

# Signatures

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# Introduction

We live in a world that is drowning with ideas. Several governorates have devoted increasing attention over the past decade to the role of small businesses in the economic growth of developing countries. Although, since the beginning of the 2000s, the innovation capacities have been held by the web GAFAs "Google, Apple, Facebook and Amazon". In short, the web has never been so centralized.

Block chain paves the way for a new web, based on decentralization, with new business models and new approaches. Built upon the success of bitcoin, this alternative technology has opened up the market to young entrepreneurs to exchange their capacity for innovation. The appeal of block chain to industry and startups builds upon the promise to make data reliable, immutable, transparent, and decentralized. In fact, the principal advantages of block chain, apart from the variability of data, is the guarantee of trust in the trustless environment and successful peer-to-peer interactions without the need for a central governing body (the third party).

The need for a technical infrastructure that encompasses these features has led researchers to invest more in this field, hence the appearance of what we call the curation markets, Initial Coin Offering (ICO) and the token economy all based on crypto economic emerging primitive called token bonding curve.

Using TBC "Token bonding curves" this technology allows us to create systems that manage and distribute intellectual property and bind network participants to achieve common goals.

In this context, we have reflected in Elghazela innovation center to develop a Crypto economic model for an existing block chain solution using the continuous token models. This project aims to incentivize the users (i.e., founding members of the organization, devoted contributors or initial investors) during the startup's pre-launch phases.

The internship at the ElGhazela innovation center, taking place over a period of six months (from February to June 2021) is for me the opportunity to discover the professional world and more specifically the Token engineering environment. So, I was able to initiate in many areas such as Cryptocurrency, Block chain and curve analysis...

The report's first chapter "state of the art" describes the environment where the internship has taken place and brief overview of the project's objectives and development.

The second chapter named "Crypto economics and Token engineering "which consists of a preliminary study of the different concepts, technologies and standards deployed in the implementation of this system.

the Third chapter will be devoted to the business understanding in,which we will detail the project objectives, requirements and assumptions.

In the fourth chapter, we will define the techniques used to collect internal and external data and the phases that follow that meaning data preparation and preprocessing phases. The final chapter named " Realization : Modeling, Testing and Deployment" as its name indicates will be devoted to the implementation and realization phase.

Finally, we close our report with a conclusion and some perspectives.

# Chapitre 1

## General context of the project

### Introduction

In this chapter, we present the general context of the internship. We start by presenting the company. Then, we focus on the project : the background and existing projects. We extract the gaps that we attempt to work on. At the end, the project scope will be announced.

### 1.1 Company context

This section presents the company where our internship took place, namely Elghazela innovation center.

#### 1.1.1 About Techno-pole Elghazela

The Technopark Elghazela, presents itself as an integrated environment for the development of small and medium-sized enterprises as well as for multinationals and large groups in the Information and Communication Technologies sector. Its main vocation is to welcome and support the development of activities technologies and promote research, development and transfer technological.

Its mission is part of the national development strategy and promotion of scientific research, innovation and high-value production added in the field of Information and Communication Technologies.

It hosts support institutions such as training and research in addition to production activities with the aim of creating synergy and fertilization cross between these actors.

Elgazala Technopark now hosts more than 100 companies including 12 subsidiaries of large global groups (Microsoft, ST Microelectronics, Ericsson, Alcatel Lucent ...) as well as Tunisian success stories (Telnet, Cynapsys ...).



FIGURE 1.1 – Logo Technopark Elgazala

### 1.1.2 About innovation center

Elgazala Innovation Center is an ecosystem in which research and development projects are conducted. The center is part of Elghazala Technopark, which is one of the leading science and technology parks in the MENA region.

Thus, the center will be responsible for supervising and helping economic enterprises to identify their needs in terms of technological innovation and to work to promote the results of research and the transfer of technology. It will also be responsible for the dissemination of the culture of technological innovation through the popularization of programs and mechanisms related to innovation and the promotion of research results and technology transfer. This is how it will help develop competitiveness, improve productivity and promote new activities and innovative businesses.

The strengths of this organization are based on 2 factors :

- Human capital, which is made up of high-level executives, regional contacts and a dynamic innovation task force team comprising consultants in the various sectors of activity.
- The structures and organization which are defined by a reliable information and communication system and intelligence

### 1.1.3 CIDT “Innovation and Technological Development Center” services

**Partnership and cooperation** The objective is to promote the Tunisian company, particularly internationally, through the dissemination of information relating to its productive potential and know-how and its assets.

**Supervision, assistance and support for SMEs ”medium-sized enterprise” in terms of innovation** Transfer of skills and appropriation by the company of methods and techniques aimed at increasing the performance of the function concerned.

*Mission :*

- Promotion to companies with potential for improvement
- Diagnosis to identify the needs of the business
- Establishment of an action plan by defining the actions to be followed as well as their priority for the company.
- Preparation of an action definition support in the form of terms of reference (TOR)
- Mobilization of an international expert and launch of the action

**Technology transfer** Provide an interface structure between the socio-economic world and that of research, in order to identify and reconcile supply and demand from universities and companies.



FIGURE 1.2 – Logo Elgazala innovation center

## 1.2 Problem statement

How will value be traded on the Internet tomorrow ? To this question, the cryptocurrencies provide an ambitious answer. It's about creating new currencies, based on a new technology : the blockchain. It authorizes decentralized management of the currency without a trusted third party, the opposite of hierarchical and centralized systems of official currencies.

Monetary innovation runs even deeper, if not radical. Crypto-currencies are private currencies, without legal tender, without any backing physical or financial and totally virtual : they are created and circulate independently of any bank and are detached from any bank account. Those are new monetary objects, unprecedented in history. There are now nearly 1,600 crypto-currencies for a capitