusion in shared transactions with tamper-resistant records. The distributed replication of IBM Blockchain enables business partners to access and supply IoT data without the need for central control and management. All

business partners can verify each transaction, prevent disputes, and ensure each partner is held accountable for their individual roles in the overall transaction.

#### Use of AI

They will use some sensors that are powered by AI, but at this moment is not so clear how this could happen. A hypothesis is to connect this new project with the Watson IoT Platform.[56]

#### Smart contract characterization

The smart contract helps define many of the terms that the parties agree to follow. These smart contracts can even signal additional actions outside of the blockchain, like ordering a replacement part or placing a service call.

#### Utility Token

n.a.

#### Funding

IBM has a lot of funds that are not necessarily connected to this project.

#### Industrial synergies

IBM has many partnerships with technology companies.

#### Timeline

Tech docs on GitHub.

## **XI. Fetch.AI**

#### History

Fetch.AI is a convergent technology company founded in 2015 to leverage economic value generation by converging artificial life, machine intelligence, multi-agent simulations, cryptography, and distributed ledger technologies. Fetch refers to itself as a “decentralized digital world”.

### Solution

Fetch actively puts value-generating agents in contact with those that require it. The Open Economic Framework (OEF) provides life-support for autonomous software agents. These can be thought of as digital entities that are able to make their own decisions. They exist in a digital world that dynamically reorganizes itself to present the optimal environment for agents to operate in.

Fetch supports, rewards and encourages individual agents' intelligence whilst constructing a collective super-intelligence to support all users of the network.

### Use of Blockchain

The blockchain of Fetch.ai is focused on these 4 main points:

- Scalability: many millions of agents will be working alone or in groups to provide solutions for themselves and for other stakeholders.
- Stability: for an economic system to be useful it is necessary to have a means of trading that ensures price stability. An important aspect of achieving stability is to separate fast moving tokens from slow-moving ones.
- Useful economic work: the original Bitcoin protocol uses proof-of-work to protect against consensus attacks such as double spends. This is a powerful idea, but Fetch.ai believe that rather than solving a puzzle with no other benefit, the computational power should be used to solve relevant problems and thereby empower the economy.
- Risk and trust information — the network should provide trust, reliability, reputation, and network intelligence information to allow users of the network to access the information they need to conduct business effectively and efficiently.

This is the key value proposition of the Fetch's ledger.

### Use of AI

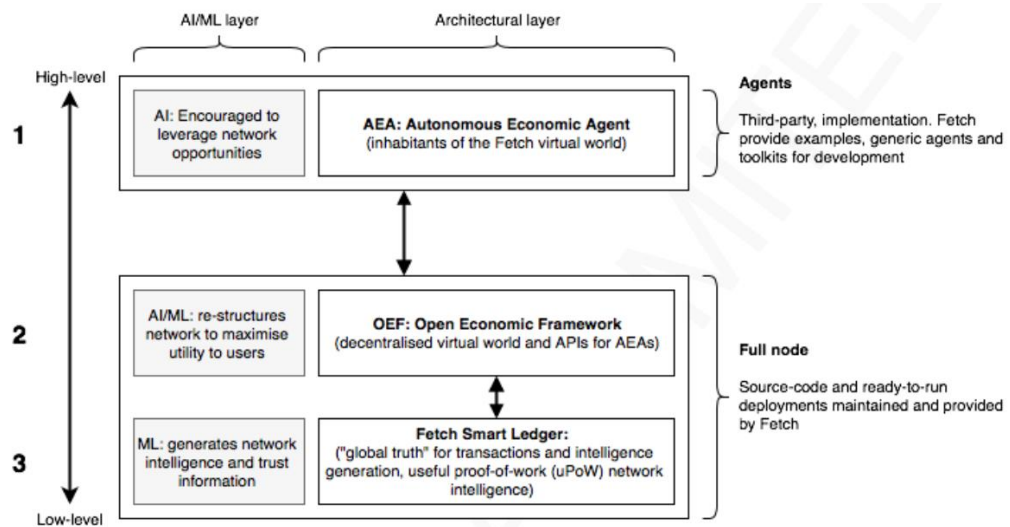


Figure 19 Fetch.ai layers

The Fetch.ai network is divided into three levels (as shown in the figure sopra), just the higher is powered by AI. The base level AEA (Autonomous Economic Agent) is a software entity that is able to perform actions without external stimulus. All AEAs must contain a unique identifier which comes from the agent's "wallet".

#### Smart contract characterization

The main idea of Fetch.ai is to create an intelligent contract and not just a smart contract, but at this moment is not so clear how they can do so.

#### Utility Token

A "trolley token" is a kind of token to be deposited in a smart contract that is refunded in one of two cases, 1) a graceful unregister with no pending/in-progress transactions or 2) the node fails. Trolley tokens ensure that there is a token requirement in order to be part of the network and encourages good behavior. It also attaches a cost to malicious agents: large-scale attacks cost tokens and all of these are likely to be lost.

Fetch are issuing a fixed number of divisible tokens that are used on the network as the digital currency for all transactions, as well as for network operations such as secure communications. Tokens can also serve as a refundable deposit for both nodes and agents wishing to perform certain operations.

#### Funding

In 2018 collect \$15M with a seed round

### Industrial synergies

One of the most important investors of the company is Outlier Ventures, with the help of Fatch.ai and other projects they want to build a Convergence Ecosystem Stack.

### Timeline

Technology and platform development



## 4. Cross case analysis

This chapter of the Thesis will answer the research questions:

3. Which is the strategic positioning of the most important company in this market?
4. Why Blockchain 4 AI?

### a. Strategic positioning

#### Two-sided platform (TSP)

The strategic positioning named "Two sides Platform" represents the case of an intermediary positioned between two different groups of users. In the case of this archetypal actor, the company is the vehicle for data or algorithms, which are paid with a native token.

TSP takes advantage of the indirect positive externalities created when:

*“The utility of an agent belonging to a group (say network) A depends on the number of agents of the group B and vice-versa:  $\begin{cases} U_{i,A}(q) = U_{i,A}(N_A(N_B), q) \\ U_{i,B}(q) = U_{i,B}(N_B(N_A), q) \end{cases}$ ”*

(Cambini, 2018)

*This network effect attracts new entrance into the platform, establishing in this way a virtuous circle.* A platform is a place where scientists, who need quality data set, or companies, who need algorithms, could find it. The platform handles the matchmaking between the demand and the supply and remunerates the seller through a native token. The importance of using the token lies in the fact of being able to connect the remuneration with the performances of the vendors.

There is a difference between platforms that are intermediaries for algorithms and the ones that are intermediaries for data. In fact, in the case of algorithms, the platform connects only the seller and the buyer. On the contrary, in the other case the platform has a very different purpose. It receives the flow of data, then these are analyzed and divided into quality data sets, after this phase the latter can be sold to the buyer. it is clear that this mechanism allows the platform to maintain control and ownership of data, which could be organized and resold many times. Opposing the platform could decide to keep these immense

datasets, in this case the role of intermediary would be just a gimmick to easily collect a lot of data. In the second case, the platform collects huge masses of data, which create a very important database and could sell many different times, creating even more sophisticated data sets.

*Definition: "TSP is a platform that has as its ultimate goal the meeting between those who need algorithms and / or data and those who are able to provide them. The blockchain is essentially used as an aid to the remuneration between the parties."*

#### Web Service Platform (WSP)

As suggested by the name, in this kind of platform it is possible to buy services, which could also be customized. The blockchain is used for a twofold purpose: firstly, to remunerate the scientists that contribute to building the infrastructure of the platform, and secondly as the payment system for paying the services. The most important applications of this archetype are connected to the AlaaS "is basically third-party offering of artificial intelligence outsourcing. So, people get to take advantage of AI without spending too much money, investing in the same and at a much lower level of risk involved". [57] Many different firms (like for example Effect.AI) want to create new decentralized and safe marketplace to sell AI to anyone, and at the same time decreasing the power of the Big Companies. In other cases, these platforms are used to sell other kinds of services, like for example financial predictions (this is the case of Numerai), that are created using AI algorithms.

To create the infrastructure that has been defined as WSP, in several cases the companies have launched campaigns to develop some parts of the algorithms that make up the infrastructure itself. This crowd aspect makes the market peculiar, and at the same time stimulates affiliation from developers and computer experts, thus bringing a network effect and also positive externalities to this strategic positioning.

*Definition: "WSP is a marketplace that allows the sale of AlaaS, AI solutions that are customized and as consistent as possible with the needs of customers."*

*The blockchain serves to simplify monetary transactions and analyze customer satisfaction with respect to output”*

### Off the Shelf (OTS)

The expression "off the shelf" is used to identify a product that can be used immediately, and at the same time that does not allow great customization. An example of off-the-shelf software is the Microsoft Office package.

In this discussion, it was decided to include in this archetype all those projects that were designed as complete and sufficient to fulfill the function that is required. Obviously, in the cases that were analyzed in the previous chapter, these software had to be integrated into the information systems of the purchaser.

In this way, these software could not be used as a stand-alone service but they must be integrated to the hosting IS. The main applications are the ones connected to intelligent database: *“is a system that manages information (rather than data) in a way that appears natural to users and which goes beyond simple record keeping”*[58].

To improve these solutions, the companies have developed AI and blockchain software, which can be used to control the transactions of data (with the help of blockchain) and in many cases that collect data in an autonomous way (with the help of AI agents). After having realized it, the company puts the software on the market, which can not undergo large variations to adapt to the buyer's request. But this also presupposes that this kind of service is already strongly centered on optimizing a particular output or solving a particular problem.

*Definition “OTS are essentially software solutions, which use blockchain and AI to optimize the functionality of a process or service. Often they can not be used as stand-alone products, rather they need to be integrated with an IS.”.*

### APP

These projects are usually mobile applications that – tapping into AI and blockchain – can help a client in two different ways:

- Managing the match between the offering and the necessities of the client, for example finding the better service on the market for him.

- Managing the time-consuming actions for him, for example, write emails with his/her tone of voice.

In any case, the app projects are services that could be installed in smartphones and give an output that is clear and precise. In these cases, AI and blockchain are used as an invisible framework to accomplish the mission of the project. the use of intelligent agents makes it possible to independently manage the match between the customer's needs and the offers on the market; an example can be the search for an insurance policy or an influencer that is suitable for the media campaign that the company wants to undertake. While the use of blockchain ensures the security of customer data, taking the example it is clear that a company that is going to make a new advertising campaign has every interest in maintaining a certain privacy on its project, to avoid that the idea is copied by a competitor before launch.

*Definition: "Applications, usually mobile, take care of managing various functions with the aid of AI, from the search for the best match between market supply and customer demand, to the management of time consuming activities in an autonomous way. The blockchain is used to guarantee the security of the data used."*

## **b. Short List analysis**

After the classification of the archetypes a question that arises is as follows: is a public or private blockchain the same?

To answer this question, I conducted an analysis of the companies that are included in the shortlist, and the figure sotto represents the summary of results.

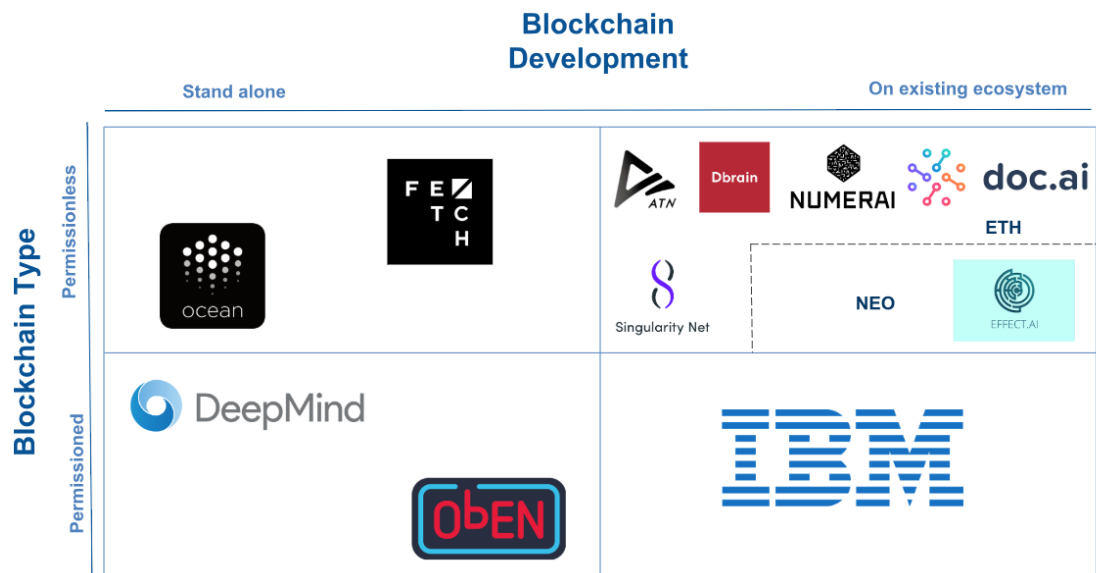


Figure 20 Shortlist matrix

With a more in-depth analysis, it is possible to characterize the actors present in the quadrants of the matrix.

DeepMind and IBM use a permissioned blockchain, respectively on a stand-alone and on an existing ecosystem. Both have a strategic positioning on the OTS archetype and both offer closed source software, which must be implemented on a proprietary IS.

This could be a strong discriminant in the choice to use a proprietary blockchain, in fact in the case of blockchain permissioned the possibility of access is allowed only to users who have received the "permission", this is consistent with the idea of the company to offer packages closed source.

The APP is the most versatile archetype of this matrix. In fact, Doc.ai is built on a permissionless and existing ecosystem while, Oben uses a permissioned and stand-alone blockchain. The main difference between the two companies is that the former uses a token based on Ethereum as a means to remunerate people who provide data to AI algorithms, while the latter stratifies the AI layer on its own blockchain. It is clear that: in a project in which the data provided by customers are the skeleton to create avatars that represent the whole person (Project PAI by Oben), without allowing duplications, exchanges of identity or errors, the blockchain is an integral part of the value chain of the final service.

While in projects such as Doc.ai, in which it is only used as an aid to remuneration, it is undoubtedly more marginal.

Most of the TSPs are built on top of a permissionless and existing ecosystem because they usually use blockchain as support to reward parties. A particular feature of Ocean Protocol and Fatch.ai is that, even if they are TSP, they use a permissionless and stand-alone blockchain. This feature is justified by Outlier Ventures, the main investors of both the companies mentioned, which intends to pursue the mission of creating a “Convergent Ecosystem” defined as a place where: *"data is the core asset. Collected by the Internet of Things and software, data is authenticated, validated and secured using distributed ledgers, consensus, and other decentralized technologies. When needed, data is transported and shared before ending up in marketplaces to be packaged up and sold. Finally, it is processed, analyzed and automated using a range of technologies including distributed computation, decentralized machine learning, and smart contracts"* (Outlier Ventures, 2018). The quote explicates how this Venture Capitalist is building a sort of DAO in which all the companies could collaborate in a particular way. In fact, in all the whitepapers of the companies financed by Outlier Venture, in the part dedicated to the functioning of the proprietary blockchain implemented in the single project, there is a clear reference to the compatibility with a "convergent ecosystem", just what Venture Capitalist sponsors in its paper .

Finally, Numerai and Effect.AI use permissionless and existing ecosystems (respectively Ethereum and Neo) because they are in process of building their Web Service Platform (WSP). In coming years, they will probably build their own blockchain: in particular, Effect.AI wants to offer AIaaS (as explained in the paragraph sopra) through his platform.

In conclusion, the experimental evidence highlights that using a permissionless ecosystem could be easier, and it is preferable for those companies that use blockchain essentially as a tool for remunerating the parts, without a real integration of it within the value chain of their project, but the fee of using the token on an existing ecosystem could be remarkably high. On the contrary, companies that want to use blockchain as the main part of their service usually prefer permissioned blockchain, build on top of an existing ecosystem (as Hyperledger) or on stand-alone infrastructure. In many cases, there is

information asymmetry about the technical features of permissioned blockchain, and it is possible that many of them are, in practice, decentralized ledger (DL) with private keys. The use of DL can reduce the enormous cost connected to the development and management of a real permissioned and private blockchain.

### **c. Blockchain 4 AI**

After the analysis of the different companies that are part of the long list and the focus on the eleven companies of the short list, this paragraph explains the benefits – common to the companies examined – resulting from the integration between blockchain and AI. Moreover, since the actors came from many different industries and background, and in addition, they follow different projects, it is possible to generalize the results and say that using Blockchain is an objective advantage for the development of AI.

### **I. ICO and funding**

ICO (initial coin offering): *“Unregulated [meaning decentralized] issuances of cryptocurrencies where investors can raise money in bitcoin or other cryptocurrencies”* [59] In practice, it is a sale of tokens or coins offered by blockchain companies in order to raise funds. Investors in ICOs hope to receive profits from their early access to the project.[60] Anyone could invest in ICO independently of the location or the amount of money that he wants to "risk" because the limits (if any) are usually low. In traditional fundraising, the sums are fixed and it is very difficult to invest in a different geographic market.[61] The peculiarity of this kind of the peculiarity of this financing model is speed, so the real distinguishing factor between various projects that were very promising in theory is essentially timing. Many blockchain-based start-ups have decided to launch an ICO to raise funds, as alternative to the traditional equity financing, encouraged by the good results of the former, and the increasing number of ICOs activates a trust cycle. (CBInsights, 2018) In a short time, total funding collected with this new mechanism exceeds those raised with traditional equity financing.

In the second half of 2017, all tech angel and seeds have totaled \$1.4B by financing 1600<sup>+</sup> startups, while ICOs collected \$1.3B to finance 150. (This is explained in the two figures sotto) (CBInsights, 2018)

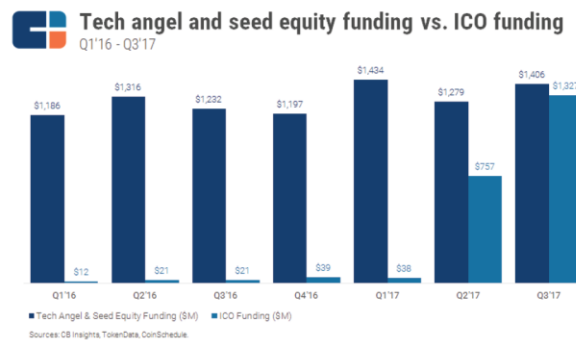


Figure 21 Total fund raised (CBInsights, 2018)

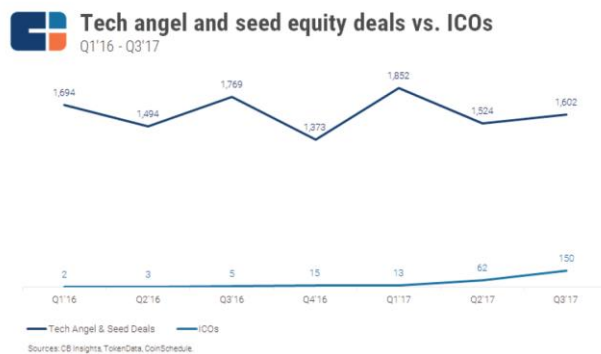


Figure 22 Total startups financed (CBInsights, 2018)

According to the CB Insight analysis, and the figure sotto, ICOs have 5x more capital deployed than in equity financing to blockchain startups. In the last part of 2017, that number jumps to 7x. [62]

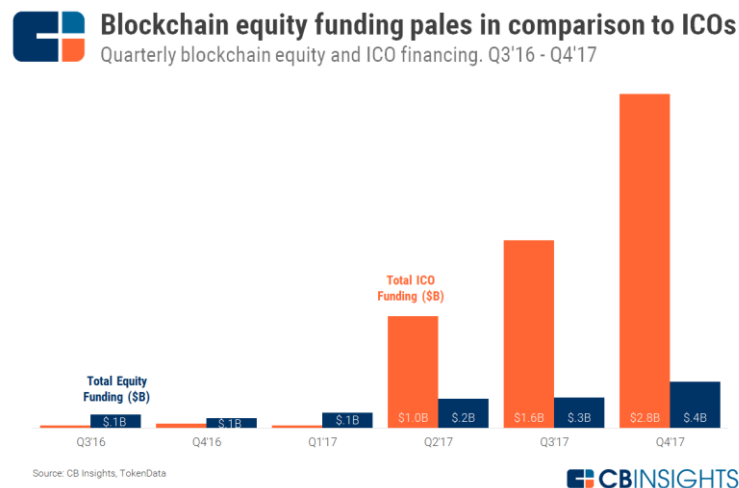


Figure 23 VC and ICO funding [62]



The most important drivers of this phenomenon are essentially two:

- Startups with ICO collect, in the early stage, a figure well above the historical average of \$3M. (CBInsights, 2018) (For example, SingularityNET raises 36M in 60seconds, this was the faster ICO ever done)
- The Venture Capitalist bureaucracy is really diminished with an ICO (as shown on the table sotto)

ICO <sup>[63]</sup>	VC <sup>[64]</sup>
Whitepaper	Introduction Summary
	Brief statement
	Executive Summary and Business Plan
	Business Model presentation
	Team presentation
	Financial Projections
	Financial request of Funds
	Additional documents requested

Table 1 ICO vs. VC documents

In conclusion, ICO is not the answer to every financial problem; in fact, it needs a lot of investments in marketing and advertising, but right now it is very attractive for tech startups, in the decentralized ledger technology (DLT) domain. This could be one of the reasons why AI startups integrate blockchain on their project.

## II. Create value to join data and algorithms

As it is known, it is not possible to create AI without quality datasets and powerful algorithms. In the case studies presented in the previous chapter, it has been explained that some companies base their business on sharing one or both of these basic assets.

First of all, it is important to underline that data, which must be used for the learning phase of AI algorithms, should come from organizations or individuals.

Secondly, it is necessary to say that "data sharing" is not a synonym of "data for free": in fact, there are many entities that sell their own data, but the big problem is to govern this kind of market. According to the study carried out by the (European Commission, 2018), B2B data sharing is often seen as a hurdle on the way to a thriving European Data Market.

The most important problems highlighted by the EC are divided into *technical obstacles* and *legal uncertainty*, as illustrated in the figure sotto:

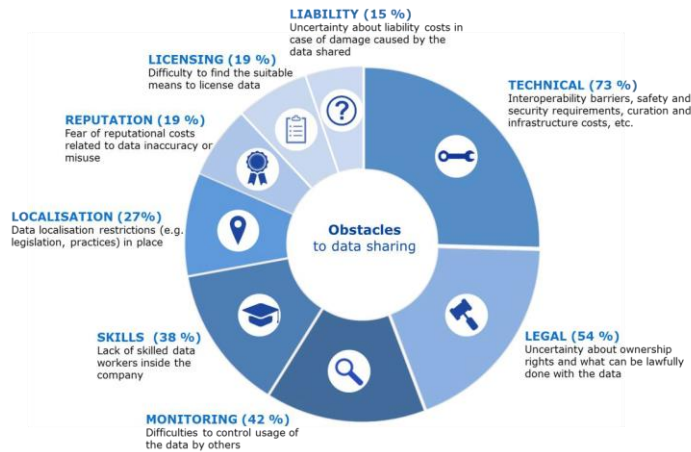


Figure 24 Obstacles to data sharing according to the survey results (European Commission, 2018)

The technical obstacles identified by companies taking part in the study are:

- High related costs
- Need for processing and store large volumes of data
- Lack of data standardization and interoperability
- Poor quality of data
- The scarcity of trust linked to technical solutions

Legal ones are:

- Legal uncertainty regarding “data ownership rights”
- Difficulties to have control over the usage of the shared data
- Legal requirements on data protection
- Data localization restrictions
- Incomplete contracts

The distinctive features of blockchain are suitable to propose potential solutions for most legal problems related to the sharing of B2B data (summarized in the table sotto). In fact, immutability, decentralization, and security of transactions, carried out through this instrument, are exactly what it takes to overcome these

obstacles. At the same time, the costs associated with the sharing are lower, because several intermediate steps are bypassed.

The most important problems connected with the data sharing could be mitigated with the help of blockchain:

- High related costs → A PwC article says: “Firms will have the possibility to reduce the need for manual intervention in aggregating, amending and sharing data, and regulatory reporting and audit documents could become easier, requiring less manual processing.”[66] By reducing the need for manual processing it is clear that costs related to intermediation are significantly reduced.
- Data ownership rights → Through the use of the blockchain, the data holder can decide which data to make public and to whom, through the use of some mechanisms related to keys that certify their ownership. In this way the uncertainty regarding the ownership of the data is totally dissolved, and at the same time the power of data management is put in the hands of the data holder. (Zyskind, Nathan, & Pentland, 2015)
- Data protection → the mission pursued by the blockchain for which: "the data are cleaned up for comparable information making it possible to readily identify the participants", [67] has led several researchers to think that it is precisely the most suitable tool to allow data protection at the global level. Some experts dare to say that the resolution of the controversial art 25 of the new European GDPR regulation may be the implementation of the blockchain as a guarantee of security. [67]
- Data localization restrictions → The fact that the blockchain has as its distinctive component the decentralization allows to completely bypass the problem connected to the location of the data. At any time the owner of the key, can access the data entered in the blockchain simply by using any Internet connection.[68]
- Incomplete contract → The need to define incomplete contracts stems from the fact that opportunism exists, and that the parties must necessarily trust each other to enter into a contract. The use of the blockchain cancels the need to place trust in the other actor who signs the contract, making the contract management system totally automatic and

without intermediation of humans. This allows to zero the component connected to opportunism, creating in theory a basis of contracts that are based on secure and easily verifiable transactions. Moreover, the factor of costs connected to the contract (analysis of contingencies, writing and enforcement) is noticeably reduced, and this leads to the definition of increasingly complete contracts. (Davidson, Filippi, & Potts, 2016)

- Data standardization and interoperability → Since the blockchain allows to create immutable and identical copies of the data entered within it, all those who have access to the blockchain can potentially simultaneously access the same data set, thus standardizing the output that can be seen. Furthermore, in many cases, participants tend to standardize the data structure. [69]
- Data quality → The data quality is defined starting from its components. Since the data to be validated in blocks must necessarily have a particular conformation, then on the whole the validation process guarantees an intrinsic coherence in the data. Moreover, blockchain applications tend to have warnings to highlight the accuracy of the data, which means that the data are necessary accurately. As for timeliness and completeness, these components are still discovered even with the help of the blockchain. But the fact of being able to say that the data related to the blockchain system have two of the four properties connected to data quality is already a big step forward. [70]
- Scarcity of trust connected to technical solution → ultimately the resolution of all the other problems related to data sharing tends to increase the trust connected to a technical solution such as blockchain

Problems	Mitigation actions
High related costs	Decreasing the need of manual intervention in managing and collecting data, because of the automatic collection and control did by the blockchain.
Data ownership rights	The use of the blockchain allows the data owner to decide how, to whom and at what cost to allow access to it
Data protection	The absence of comparable information that identifies the participants is the data protection fusion guaranteed by the use of the blockchain
Data localization restrictions	Blockchain is decentralized, everyone can access to data everywhere
Incomplete contracts	Reduction of cost connected to the contract to allows it to increase its completeness

Table 2 Blockchain mitigation actions (1)

Problems	Solutions powered by blockchain
Data standardization and interoperability	The replicability of the datasets, entails a strong standardization and interoperability of the data, which translates into a strong drive to standardize also the structure
Data quality	Responding to two of the four dimensions of data quality tends to increase the quality of the data itself
Scarcity of trust linked to technical solutions	The resolution of all other problems tends to increase trust related to data sharing

Table 3 Blockchain mitigation actions (2)

In addition, the use of blockchain facilitates also the collection of B2C data. In fact, if a person is the sole owner of his/her personal data, browsing history or mobile data, he can choose to sell or not these data, and can also choose who can buy it.

After drawing attention to this important evidence, it is possible to state that the blockchain has an activating power as regards the data sharing mechanism. This factor could allow to move much of the power on data from the big tech giants: Amazon, Google, Facebook etc ... to small startups that have as their ultimate goal the implementation of their AI solutions.

In this way, breaking up the oligopoly that the giants had formed in favor of a competition among hundreds of small players, trying to establish themselves in a totally new market space. (Mainelli, 2017)

So blockchain lowers the entry barriers in the big data market, using a safe and simple data sharing.

Furthermore, the possibility of having datasets, which can be used to train AI algorithms, is a fundamental driver for AI development. For this reason, the blockchain also indirectly activates the progress of AI technology. Additionally, there is the great importance of sharing algorithms, as underlined in the previous chapter by the presence of many TSPs on this topic.

In general, it is not necessary to pay the developers through the blockchain and the use of tokens, but apart from the evidence that the use of this new technology has a network effect and positive externalities, there are also more practical reasons that push to integrate the blockchain into AI projects. First of all, the use of smart contracts and tokens makes it possible to remunerate the actor with respect to the performances he has obtained automatically, in fact it is possible to program the smart contract in such a way that takes into account the score acquired before managing the payment. In addition, the use of this crowd management, which is facilitated through the integration of the blockchain, allows payment for benefits rather than a permanent engagement, during the period of construction of the infrastructure.

In conclusion, it is possible to confirm that, the blockchain in direct or indirect way is objectively and enabling factor for development in AI. [67]

### III. AI DAO

The combination of data and algorithms create multi-sided network effects for every stakeholder present in the AI market (users, data providers, and scientists), establishing a virtuous cycle. [71] This is the main reason why there is a convergence between the data sharing platform and the algorithms sharing platform (SingularityNET have a partnership with Dbrain, [71] Ocean Protocol and Fatch.AI are part of the Outlier Venture's Convergence ecosystem (Outlier Ventures, 2018)). The main idea is to create decentralized AI marketplaces, where AI could be sold, purchased and also developed in an autonomous, secure and decentralized way. This kind of characterization it is also called AIaaS: [57] a self-reinforced network that attracts many participants and in loop create better AI. These new marketplaces are really important because they reduce the power of monopolists as data holders, and at the same time, they transform AI in a service accessible to everyone. Creating powerful AI systems that attract the best data and models through direct economic incentives and using Web 2.0 as a commodity. Finally, AIaaS will push the technological research into this area due to the accessibility for scientists and researchers.[72] In the figure sotto is shown the timeline of the tech trend of the last 60 years, at this moment the market is in the "Crypto Era" and AIaaS is a core part of this era.

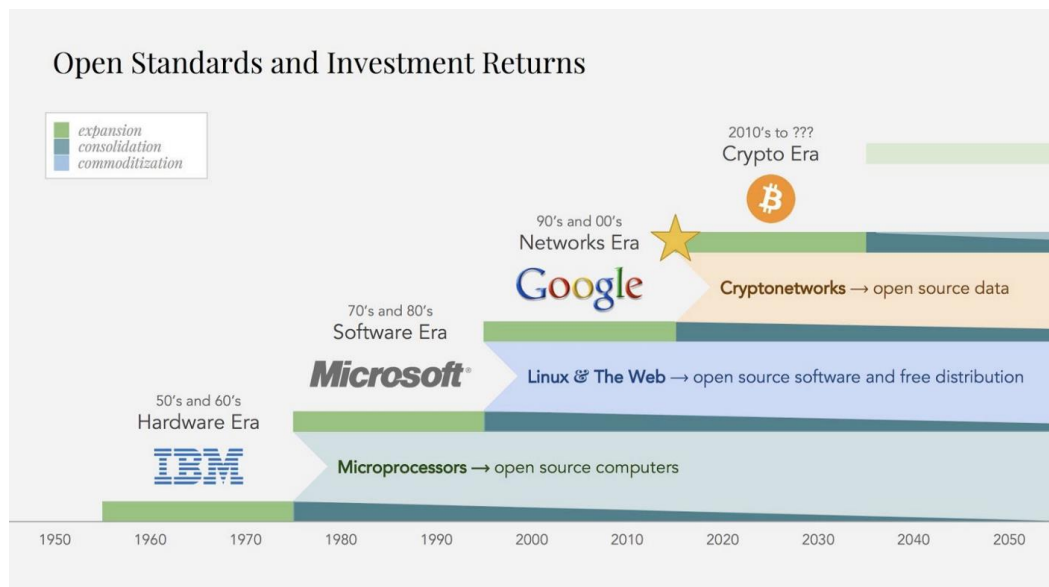


Figure 25 Standardization and commoditization in tech. [72]

Taking a further step forward, the focus is on an additional application of AI and blockchain, AI DAO. As defined in the first chapter, DAO is a computer

algorithm that carries out token ownership rights, contractual obligations, and business logic rules. [72] In this case, all the activities usually carried out by a traditional organization (e.g., royalty distribution, crowdfunding, subscriptions payments, prediction markets) are done through a set of algorithms that run on smart contracts. AI DAO's underlying idea is that machine-driven organizations can become reality, with no or limited human intervention.[74] For example, it is possible to imagine a new version of Uber with self-driving cars managed by AI. In this case, AI algorithms can learn about the traffic or the topography of the city by driving in the streets. This approach could work with many different physical objects: airplanes, phones, locks and so on, and in some years, humans will have nothing left and they will only be renters of AI services. [71] It is clear that is a really extreme point of view, but there is some powerful evidence that AI development is already going in this direction. The figure sotto depicts how AI will evolve in years to come, being characterized by applications increasingly sophisticated and autonomous.

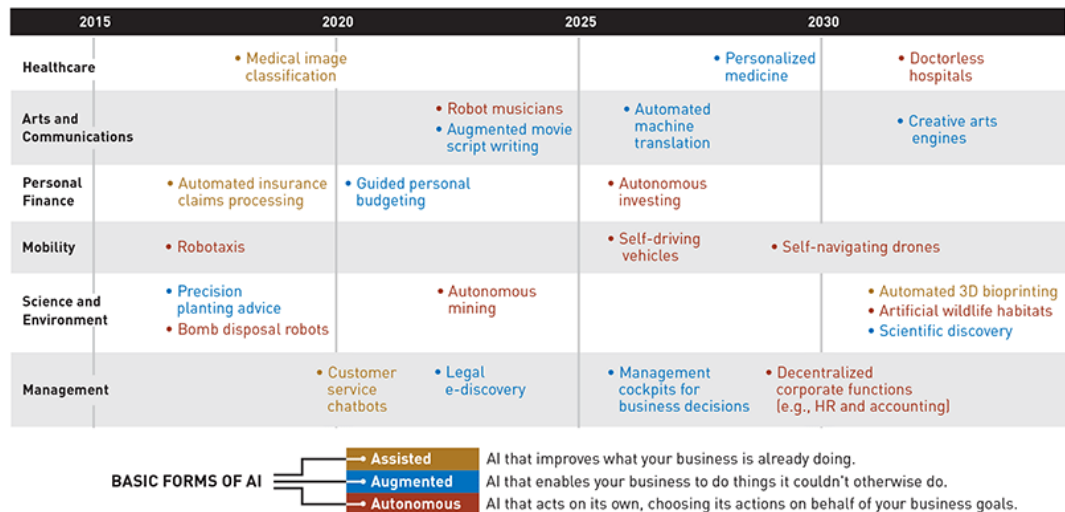
When it comes to AI, there are three layers: [75]

- Assisted software amplifies the value of existing activities. It is based on ruled and repetitive tasks and the agent simulates the action performed by humans beings. This type of AI is used to verify crosscheck data or to simulate some complex scenarios that could be used by companies to make decisions decreasing risks.
- The augmented software introduces new capabilities that humans have not, allowing companies to acquire capabilities they did not have before. This type of software is used in matches, for example, users preferences users and films offerings (Netflix) or in legal research
- Autonomous Intelligence is characterized by making decisions without human engagement or supervision. Those algorithms are now implemented in facial recognition tools or in an automated stock trading market, but their potential us practically infinite.



### Exhibit 1: Anticipated AI Applications

Estimated dates of commercial availability for products and services incorporating the three forms of artificial intelligence.



Source: PwC research and analysis

Figure 26 AI development timeline [75]

At a closer look, it is worth noting that all the examples of the figure having to do with autonomous intelligence are instances for AI DAO. In all these cases, the decision-making responsibilities are in the “hands” of an AI agent (a smart contract on the blockchain). There are two different possibilities: AI can make all decisions for humans, or in a radical scenario AI is placed at the center of DAO and in this case the AI agent became the general manager of it.[73] In any case, the intersection between AI and blockchain is necessary for the implementation of all these projects and the main objective is the use of smart contracts, AI and data to create a new era for companies.

In conclusion, AI DAOs will create a new economic reality, where the competition will be between AI managers in a decentralized network.[73]

## Conclusions and opportunities for future research

In conclusion, the thesis shows that there are substantial evidences for which the blockchain and the AI are the completion of each other in many aspects. However, it must be emphasized that most of the projects analyzed are absolutely at a very low stage of maturity; it is probable that when they are actually placed on the market they will have undergone important changes. The most important output lies in the fact that it has highlighted that many different companies are turning their attention to solutions of intersection between the two technologies, regardless of the industries to which they belong. The improvements that the blockchain will bring to AI solutions are clear and undeniable, even if not yet perfectly tangible or quantifiable. All the companies that are entering this new market have improvement spas, but the fact that they have been so reactive, almost the first mover, can only play to their advantage. In fact, it is probable that, when the market is ripe and ready, they will have accumulated a considerable advantage, both in terms of know-how and strategic positioning.

The strategic positions mapped in this thesis are probably only provisional, some factors, analyzed in the study of the sources, allow to venture that the TSP will, probably a stage of transition, towards something more durable and stable, such as WSP. It is possible to say that the creation of AIaaS solutions will be the predominant standard in these markets, but obviously they are only hypotheses.

The questions still open are many, but there are three below:

- **Policy** → What will the regulator decide to do? How to treat a market that is born as an intersection between two deeply innovative technologies, and that it is not possible to know what kind of future will it have? Will the regulator decide to enact the rules for the blockchain and then focus on the intersection market, or will it develop something that can be applicable to both?
- **Dominant Standard** → If the standard of blockchain 1.0 was Bitcoin and that of blockchain 2.0 was Ethereum, will there be a standard for blockchain 4 AI? Or will each company continue to decide for itself on which infrastructure to base its project? Are there any evidences that lead

to say that the optimization of AI occurs through the use of a given infrastructure rather than another?

- **Business model** → The mapped projects are all in “pre-market” stages, but when will they be commercialized what kind of business model companies decide to implement? In practice, how will revenues be made? And will these revenues really be sufficient to generate profits by citing the costs that are related to AI and blockchain achievements?

## Bibliografia

- BitFury Group. (2016). *Digital Assets on Public Blockchains*. whitepaper.
- Buterin, V. (2014). *Ethereum White Paper*. whitepaper.
- Cambini, C. (2018). The Economics of Platforms: Multi-sided markets and Market Strategy.
- CBInsights. (2018, 01). Blockchain Investment Trends in Review.
- Cohen, L., Manion, L., & Morrison, K. (2005). *Research Methods in Education*. London and New York: Routledge/Falmer.
- Davidson, S., Filippi, P. D., & Potts, J. (2016). *Economics of Blockchain*. paper.
- Eisses, J. V. (2018). *Effect Network: Decentralized Network for Artificial Intelligence*. whitepaper.
- European Commission. (2018). *Study on data sharing between companies in Europe*. Study.
- Ferro, E., & Osella, M. *Modelli di Business nel Riutilizzo dell'Informazione Pubblica*. . Study, Osservatorio ICT Della Regione Piemonte. .
- Garrod, J. (2016). *The Real World of the Decentralized Autonomous Society*. paper.
- Gupta, V. (2017). The Promise of Blockchain Is a World Without Middlemen . *HBR* , 5.
- Harvard University. *An Introduction to blockchain*. paper.
- Hof, R. (2013). Deep Learning. *MIT Technology Review* .
- Infosys. (2017). *Breaking barriers: Factors impacting large-scale Blockchain Adoption*. viewpoint.
- Joichi, I., Narula, N., & Robleh, A. (2017). The Blockchain Will Do to the Financial System What the Internet Did to Media. *HBR* , 5.
- JPMorgan. (2016). *Quorum Whitepaper*. Whitepaper.
- Kosba, A. (2016). *Hawk: The Blockchain Model of Cryptography and Privacy-Preserving Smart Contracts*. paper.
- Lakhani, M., & Iansiti, K. (2017). The truth about blockchain. *HBR* , 11.
- LeCun, Y., Bengio, Y., & Hinton, G. (2015). Deep learning. *International journal of science* .

Lessig, L. (2000). *Code is Law*. paper.

Liddy, E. D. (2001). *Natural Language Processing*. paper, Syracuse University.

Linux Foundation. (2016). *Hyperledger Architecture, Volume 1*. whitepaper.

Liu, D. (2007). *Proof of Work can Work* . paper.

Mainelli, M. (2017, 10 05). Blockchain could help us reclaim control of our personal data. *HBR* , 5.

Mattila, J. (2016). *THE BLOCKCHAIN PHENOMENON*. paper.

Mitchell, T. (2006). *The Discipline of Machine Learning*. Pittsburgh.

Nakamoto, S. (2008). *Bitcoin: A Peer-to-Peer Electronic Cash System*. whitepaper.

Nakamoto, S. (2009). *Bitcoin: A Peer-to-Peer Electronic Cash System*. whitepaper.

Osella, M. (2013). *A Multi-Dimensional Approach for Framing Crowdsourcing Archetypes*. thesis, Torino.

Outlier Ventures. (2018). *The Convergence Ecosystem*. Paper.

Pettigrew, A. M. (1973). The Politics of Organizational Decision Making. . *Annual Review Of Energy* .

Russel, S., & Norvig, P. (1995). *Artificial Intelligence, A modern approach*. Upper Saddle River, New Jersey: Pearson Education.

Samuel, A. (1959). *Some Studies in Machine Learning Using the Game of Checkers*.

Swan, M. (2015). *Blockchain: blueprint for a new economy*. O'Reilly.

Tapscott, D., & Tapscott, A. (2016). *Blockchain Revolution* . Portfolio Penguin.

Tapscott, D., & Tapscott, A. (2016). The Impact of the Blockchain Goes Beyond Financial Services. *HBR* , 5.

Tellis, W. (1997). *Introduction to case study. The Qualitative Report*.

The blockchain Review. (2015). *Ethereum White Paper Made Simple*. whitepaper.

University of New South Wales. (2017). *The Double-Spending Problem and Cryptocurrencies*. discussion paper, Canberra.

Valenta, M. (2017). *Comparison of Etehreum, Hyperledger Fabric and Corda*. paper.

Weiss, M., & Corsi, E. (2018). *Bitfury: Blockchain for Government*. paper, Harvard University.

- Wood, G. (2014). *ETHEREUM: A SECURE DECENTRALISED GENERALISED TRANSACTION LEDGER*. yellowpaper.
- Yin, R. (1994). *Case study research: design and methods*. Sage Publications.
- Zyskind, G., Nathan, O., & Pentland, A. ' (2015). *Decentralizing Privacy: Using Blockchain to Protect Personal Data*. paper.

## Webography

- [1] <https://www.economist.com/briefing/2015/10/31/the-great-chain-of-being-sure-about-thingsfbisdbg>
- [2] <https://medium.com/iov-internet-of-values/key-principles-about-the-internet-of-value-12f08fbdf975>
- [3] <https://www.cbinsights.com/research/bitcoin-blockchain-startup-market-map/>
- [4] <https://www.technologyreview.com/s/610781/in-blockchain-we-trust/>
- [5] <https://www.wired.com/story/how-the-blockchain-is-redefining-trust/>
- [6] <https://bitcoin.org/en/getting-started>
- [7] <https://blockgeeks.com/public-blockchain/>
- [8] <https://towardsdatascience.com/what-is-a-dapp-a455ac5f7def>
- [9] <https://www.forbes.com/sites/shermanlee/2018/01/22/explaining-directed-acylic-graph-dag-the-real-blockchain-3-0/#57908f67180b>
- [10] <https://en.bitcoin.it/wiki/Mining>
- [11] <https://medium.com/@remiveee/what-is-blockchain-3-0-da980941b475>
- [12] <https://medium.com/@7sevendcoin/types-of-blockchain-public-private-and-consortium-blockchain-e190604df820>
- [13] <https://blog.slock.it/public-vs-private-chain-7b7ca45044f>
- [14] <https://neo.org/>
- [15] <https://blockgeeks.com/guides/eos-blockchain/>
- [16] <https://www.r3.com/corda-platform/>
- [17] <https://www.hyperledger.org/about>
- [18] <https://www.crunchbase.com/organization/digital-asset-2#section-funding-rounds>
- [19] <https://medium.com/the-mission/a-brief-history-of-blockchain-an-investors-perspective-e9b6605aad68>
- [20] <https://www.marketsandmarkets.com/Market-Reports/blockchain-technology-market-90100890.html>
- [21] <https://www.grandviewresearch.com/press-release/global-blockchain-technology-market>

- [22] <https://www.cbronline.com/uncategorised/top-10-biggest-blockchain-players/>
- [23] <https://www.statista.com/statistics/647231/worldwide-blockchain-technology-market-size>
- [24] <https://medium.com/@lukaskai/todays-topic-1-blockchain-market-trends-for-2018-7ad199f8fece>
- [25] [https://www.reddit.com/r/CryptoMarkets/comments/7la3jg/blockchain\\_market\\_map/](https://www.reddit.com/r/CryptoMarkets/comments/7la3jg/blockchain_market_map/)
- [26] <https://www.cbinsights.com/research/blockchain-vc-ico-funding/>
- [27] <https://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/blockchain-beyond-the-hype-what-is-the-strategic-business-value>
- [28] <https://medium.com/@sohilgupta/blockchain-technology-applications-3ad1dc717a0f>
- [29] <https://www.cbinsights.com/research/financial-services-corporate-blockchain-investments/>
- [30] <https://www.technologyreview.com/s/513696/deep-learning/>
- [31] <https://www.forbes.com/sites/forbestechcouncil/2018/07/02/what-is-natural-language-processing-and-what-is-it-used-for/#248b1ca55d71>
- [32] <https://www.accenture.com/us-en/insight-artificial-intelligence-future-growth>
- [33] <https://www.statista.com/statistics/607716/worldwide-artificial-intelligence-market-revenues/>
- [34] <https://www.cbinsights.com/research/artificial-intelligence-top-startups/>
- [35] <https://markets.businessinsider.com/news/stocks/global-artificial-intelligence-market-analysis-2014-2025-market-to-grow-at-at-a-cagr-of-57-2-2017-2025-to-reach-58-97-billion-1002269723>
- [36] <https://www.ft.com/content/e33a6994-447e-11e8-93cf-67ac3a6482fd>
- [37] <https://www.statista.com/statistics/641922/worldwide-artificial-intelligence-computer-vision-market-revenues/>
- [38] <https://www.forbes.com/sites/robertpearl/2018/03/13/artificial-intelligence-in-healthcare/#bb4da691d750>
- [39] <https://sigmoidal.io/real-applications-of-ai-in-finance/>



- [40] <https://www.economist.com/special-report/2018/03/31/how-ai-is-spreading-throughout-the-supply-chain>
- [41] <https://www.forbes.com/sites/yoavvilner/2018/08/05/trust-security-and-efficiency-how-blockchain-really-intersects-with-artificial-intelligence/#2b4ab1c22c92>
- [42] <https://www.forbes.com/sites/bernardmarr/2018/03/02/artificial-intelligence-and-blockchain-3-major-benefits-of-combining-these-two-mega-trends/#5fb5e16b4b44>
- [43] <https://outlierventures.io/why-we-are-investing-in-ocean-protocol/>
- [44] <https://www.techemergence.com/ai-in-blockchain/>
- [45] <https://medium.com/numeraire/numeraire-master-plan-1a00f133dba9>
- [46] <https://www.wired.com/2017/02/ai-hedge-fund-created-new-currency-make-wall-street-work-like-open-source/>
- [47] <https://medium.com/numeraire/numeraire-the-cryptocurrency-powering-the-world-hedge-fund-5674b7dd73fe>
- [48] [https://www.reddit.com/r/ethereum/comments/766smf/im\\_richard\\_craib\\_founder\\_of\\_numeraire\\_ama/](https://www.reddit.com/r/ethereum/comments/766smf/im_richard_craib_founder_of_numeraire_ama/)
- [49] <https://bitcoinmagazine.com/articles/dbrain-and-blockchain-artificial-intelligence/>
- [50] <https://medium.com/effect-ai/announcing-effect-ai-288dc5e4733a>
- [51] <https://atn.io/>
- [52] <https://www.wired.com/2017/03/google-deepminds-untrendy-blockchain-play-make-actually-useful/>
- [53] <https://en.wikipedia.org/wiki/DeepMind>
- [54] <https://www.ibm.com/us-en/marketplace/iot-blockchain>
- [55] <https://developer.ibm.com/patterns/develop-an-iot-asset-tracking-app-using-blockchain/>
- [56] [https://www.ibm.com/internet-of-things/spotlight/blockchain?cm\\_mmc=OSocial\\_Blog\\_-\\_Blockchain%20and%20Watson%20Financial%20Services\\_Blockchain\\_-\\_WW\\_WW\\_-\\_Blockchain%20is%20good%20for%20your%20health%20and%20your%20business%20In%20Text%20IoT%20Spotlight%20Blockchain&cm\\_mmca1=000020YK&cm\\_mmca2=10005803&?cm\\_mmc=OSocial\\_Blog\\_-\\_Blockchain\\_Blockchain\\_-\\_WW\\_WW\\_-\\_](https://www.ibm.com/internet-of-things/spotlight/blockchain?cm_mmc=OSocial_Blog_-_Blockchain%20and%20Watson%20Financial%20Services_Blockchain_-_WW_WW_-_Blockchain%20is%20good%20for%20your%20health%20and%20your%20business%20In%20Text%20IoT%20Spotlight%20Blockchain&cm_mmca1=000020YK&cm_mmca2=10005803&?cm_mmc=OSocial_Blog_-_Blockchain_Blockchain_-_WW_WW_-_)

BLOG%20Link%20in%20Text%20for%20Blockchain%20on%20IoT%  
20Watson%20IoT%20Page&cm\_mmca1=000020YK&cm\_mmca2=100  
05803

- [57] <https://hackernoon.com/understanding-artificial-intelligence-as-a-service-aiaas-780f2e3f663c>
- [58] [https://en.wikipedia.org/wiki/Intelligent\\_database](https://en.wikipedia.org/wiki/Intelligent_database)
- [59] <https://www.ft.com/search?q=ico>
- [60] <https://cointelegraph.com/ico-101/how-to-launch-an-ico-a-detailed-guide#be-a-part-of-the-cryptocurrency-community>
- [61] <https://medium.com/@cryptomedics/ico-vs-vc-a-breakdown-19aa0f001561>
- [62] <https://www.cbinsights.com/research/blockchain-vc-ico-funding/>
- [63] <https://cointelegraph.com/ico-101/how-to-launch-an-ico-a-detailed-guide#be-a-part-of-the-cryptocurrency-community>
- [64] <http://vc-list.com/documentationsneeded-before-seeking-venture-capital/>
- [65] <https://www.pwc.com/m1/en/media-centre/articles/blockchain-new-tool-to-cut-costs.html>
- [66] <https://www2.deloitte.com/dl/en/pages/legal/articles/blockchain-datenschutzrecht.html>
- [67] [https://medium.com/@Francesco\\_AI/the-convergence-of-ai-and-blockchain-whats-the-deal-60c618e3accc](https://medium.com/@Francesco_AI/the-convergence-of-ai-and-blockchain-whats-the-deal-60c618e3accc)
- [68] <https://hackernoon.com/decentralized-data-why-blockchain-is-meaningless-and-trustless-is-everything-318fd14d3827>
- [69] <https://www.pmg.com/blog/the-promise-of-blockchain-and-standardized-data/>
- [70] <https://www.talend.com/blog/2018/06/11/4-possible-ways-a-blockchain-can-impact-data-management/>
- [71] <https://medium.com/@FEhrsam/blockchain-based-machine-learning-marketplaces-cb2d4dae2c17>
- [72] <https://medium.com/@trentmc0/wild-wooly-ai-daos-d1719e040956>
- [73] <https://www.forbes.com/sites/forbestechcouncil/2017/11/16/why-decentralized-artificial-intelligence-will-reinvent-the-industry-as-we-know-it/#20141643511a>
- [74] <http://mattturck.com/ai-blockchain/>

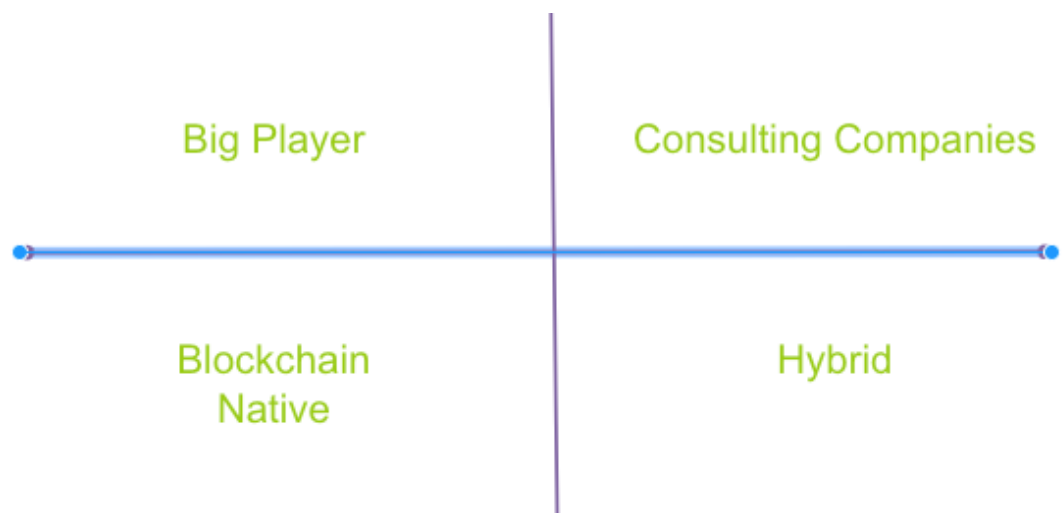
[75] <https://www.strategy-business.com/article/A-Strategists-Guide-to-Artificial-Intelligence>

## Appendix 1: Long list

To allow the classification of companies, which are present in the intersection market between blockchain and AI, some criteria have been chosen (which are summarized in the first column of the following. ()). Some of these criteria are easy to understand (year of foundation, number of employees, etc.). Others instead need a necessary explanation.

### **d. Quadrant in the matrix**

The "quadrant of the matrix" label refers to the positioning that the single company has within the matrix inserted in Figure 27.

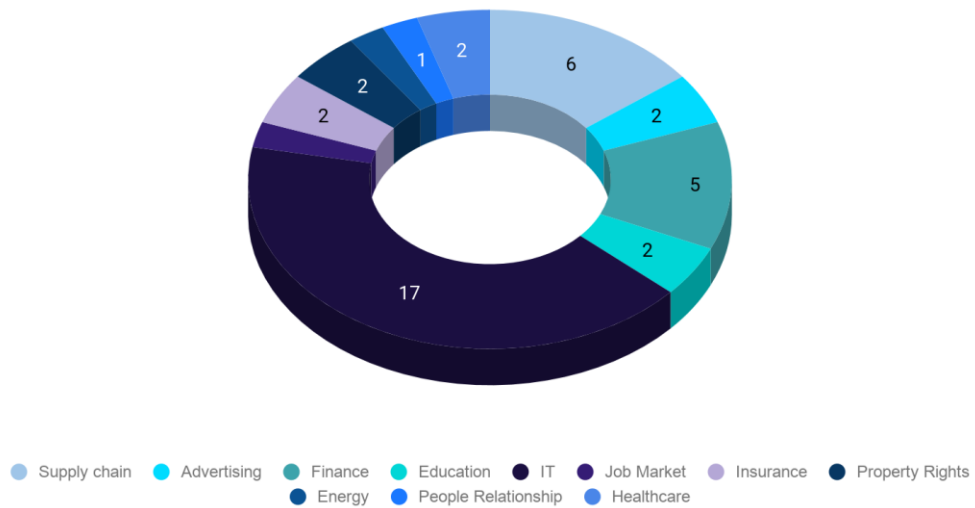


**Figure 27 Matrix**

### **e. Industry**

All the companies have been registered with respect to specific sectors (industries), to allow them to be grouped together. The aggregate results are presented in the figure sotto.

## Industries



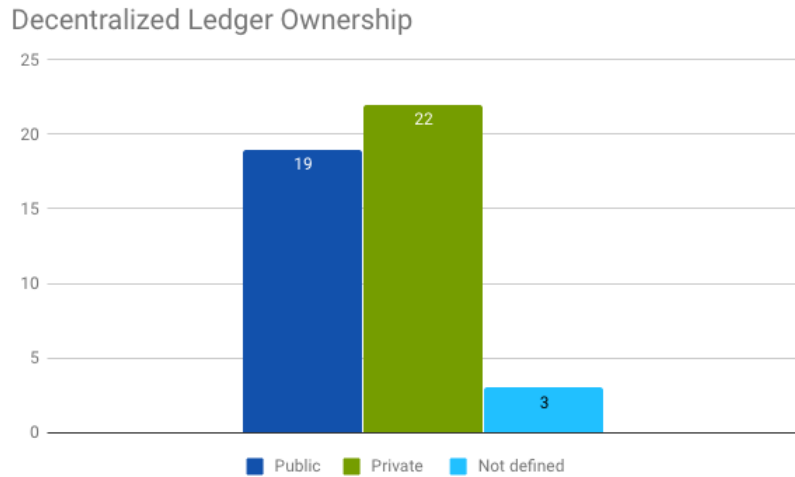
**Figure 28 Industries**

### **f. Offering**

In this line we tried to explain briefly what the offer was, that each company proposed with its own project. Obviously it is a very concise description, but it aims to allow an overview of the projects presented.

### **g. Distributed Ledger Ownership**

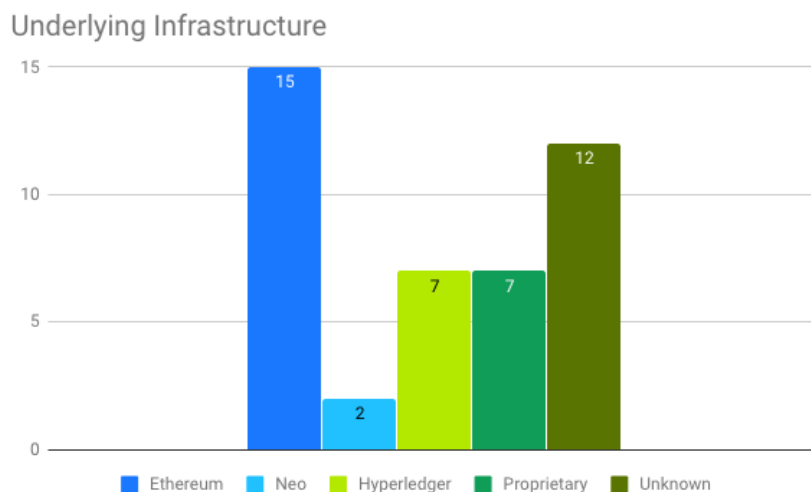
This label has been inserted to understand how companies were distributed with respect to the possibility of positioning their blockchain on permissionless or permissioned infrastructures. The figure sotto explains the findings:



**Figure 29 DL Ownership**

#### **h. Underlying Infrastructure**

The analysis carried out with this line shows what kind of infrastructure the single company has used for the blockchain connected to it. Whether it is permissionless or permissioned, note or not in the panorama of infrastructures on the market. The percentage is shown in the figure sotto:



**Figure 30 Underline Infrastructure**

## i. Timeline

To allow a more homogeneous classification, a particular taxonomy has been defined, which summarizes the various stages of progress in which each project is located. The method used is explained graphically in the following Figure 31.

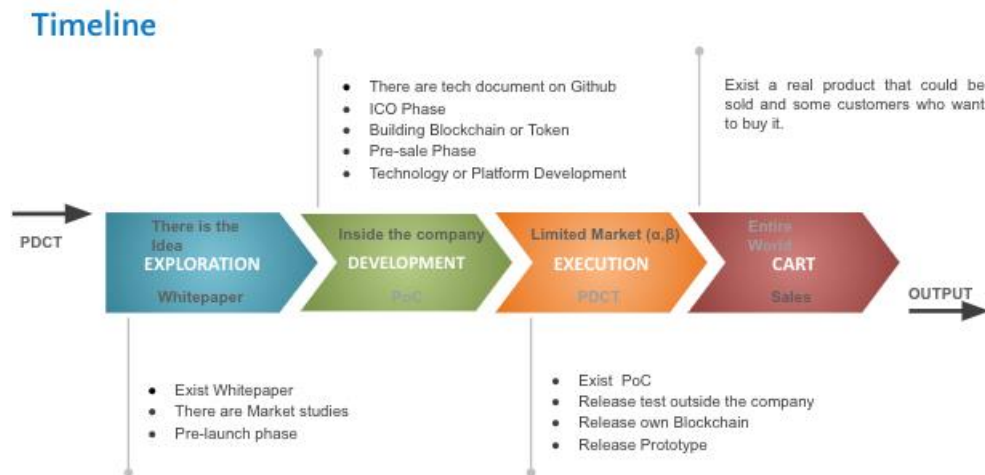


Figure 31 Timeline

The companies are distributed according to the four taxonomies as shown in the graph Figure 32:

Timeline

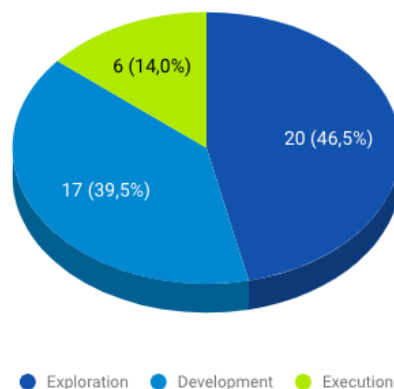


Figure 32 Timeline (2)

**Table 4 Long List**

Company Name	Accenture	Adents (Microsoft)	AdHive	Agate	AIAR
Quadrant in the Matrix	Consulting Company	Big Player	Blockchain Native	Blockchain Native	Hybrid
Founded Date	1989	2007	2017	2017	2017
Total Funding Amount (\$)	n.a.	23.5M	17.5M	1.5M	2.5M
Number of Employees	10001+	51-200	11-50	11-50	11-50
Industry	n.a.	Supply chain	Advertising	Finance	Education
Offering	n.a.	Platform for intelligent supply chain	Platform that connect brands and influencers	Gateway for cryptoeconomy	Education app with certificated studies
Smart Contract (Yes/No)	Probably	Yes	Yes	Yes	Yes
Name of the Contract	n.a.	n.a.	(standard Ethereum contract)	n.a.	n.a.
Utility Token	n.a.	n.a.	Yes	Yes	Yes
Name of the Token	n.a.	n.a.	AdHive Token	AGT Token	EdToken
Distributed Ledger Ownership	Private	Private	Public	Private	Private
Underlying Infrastructure	Unknown	Unknown	Ethereum	Unknown	Hyperledger
Name of Project	Exploration	NovaTrack	n.a.	Agate iFiat Ecosystem	AIAR® Digital Ecosystem of Learning
Progress	Market Studies	Market Studies	Token sale	ICO	Building Token
Timeline	Exploration	Exploration	Development	Development	Development
BC 4 AI	No	Yes	Yes	No	Yes
Web Site	<a href="https://www.accenture.com/it-it/new-applied-now">https://www.accenture.com/it-it/new-applied-now</a>	<a href="https://adents.com/adents-novatrack">https://adents.com/adents-novatrack</a>	<a href="https://adhive.tv/">https://adhive.tv/</a>	<a href="https://www.agatechain.org/">https://www.agatechain.org/</a>	<a href="https://aiar.com/">https://aiar.com/</a>



Company Name	<b>ATN.io</b>	<b>Bankorus</b>	<b>Cerebrum</b>	<b>Cisco</b>	<b>Cortex</b>
Quadrant in the Matrix	Hybrid	Hybrid	Blockchain Native	Big Player	Blockchain Native
Founded Date	1 Oct 2016	2013	n.a.	1984	n.a.
Total Funding Amount (\$)	10M	5.2M	n.a.	-	n.a.
Number of Employees	11-50	11-50	n.a.	10001+	11-50
Industry	IT	Finance	IT	Supply chain	IT
Offering	Platform that connect scientists and buyer of AI	APP for the asset management of HNWI	Crowdsourcing of ML alghoritms		Platform where smart contract are created autonomously by AI
Smart Contract (Yes/No)	Yes	Yes	Yes	Yes	Yes
Name of the Contract	n.a.	bLoan	Nuclei, Nucleus, Dividend.	n.a.	n.a.
Utility Token	Yes	n.a.	Yes	n.a.	Yes
Name of the Token	ATN Token	n.a.	Neuron	n.a.	n.a.
Distributed Ledger Ownership	Public	Private	Public	Private	Private
Underlying Infrastructure	Ethereum	Unknown	Ethereum	Hyperledger	Unknown
Name of Project	n.a.	Bankorus	n.a.	n.a.	n.a.
Progress	Tech docs on GitHub	Pre-sale	Tech docs on GitHub	Market Studies	Whitepaper
Timeline	Development	Development	Development	Exploration	Exploration
BC 4 AI	Yes	Yes	Yes	Yes	Yes
Web Site	<a href="https://atn.io/">https://atn.io/</a>	<a href="https://www.bankorus.com/">https://www.bankorus.com/</a>	<a href="https://cerebrum.world/">https://cerebrum.world/</a>	<a href="https://www.cisco.com/">https://www.cisco.com/</a>	<a href="http://www.cortexlabs.ai/">http://www.cortexlabs.ai/</a>

Company Name	<b>DBrain</b>	<b>DeepBrain Chain</b>	<b>DeepMind (Google)</b>	<b>Deloitte</b>	<b>Decentralized Machine Learning (DML)</b>
Quadrant in the Matrix	Hybrid	Hybrid	Big Player	Consulting Company	Blockchain Native
Founded Date	1 Aug 2017	n.a.	2010	1 Jan 1895	2017
Total Funding Amount (\$)	8.2M	n.a.	(Acquired)	-	n.a.
Number of Employees	11-50	11-50	51-100	10001+	11-50
Industry	IT	IT	Healthcare	Supply chain	IT
Offering	Platform for sharing quality data that will be use for AI training	AIaaS: platform that sell AI to companies	Software that collect Heath data that will be available to researchers	Package for the supply chain of perishable goods	Platform that collect and sell sets of data and ML alghoritm.
Smart Contract (Yes/No)	Yes	Yes	Probably	Yes	Yes
Name of the Contract	Spock protocol, Picard Protocol	n.a.	n.a.	n.a.	n.a.
Utility Token	Yes	Yes	n.a.	n.a.	Yes
Name of the Token	n.a.	DBC Token	n.a.	n.a.	DML Token
Distributed Ledger Ownership	Public	Public	Private	Not defined	Public
Underlying Infrastructure	Ethereum	Neo	Proprietary	n.a.	Ethereum
Name of Project	n.a.	n.a.	DeepMind Health	n.a.	n.a.
Progress	Release tests outside the company	Whitepaper	Whitepaper	Market Studies	Release tests outside the company
Timeline	Execution	Exploration	Exploration	Exploration	Execution
BC 4 AI	Yes	Yes	Yes	Yes	Yes
Web Site	<a href="https://dbrain.io/">https://dbrain.io/</a>	<a href="https://www.deepbrainchain.org/pc/en/index.html">https://www.deepbrainchain.org/pc/en/index.html</a>	<a href="https://deepmind.com/">https://deepmind.com/</a>	<a href="https://www2.deloitte.com/insights/us/en.html">https://www2.deloitte.com/insights/us/en.html</a>	<a href="https://decentralizedml.com/">https://decentralizedml.com/</a>

Company Name	<b>Doc.ai</b>	<b>Dopamine.AI</b>	<b>Effect.AI</b>	<b>Everythink</b>	<b>Fetch.AI</b>
Quadrant in the Matrix	Blockchain Native	Hybrid	Blockchain Native	Hybrid	Hybrid
Founded Date	4 Aug 2016	n.a.	2015	9 Aug 2016	2017
Total Funding Amount (\$)	12.3 M	n.a.	11M	170K	15M
Number of Employees	2-10	2-10	11-50	1-10	11-50
Industry	Healthcare	IT	IT	Job Market	IT
Offering	App that through the help of AI technology could recognize some symptoms	Platform for data providing	AIaaS, bulding a big decentralized machine	Sharing platform for work resources	Platform for sharing alghoritms from scientists and buyers
Smart Contract (Yes/No)	Yes	Yes	Yes	Yes	Yes
Name of the Contract	n.a.	n.a.	-	n.a.	n.a.
Utility Token	Yes	Yes	Yes	Yes	Yes
Name of the Token	n.a.	Dopamine Token	EFX Token	-	Fetch Token
Distributed Ledger Ownership	Public	Public	Public	Public	Private (Fetch Smart Ledger)
Underlying Infrastructure	Ethereum	Ethereum	Neo	Hyperledger	Proprietary
Name of Project	Neuron	n.a.	Effect M-Turk	Hands.ai	n.a.
Progress	ICO	Whitepaper	Release tests outside the company	Whitepaper	Technology and Platform Development
Timeline	Development	Exploration	Execution	Exploration	Development
BC 4 AI	Yes	Yes	Yes	No	Yes
Web Site	<a href="https://www.doc.ai/">https://www.doc.ai/</a>	<a href="https://dopamine.ai/#our-team">https://dopamine.ai/#our-team</a>	<a href="http://effect.ai/">http://effect.ai/</a>	<a href="https://everythink.ai/">https://everythink.ai/</a>	<a href="https://fetch.ai/">https://fetch.ai/</a>

Company Name	Figure	IBM	Invacio	Iris.ai	Linius
Quadrant in the Matrix	Hybrid	Big Player	Blockchain Native	Hybrid	Hybrid
Founded Date	2018	6 Jun 1911	n.a.	11 nov 2015	2011
Total Funding Amount (\$)	50M	n.a.	29.1M	2.4M	16.5M
Number of Employees	11-50	10001+	n.a.	2-10	11-50
Industry	Insurance	Supply chain	Finance	Education	Property Rights
Offering	Facilitate the choice and the sell of insurance policies	Intelligent supply chain that with the help of sensors send reliable report to the blockchain	Service of banking that integrate fiat and crypto currencies	Platform used for the scientific research	Platform that connect video creators and video player to guarantee the property rights
Smart Contract (Yes/No)	Yes	Yes	Probably	Yes	Yes
Name of the Contract	n.a.	n.a.	n.a.	n.a.	n.a.
Utility Token	n.a.	n.a.	n.a.	Yes	n.a.
Name of the Token	n.a.	n.a.	n.a.	Aiur	n.a.
Distributed Ledger Ownership	Private	Private (Hyperledger Fabric)	Private (Tamius)	Public	Private
Underlying Infrastructure	Unknown	Hyperledger	Unknown	Ethereum	Unknown
Name of Project	n.a.	n.a.	Tamius	Aiur	n.a.
Progress	Release tests outside the company	Tech docs on GitHub	Market Studies	Whitepaper	Whitepaper
Timeline	Execution	Development	Exploration	Exploration	Exploration
BC 4 AI	Yes	Yes	Yes	Yes	No
Web Site	<a href="https://figure.com/">https://figure.com/</a>	<a href="https://www.ibm.com/it-it/">https://www.ibm.com/it-it/</a>	<a href="https://www.invacio.com/solutions.html">https://www.invacio.com/solutions.html</a>	<a href="https://projectaiur.com/">https://projectaiur.com/</a>	<a href="https://www.linius.com/">https://www.linius.com/</a>

Company Name	Matrix AI	McKinsey	Namahe	Nebula AI	Neuromation
Quadrant in the Matrix	Blockchain Native	Consulting Company	Hybrid	Blockchain Native	Blockchain Native
Founded Date	2016	1926	2010	2017	2017
Total Funding Amount (\$)	n.a.	-	n.a.	n.a.	50M
Number of Employees	51-200	10001+	n.a.	11-50	11-50
Industry	IT	n.a.	Supply chain	IT	IT
Offering	Intelligent chain that automatically create new smart contract	n.a.	Platform for intelligent supply chain	Platform where AI developers could deploy their product	Platform for sharing data, that will be used to AI learning
Smart Contract (Yes/No)	Yes	Probably	Yes	Yes	No
Name of the Contract	n.a.	n.a.	n.a.	Helix, Orion	n.a.
Utility Token	n.a.	n.a.	Yes	Yes	n.a.
Name of the Token	-	n.a.	NMH Token	NBAI Token	n.a.
Distributed Ledger Ownership	Private (Matrix)	n.a.	Private	Private (NBAI)	Public
Underlying Infrastructure	Proprietary	n.a.	Hyperledger	Hyperledger	Ethereum
Name of Project	n.a.	n.a.	n.a.	n.a.	n.a.
Progress	Tech docs on GitHub	Market Studies	Pre-sale	Token Test	Market Studies
Timeline	Development	Exploration	Development	Development	Exploration
BC 4 AI	No	Yes	No	Yes	Yes
Web Site	<a href="https://www.matrix.io/">https://www.matrix.io/</a>	<a href="https://www.mckinsey.com/">https://www.mckinsey.com/</a>	<a href="https://namahe.io/">https://namahe.io/</a>	<a href="https://www.nebula-ai.com/">https://www.nebula-ai.com/</a>	<a href="https://neuromation.io/en/">https://neuromation.io/en/</a>

Company Name	<b>NOIZ</b>	<b>Numerai</b>	<b>Oben</b>	<b>Ocean Protocol</b>	<b>OSA</b>
Quadrant in the Matrix	Blockchain Native	Hybrid	Hybrid	Blockchain Native	Hybrid
Founded Date	n.a.	1 Oct 2015	26 feb 2014	2017	2014
Total Funding Amount (\$)	n.a.	7.5M	23.7M	44.2M	n.a.
Number of Employees	11-50	2-10	11-50	11-50	11-50
Industry	Advertising	Finance	IT	IT	Supply chain
Offering	Platform for advertisers and publishers	Platform for investments in hedge funds, automatically invested	Application of personal data to personal assistants powered by AI and Blockchain	Platform where is possible to find and sell data	Service of intelligent supply chain build with the help of blockchain and sensors
Smart Contract (Yes/No)	Yes	Yes	Yes	Yes	Yes
Name of the Contract	n.a.	Numerarie	n.a.	n.a.	n.a.
Utility Token	Yes	Yes	n.a.	Yes	Yes
Name of the Token	NOIZ Token	NRM Token	n.a.	Ocean Token	OSA Token
Distributed Ledger Ownership	Private	Public	Private (PAI Blockchain Protocol)	Private	Private
Underlying Infrastructure	Proprietary	Ethereum	Proprietary	Proprietary	Unknown
Name of Project	n.a.	n.a.	PAI ( Personal Artificial Intelligence)	n.a.	Ambrosus
Progress	Pre-sale	Token sale	Release Prototype	Pre-launch	Blockchain Development and testing
Timeline	Development	Development	Execution	Exploration	Development
BC 4 AI	Yes	Yes	Yes	Yes	Yes
Web Site	<a href="https://noizchain.com/">https://noizchain.com/</a>	<a href="https://numer.ai/homepage">https://numer.ai/homepage</a>	<a href="https://oben.me/">https://oben.me/</a>	<a href="https://oceanprotocol.com/">https://oceanprotocol.com/</a>	<a href="https://osadc.io/en/#team-group">https://osadc.io/en/#team-group</a>

Company Name	<b>Poleecy</b>	<b>Samsung SDS</b>	<b>Sensay</b>	<b>SingularityNET</b>	<b>Talla</b>
Quadrant in the Matrix	Hybrid	Big Player	Hybrid	Blockchain Native	Hybrid
Founded Date	2 feb 2018	15 mar 1985	27 mar 2014	2017	2015
Total Funding Amount (\$)	300K	n.a.	21M	36M	12.3M
Number of Employees	1-10	10001+	11-50	11-50	11-50
Industry	Insurance	Finance	Property Rights	IT	IT
Offering	App that help the match between client and policies	Service implemented in IS to manage payment and finance transactions.	Messaging app that help people on managing ther own data	Platform for AI alghoritm sharing	Platform that connect AI developers and companies
Smart Contract (Yes/No)	Yes	Yes	Yes	Yes	Yes
Name of the Contract	n.a.	n.a.	SDN	n.a.	(standard Ethereum contract)
Utility Token	n.a.	n.a.	Yes	Yes	Yes
Name of the Token	n.a.	n.a.	SENSE	Agi Token	BotCoin
Distributed Ledger Ownership	Private	Private (Nexledger)	Public	Public	Public
Underlying Infrastructure	Hyperledger	Proprietary	Ethereum	Ethereum	Ethereum
Name of Project	n.a.	Nexfinance	Humans.AI	n.a.	n.a.
Progress	Market Studies	Whitepaper	Whitepaper	Pre-launch	Whitepaper
Timeline	Exploration	Exploration	Exploration	Exploration	Exploration
BC 4 AI	Yes	Yes	Yes	Yes	Yes
Web Site	<a href="https://poleecy.com/">https://poleecy.com/</a>	<a href="https://www.samsungsds.com/global/en/solutions/off/nexfinance/nexfinance.html">https://www.samsungsds.com/global/en/solutions/off/nexfinance/nexfinance.html</a>	<a href="https://sensay.it/">https://sensay.it/</a>	<a href="https://singularitynet.io/">https://singularitynet.io/</a>	<a href="https://botchain.network/">https://botchain.network/</a>

Company Name	<b>Though Network</b>	<b>Verv</b>	<b>Viola.AI</b>
Quadrant in the Matrix	Blockchain Native	Hybrid	Blockchain Native
Founded Date	2016	5 mar 2010	n.a.
Total Funding Amount (\$)	n.a.	4.2M	n.a.
Number of Employees	11-50	11-50	11-50
Industry	IT	Energy	People Relationship
Offering	Platform that collect and store data for AI learning	Platform where families could sell their green energy	Dating app
Smart Contract (Yes/No)	Yes	Yes	Yes
Name of the Contract	n.a.	n.a.	(standard Ethereum contract)
Utility Token	n.a.	Yes	Yes
Name of the Token	n.a.	VLUX	Violet
Distributed Ledger Ownership	Private (Fabric)	Public	Public
Underlying Infrastructure	Proprietary	Ethereum	Ethereum
Name of Project	n.a.	Vlux	n.a.
Progress	PoC	Technology Development	Technology Development
Timeline	Execution	Development	Development
BC 4 AI	Yes	Yes	Yes
Web Site	<a href="https://thought.live/">https://thought.live/</a>	<a href="https://vlux.io/#">https://vlux.io/#</a>	<a href="https://viola.ai/">https://viola.ai/</a>



## **Appendix 2: Knowledge Base whitepaper long list.**

<b>Title</b>	<b>Date</b>	<b>Abstract</b>	<b>Link</b>
AdHive: Add your passion	2017	AdHive will be the first AI-controlled Influencer Marketing platform with Blockchain technological solutions. The AdHive platform fully automates all steps of interaction with influencers in order to save a huge amount of time and effort for advertisers. The platform will offer brands the opportunity to place a native video ad on an unlimited number of influencer channels without having to worry about proper execution. Native video advertising will become easy to run, and new opportunities for blog monetization will power community development and increase audience and advertising capacity.	<a href="https://adhive.tv/docs/AdHive_Whitepaper.pdf?v=1">https://adhive.tv/docs/AdHive_Whitepaper.pdf?v=1</a>
Agate: CryptoEconomy 2.0	2018	For the majority of cryptocurrency users, everyday transactions are heavily impractical on both the merchants' and buyers' sides. Lengthy transaction settlements, high transactions fees and a lack of user-friendly merchant facilities mean that many cryptocurrencies, although popular, are not used for commonplace purchases. Agate is a new, decentralized blockchain and comprehensive crypto infrastructure for everyday banking and merchant transactions. It boasts the highest transactions speed on the market (instantaneous) with substantially low-cost transaction fees. As the infrastructure includes a user-facing app, smartbot-AI optimal trading, a merchant-facing app, an API platform, stable coin, plugins, a physical Point of Sale (POS) terminal and debit withdrawal capabilities. Therefore, Agate will be a gateway to connect millions of physical stores, online merchants, users and developers to the cryptoeconomy once established.	<a href="https://www.agatechain.org/pdf/WhitePaper/Agate_whitepaper_English.pdf">https://www.agatechain.org/pdf/WhitePaper/Agate_whitepaper_English.pdf</a>
AIAR® - The world's first 360o ecosystem for microlearning	2017	We live in an age characterized by serious problems and incredible opportunities. AIAR®, the next digital unicorn, targets both. Given the successful implementation of its global ecosystem of learning, AIAR® will not only help to cure a large part of the world's crucial problems, but also earn a considerable amount of money to its contributors while doing it. The venture is now offering a first exclusive opportunity regarding a limited edition of tokens to a considerable discount at the ICO private sale stage, before taking the next step into an aggressive ICO public sale at global level in October.	<a href="https://drive.google.com/file/d/1k_NIZTYPPSsOSx8iuEZDFH_WJ14yDm7lx/view">https://drive.google.com/file/d/1k_NIZTYPPSsOSx8iuEZDFH_WJ14yDm7lx/view</a>

Cerebrum: whitepaper	2017	We live in a time when sensors and measured data are expanding at an accelerating and, perhaps, unsettling pace. There exists, therefore, an unprecedented capacity for amplifying our human intelligence with artificial intelligence. And yet, crowdsourced data science and machine learning platforms, and the brilliant minds these breed, remain stagnant in scale and impact. Cerebrum addresses this challenge elegantly. The power of Cerebrum is reflected in its careful disposition to data privacy concerns, its affirmation of the primacy of machine learning, its insistence that decentralization is imperative for global scalability, and above all, its emphasis on artificial general intelligence.	<a href="https://static1.squarespace.com/static/596d4c2b1b631b29938477bd/t/5a6d2fbd0d9297147585af4b/1517105092539/cerebrum_whitepaper.pdf">https://static1.squarespace.com/static/596d4c2b1b631b29938477bd/t/5a6d2fbd0d9297147585af4b/1517105092539/cerebrum_whitepaper.pdf</a>
Blockchain by Cisco	2017	Blockchain, called the “tech breakthrough megatrend” by PWC <sup>1</sup> , is rapidly gaining broad acceptance. According to IDC, global spending on this innovative technology is expected to reach \$2.1 billion in 2018. <sup>2</sup> Across the globe, industries are investigating ways to use blockchain to increase trust across their business value chains and address primary challenges around complexity, transparency, and security.	<a href="https://www.cisco.com/c/dam/en/us/solutions/collateral/digital-transformation/blockchain-whitepaper.pdf">https://www.cisco.com/c/dam/en/us/solutions/collateral/digital-transformation/blockchain-whitepaper.pdf</a>
Cortex - AI on Blockchain The Decentralized AI Autonomous System	2017	In the current blockchain world, the chain of built-in Turing Complete smart contracts is widely used, attracting a large number of application developers. However, due to the high cost of over-idealized World Computer concept, smart contracts limit their capabilities at design stage and do not fully exploit Turing Complete immense computational potential. As a result, developers are limited to write short programs and access only a very small amount of resources. While the proliferation of common smart contracts depends on the performance gains of new technologies, some extremely useful routines can be introduced ahead of time and can be applied with reasonable optimization and hardware support. This article describes a new public chain, Cortex. By revising and extending the instruction set, Cortex adds AI algorithms support for smart contracts so that anyone can add AI to their smart contracts. At the same time, Cortex has proposed an incentive mechanism for collective collaboration that allows anyone to submit and optimize models in Cortex, and the contributors to the models can be rewarded. Just as what’s happening in some areas, thanks to Cortex’s openness and sharing features, Cortex is set to create many models that transcend human capabilities. At the same time, as a social experiment, we also look forward to the Artificial General Intelligence (AGI) being born on the Cortex.	<a href="https://www.cortexlabs.ai/Cortex_AI_on_Blockchain_EN.pdf">https://www.cortexlabs.ai/Cortex_AI_on_Blockchain_EN.pdf</a>
Whitepaper 0.2 The blockchain platform to label data and to build AI apps	2018	Artificial Intelligence (AI) appears to be the next big thing. AI is all about data. Datasets used for machine learning are still labeled by hand, which requires a big effort. This creates a lot of friction: labeling quality is not guaranteed, and the initial source data is not secured. Dbrain is designed to work together in secure, seamless, integrated processes for buying, designing, and building AI apps, from start to finish.	<a href="https://whitepaper.dbrain.io/challenges/">https://whitepaper.dbrain.io/challenges/</a>

Decentralized Machine Learning. White paper	2018	<p>In the era of rapid development in artificial intelligence and machine learning, data quality and relevancy are essential to generate usable applications of high quality and accuracy for machine learning. As compared to publicly-accessible data, privately-held data are more relevant and timely for machine learning. These private data are usually untapped and inaccessible as they are stored in individual electronic devices such as smartphones, tablets and computers. Leading technology firms try to access these private data when individuals are unaware of or by providing free service to them in return. Nevertheless, these leading technology firms can only obtain a portion of the private data, which are subset of the massive untapped private data owned by all individuals. Decentralized Machine Learning (DML) protocol is designed to expand the reach to untapped private data and unleash their potential to facilitate machine learning development while providing economic incentives and protecting data privacy. Machine learning algorithm will be run on the devices without extracting the data from the devices, which will be kept within the devices. Only the machine learning result will be aggregated with outcomes generated from other devices to form an unbiased, comprehensive and accurate crowdsourced analytics and predictions. Through DML protocol, both the private data and processing power for machine learning are decentralized as algorithms are run directly on individual devices by utilizing their idle processing power.</p>	<a href="https://decentralizedml.com/DM_L_whitepaper_31Dec_17.pdf">https://decentralizedml.com/DM_L_whitepaper_31Dec_17.pdf</a>
Artificial Intelligence Computing Platform Driven By BlockChain	2017	<p>With the exponential development of GPU computing power, big data, Internet of things, sensors, and other fields over the past few years, artificial intelligence has begun to break out, in a way that futuristic technologies such as facial recognition and voice interaction are being integrated into our lives day by day. From 2012 to 2016, there was an increase of 5154 artificial intelligence startups in the whole world, the total financing amount reached \$22.4 billion, and many medium and large companies have set up artificial intelligence departments while the net investment in artificial intelligence world-wide became more than \$100 billion. It can be said that after the rise and fall several times in history, the era of artificial intelligence has finally arrived! In the past few years, the DeepBrain Chain core team has been deeply exploring the forefront of artificial intelligence, was awarded First Prize in Enterprise Sector, and was awarded Second Prize in Academic Sector &amp; Enterprise Sector of SMP 2017 Chinese Man-Machine Dialogue Field Authority Evaluation Contest held by Artificial Intelligence Research Center of the Harbin Institute of Technology, exceeding over 30 domestic first-class academic and corporate AI teams which participated in the competition. We have been committed to artificial intelligence landing applications and services for a variety of Internet of things equipments, so that ordinary equipments could have the brain, with dialogue, thinking, and reasoning abilities. In 2014, as a result, the world's first AI sound box Small Zhi was launched half a year earlier than the Amazon Echo. In 2017, the first national AI brain open platform DeepBrain was launched. When we do AI products, we realize that nearly 10% to 30% of the budget of a lot of artificial intelligence enterprises will be put into construction of AI's computing power. These include the purchase and maintenance of high computing performance hardware, which have become a heavy burden to enterprises, restricting</p>	<a href="https://www.deepbrainchain.org/assets/pdf/DeepBrainChainWhitpaper_en.pdf">https://www.deepbrainchain.org/assets/pdf/DeepBrainChainWhitpaper_en.pdf</a>

		investment in technology research and development. Is there a good way to completely solve this painful point, so that AI enterprises can promote the technological revolution more smoothly? This is where DeepBrain Chain enters. DeepBrain Chain is the first and only artificial intelligence platform in the world, driven by blockchain technology. By utilizing DeepBrain Chain's platform, artificial intelligence enterprises can reduce 70% of hardware cost. In addition, potential privacy risk for enterprises when using data can be effectively avoided. This is because the algorithm of the platform is fixed by smart contract and thus cannot be changed.	
NeuRoN: Decentralized Artificial Intelligence, Distributing Deep Learning to the Edge of the Network	2017	NeuRoN is a decentralized artificial intelligence network. It is a distributed and permissionless network of users with data ownership necessary to train neural network models. A publicly accessible network democratizes access to artificial intelligence. Thus, simultaneously protecting user data and incentivizing the use of their data for the greater good of humanity. An initial implementation of the network will focus on decentralizing the stochastic gradient descent algorithm to enable the network to operate in a permissionless and decentralized fashion. Furthermore, NeuRoN will function as a token-based economy. Participants will be required to prove ownership of tokens and receive tokens for participating. This enables broader participation and incites greater desire to interact amongst those qualified to discover new insights within our decentralized artificial intelligence platform.	<a href="https://s3-us-west-1.amazonaws.com/ai.doc.static/pdf/whitepaper.pdf?t=1528728614908">https://s3-us-west-1.amazonaws.com/ai.doc.static/pdf/whitepaper.pdf?t=1528728614908</a>
The Dopamine Network	2017	As scientists, we try to replicate nature in ways that benefit the greater cause of humanity. From medicine to energy, nature is the basis of technologies that sustain our life. In the field of artificial intelligence (AI), we use neuroscience, the study of the human brain, as an inspiration to develop machines that can think at a high level. Intelligent machines can solve problems, such as having to work, drive, or clean your home. Super-intelligent machines can potentially solve even bigger challenges, such as hunger or natural disasters. A neural network is a sophisticated data processing paradigm that is inspired by biological brain. We believe that highly sophisticated data processors, individuals or organizations like Google with intellectual property (IP) for processing or holding data, can form networks that independently learn and grow much more rapidly than a simple neural network. The conduit to super-intelligence will be through the formation of Decentralized Collaborative Processing Networks (DCPNs) where highly sophisticated data processors work together to create a larger super mind. A great example of a naturally occurring simple DCPN is the collaboration in medical research done by virologists during the outbreak of Zika. Many scientists from around the world selflessly shared their findings, built on top of others' work, and collaborated tirelessly to identify Zika's root causes and implement preventative measures to control the outbreak. Within months, more research had been done on Zika than on any other outbreak in history over such a short period of time. Their incentive was to save humanity, and the urgency was high. But how can you bring sophisticated researchers together when the urgency is not as tangible as an epidemic? How do you encourage collaboration to find solutions to global warming, war, and pollution? The Dopamine Network is the first ecosystem for Decentralized Collaborative Processing Networks (DCPN), protecting individuals' IP while providing an incentive structure designed to encourage collaboration and penalize bad actors. The world is dominated by centralized organizations who do not collaborate because societal and economic incentivizes encourage competition and IP protection. Through the use of Ethereum smart contracts and Dopamine tokens, we can economically incentivize individuals and organizations to use their IP collaboratively, reducing the need to trust each other or join a centralized organization. Dopamine is committed to building an ecosystem of data suppliers and consumers of	<a href="https://dopamine.ai/wp-content/uploads/2018/03/Dopamine-Whitepaper-v1.1.pdf">https://dopamine.ai/wp-content/uploads/2018/03/Dopamine-Whitepaper-v1.1.pdf</a>

		processed data who will supply data to and purchase results from the DCPN. The first consumer of DCPN output will be the Dopamine Fund, incentivizing data consumers and service providers to join the network. Dopamine Foundation will also actively seek data processors to join the network and create campaigns for individuals and organizations to publish their data to the Dopamine Network. Our mission is to attract, through economic incentivization, the world's first DCPN structured in a way that allows for learning, growth, and general super intelligence.	
Effect Network: Decentralized Network for Artificial Intelligence	2018	The Artificial Intelligence (AI) market is growing at a remarkable rate but has become more inaccessible than ever. The requirement for large annotated datasets and a complex technical infrastructure has driven AI development behind the closed doors of corporations. This paper introduces an open, decentralized network called Effect.AI, that provides services in the AI market. The network replaces several existing services and requires no fees, has a low barrier of entry and provides fast growth of the industry. This is accomplished by three platforms that run on the NEO blockchain and are fueled by a network token called EFX. The first platform is a marketplace for tasks that require human intelligence. It allows anyone in the world to perform tasks for a fair payment and gives businesses access to a large workforce of human intelligence. The second platform is a decentralized registry of AI services described by a rich ontology. On this platform any algorithm can be accessed as a service in a unified manner and has a convenient way to receive payment. The last platform provides a decentralized, distributed computational platform that can run popular deep learning frameworks. The effect of this network will define the future relationship between humans and AI.	<a href="http://effect.ai/download/effect-whitepaper.pdf">http://effect.ai/download/effect-whitepaper.pdf</a>
Hands	2018	Hand made. Hand-held. Our many hands make light work. Hands pray, they guide and give; create and clap. Give us a hand; hold hands. Here's a hand up; a hand-out. Keep your hand in. Handsome; handy. A handful. There are so many words and metaphors for hands because hands ARE us. Hands up, hands down; a handshake to seal the deal.	<a href="http://hands.ai/whitepaper/?page=1">http://hands.ai/whitepaper/?page=1</a>

Fetch: technical Introduction	2018	<p>Today's digital world is increasingly sub-optimal and feels oddly, and somewhat ironically, disconnected given how "connected" we now are. It is full of underutilised assets: hotel rooms lie empty, cars sit parked and unused for over 90% of their lives, half empty shipping containers travel the world, overcrowded, poorly optimised transport infrastructure eats at our sanity, power grids have peaks and troughs in usage that are shocking and organising even the simplest thing requires a herculean effort in hunting and gathering. In short, we live in an increasingly complex world that we must somehow find ever more ridiculous ways to adapt to rather than one that figures out how to adapt to us, and, for that matter, itself. Centralised systems are poorly placed to solve today's complex problems as they can't effectively work together to find solutions from the bottom-up. We propose an open, decentralised system where large numbers of simple things can cooperate—unsupervised—to solve problems without having had prior exposure to them. Fetch achieves this by creating a decentralised digital world where a collective super intelligence actively delivers answers to you: a world where information that benefits you and information that might benefit you is delivered effortlessly. Fetch brings the world closer together and delivers power to the individual. It provides solutions to problems that no one has yet dared to address, enabled by a system that can handle huge numbers of tiny transactions conducted by our digital representatives. We don't fix the old economy, we present an entirely new one.</p>	<a href="https://fetch.ai/technical-introduction">https://fetch.ai/technical-introduction</a>
Namahe sustainable value chains.	2017	<p>Globalisation has had a positive impact in creating one marketplace where we can buy and sell goods and services based on the most economical value chains. We have created systems and tools to get buyers and sellers together, however, the effort spent on creating tools and systems for creating transparency across the value chains has been minimal. As a result there are inefficiencies &amp; a risk of exploitation in value chains especially lower down the supply chain. Most of the products that we buy have a long value chain. This value chain is based on a supply chain model that is most economical for manufacturing the product. These supply chains cross countries and continents and can at times have an informal part which is invisible. Namahe Ecosystem offers a vision for a new standard that can be used in any industry to bring in transparency and to connect the various elements of the value chain, however far they might be in terms of geography. This white paper outlines the value proposition of the Namahe Platform, the company's business model, and the token distribution mechanics. Namahe as a brand name was registered in Switzerland in 2010 and in Singapore in March 2018. The team has extensive experience in setting up, managing and developing automated interfaces &amp; tools whilst effectively working with regulatory authorities.</p>	<a href="https://namahe.io/wp-content/uploads/2018/06/Namah-e-Whitepaper.pdf">https://namahe.io/wp-content/uploads/2018/06/Namah-e-Whitepaper.pdf</a>

Nebula ai (nbai) Decentralized ai blockchain Whitepaper	2018	<p>The blockchain technology provides a digital trust mechanism for human beings which enhances the efficiency of exchange of an asset that is of value to someone including but not limited to votes, IP etc. and reduces costs - the genuinely credible and efficient Internet of Value is approaching. In recent years, many breakthroughs have been made in the field of artificial intelligence (AI), and AI is now penetrating every corner of society and will become an essential cornerstone of change in society. Nebula AI Inc., (Nebula AI) is committed to building a decentralized artificial intelligence computing blockchain (NBAI) that reduces the energy costs of traditional Proof of Work by converting GPU mining machines into AI computing services. The AI transactions recorded on NBAI will be irreversible. The distributed computing network also ensures high concurrency and low latency computing power. The conversion of GPU mining machines makes it possible to provide more cost-effective artificial intelligence services. Nebula AI will cooperate with large-scale third-party Internet data centers to provide adequate computing power for AI computing. Nebula AI has established an artificial intelligence training centre in Canada. System-based quantitative finance, image identification and other blockchain applications are also in development. The well-developed NBAI ecosystem integrates the top-level applications such as DAI App, scientific research and application, university education, and the bottom level of NBAI blockchain, Artificial Intelligence Mining Machine and Artificial Intelligence Data Center. The innovative economic model of the NBAI ecosystem is the realization of a complete set of value-added economic systems.</p>	<a href="https://nebula-ai.com/whitepaper/NBAI_whitepaper_EN.pdf">https://nebula-ai.com/whitepaper/NBAI_whitepaper_EN.pdf</a>
A decentralized Cognitive ad network	2018	NOIZ believes in a transparent advertising space that gives control back to consumers and is free from the influence of advertisers, publishers and centralized ad exchange networks that seek to use consumer personal information in a malignant way.	<a href="https://drive.google.com/file/d/1aEW8qgfK9W6KBPBemI6YJfk4jgLfItzV/view">https://drive.google.com/file/d/1aEW8qgfK9W6KBPBemI6YJfk4jgLfItzV/view</a>
Numeraire: A Cryptographic Token for Coordinating Machine Intelligence and Preventing Overfitting	2017	Machine learning competitions are susceptible to intentional overfitting. Numerai proposes Numeraire, a new cryptographic token that can be used in a novel auction mechanism to make overfitting economically irrational. The auction mechanism leads to equilibrium bidding behavior that reveals rational data scientists' confidence in their models' ability to perform well on new data. The auction mechanism also yields natural arguments for the economic value of a Numeraire token.	<a href="https://numer.ai/static/media/whitepaper.29bf5a91.pdf">https://numer.ai/static/media/whitepaper.29bf5a91.pdf</a>

Decentralized, peer-enabled ai identities for the ai economy	2017	<p>The cornerstone of artificial intelligence (AI) is the ability to make highly competent, humanistic decisions that successfully pass the Turing test [1]. In the last decade, we've seen rapid advancement of strong, sophisticated AI machines in a variety of industries; the autonomous vehicle industry is delivering a new transportation economy; Alphabet's AlphaGO has toppled the best Go board players in the world; neural networks like IBM Watson learn and process vast amounts of information at unimaginable paces. The peak of artificial intelligence is almost here, but with several limitations: current AI is only developed for a narrow, task-specific domains, is prohibitively resource-intensive, and thus is heavily influenced by and for the interests of a select number of industry leaders. For these reasons Project PAI is developing an open-source blockchain protocol to decentralize AI development for everyone. The foundation for an interoperable AI blockchain starts from the ground up firstly with creating AI for the individual.</p>	<a href="https://projectpai.com/assets/files/whitepaper/projectpai_whitepaper.pdf">https://projectpai.com/assets/files/whitepaper/projectpai_whitepaper.pdf</a>
Ocean Protocol: A Decentralized Substrate for AI Data & Services	2018	<p>This paper presents Ocean Protocol. Ocean is a decentralized protocol and network of artificial intelligence (AI) data/services. It incentivizes for a vast supply of relevant AI data/services. This network helps to power AI data/service marketplaces, as well as public commons data. The heart of Ocean's network is a new construction: a Curated Proofs Market. CPMs bridge predicted relevance with actual relevance of each AI service, by having curation markets for cryptographic proofs (e.g. proof of data availability).</p>	<a href="https://oceanprotocol.com/tech-whitepaper.pdf">https://oceanprotocol.com/tech-whitepaper.pdf</a>
A Blockchain Platform and Solution	2017	<p>Blockchain is a trustworthy record or ledger of all transactions that have taken place. It uses the "Consensus Protocol" for validating processes and provides for a secure, verified route for transactions and the storage of values. Utilizing this technology eliminates the reliance on centralized management systems with trusted third-party intermediaries. The opportunity to substitute trust-verification functions of centralized mediators with decentralized consensus-based systems is a key factor in generating high levels of interest in blockchain with institutions and corporations worldwide. Faster transaction speeds, lower costs, and higher security are some of the major benefits from implementing a blockchain solution. Furthermore, blockchain will act as a catalyst in driving the digital innovation movement toward the integration of the entire global economic structure into one open system. Samsung SDS defines blockchain as a digital vehicle that enables permissioned entities to transfer, exchange, consent and utilize the value and information of digitized assets. Samsung SDS Nexledger platform functions as a digital vehicle that enables corporations and institutions to have access to a wide variety of blockchain-based solutions. Nexledger provides the infrastructure and services required to implement this nascent technology in all industries, including Financial Services, Electronics, Manufacturing, and Logistics. Details of both the Nexledger platform and available industry solutions are provided within.</p>	<a href="https://icorating.com/upload/whitepaper/57lSwVZ0fD6jMeWWPw6hCDHcJRaSAuEX5lXRzEah.pdf">https://icorating.com/upload/whitepaper/57lSwVZ0fD6jMeWWPw6hCDHcJRaSAuEX5lXRzEah.pdf</a>



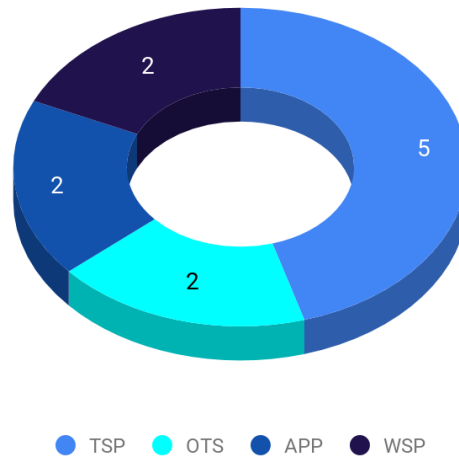
Rewarding Human Capital	2017	<p>Humans are the most successful high-order species on the planet because of our ability to pass information to each other, over generations and across huge populations. Language and conversation are the means of information transfer. The Internet and mobile revolution has amplified human connection and the ability to communicate globally, instantly. Currently, humans are limited by closed social networks and indexed by advertising-supported social graphs, with no easy means to explore and efficiently leverage information shared within these centralized cliques, ultimately leading to the loss of much of the cornucopia of human knowledge. Locked away within these networks as they eventually fall in popularity is an untold amount of information. This is exacerbated today by multiple messaging apps that consume more of users' attention span than any other type of application and operate in silos, with no common knowledge repository and no way to interconnect knowledge stored within these apps. Sensay solves this problem with a decentralized, transparent, interoperable messaging platform enabling anyone to chat and unlock transactions across messaging applications in a distributed network.</p>	<a href="https://sensetoken.com/pdfs/sensetoken_whitepaper_en.pdf">https://sensetoken.com/pdfs/sensetoken_whitepaper_en.pdf</a>
The Evolution of Energy	2017	<p>Since 2009, Verv has achieved significant traction in the UK energy industry for its patented disaggregation technology that provides households with a detailed appliance-level understanding of their electricity use. Following the successful launch of the Verv Home Hub (VHH), we plan to extend its functionality through the rollout of the Verv Trading Platform (VTP), a blockchain-powered energy trading platform that is being built to enable households and energy consumers to trade electricity in a peer-to-peer exchange.</p>	<a href="https://vlux.io/media/VLUX_Whitepaper.pdf">https://vlux.io/media/VLUX_Whitepaper.pdf</a>
The First Blockchain-Powered Relationship Registry & Love A.I.	2018	<p>Singles and couples face numerous challenges in their journey of finding love and sustaining their relationships. There is a lack of trust and transparency as singles risk being victims of love scams, fake profiles created by unethical dating services and people lying on their online dating profiles due to the lack of identity and relationship status verification. Increasing number of couples are facing difficulty in sustaining their relationships or marriages due to differing expectations, exacerbated by a lack of transparency for their marriage status. Viola.AI is our solution for singles and couples experiencing these love and relationship challenges. Viola.AI harnesses on the latest technology in Blockchain and Artificial Intelligence to develop the REL-Registry which is a global decentralised registry that verifies identity and relationship status. The verified users can then engage with the powerful lifelong A.I. relationship assistant equipped with useful recommendations to help create and sustain successful and happy relationships for all singles and couples.</p>	<a href="https://viola.ai/whitepaper/viola-tech.pdf?v=1.73">https://viola.ai/whitepaper/viola-tech.pdf?v=1.73</a>

### **Appendix 3: Short List**

In the following table was presented the companies that are part of the short list, with also the archetypes associated (figure tot)

Company	Industry	Archetypes characterization
ATN.io	IT	TSP
DBrain	IT	TSP
DeepMind (Google)	Healthcare	OTS
Doc.ai	Healthcare	APP
Effect.AI	IT	WSP
Fetch.AI	IT	TSP
IBM	Supply chain	OTS
Numerai	Finance	WSP
Oben	IT	APP
Ocean Protocol	IT	TSP
SingularityNET	IT	TSP

## Archetypes characterization



## **Appendix 4: Venture Capitalist**

In the following table the most important venture capitalist of the intersection market.

Company Name	Geographic Area	Business Area of Investment	Investor Type	Investment stage
CapHorn Invest	Paris, France	B2B digital companies	Venture Capital	Early Stage Venture, Seed
Comet Labs	San Francisco, CA, USA	AI and robotic	Micro VC, Venture Capital	Early Stage Venture, Seed
Crystal Stream Capital	China	Tech Companies	Venture Capital	Early Stage Venture, Seed
DCM Ventures	Menlo Park, CA, USA	Tech Companies	Private Equity Firm, Venture Capital	Early Stage Venture, Late Stage Venture, Seed
Draper Associates	Menlo Park, CA, USA	Tech Companies	Venture Capital	Debt, Early Stage Venture, Late Stage Venture, Seed
Google Ventures	Mountain View CA, USA	Tech Companies	Corporate Venture Capital, Venture Capital	Early Stage Venture, Late Stage Venture, Seed
Greycroft	New York, NY, USA	Internet and mobile markets	Venture Capital	Early Stage Venture, Late Stage Venture, Private Equity, Seed
Legend Star	Beijing, China	Tech Companies	Venture Capital	Early Stage Venture, Seed
Microsoft Accelerator	Redmond, WA, USA	Not defined	Accelerator	Non Equity Assistance, Seed
Mithril Capital Management	San Francisco, CA, USA	Finance	Venture Capital	Late Stage Venture, Seed
NewDo	Palo Alto, CA, USA	Not defined	Micro VC, Venture Capital	Early Stage Venture, Seed
Omnes Capital	Paris, France	Finance	Venture Capital	Debt, Early Stage Venture, Late Stage Venture, Private Equity, Seed
Outlier Ventures	London, England	Tokenized Communities	Venture Capital	Early Stage Venture, Seed
PJC	Boston, MA, USA	Software	Venture Capital	Debt, Early Stage Venture, Late Stage Venture, Seed
Plug and Play	Sunnyvale, CA, USA	Not defined	Accelerator	Early Stage Venture, Seed
Ribbit Capital	Palo Alto, CA, USA	Finance	Venture Capital	Early Stage Venture, Late Stage Venture, Seed
RPM Ventures	Ann Arbor, MI, USA	Mobility	Venture Capital	Early Stage Venture, Seed

Softbank China Venture Capital	Shanghai, China	Not defined	Venture Capital	Early Stage Venture
Union Square Ventures	New York, NY, USA	Finance	Venture Capital	Debt, Early Stage Venture, Seed
Zeroth	Hong Kong	ML and AI	Accelerator	Seed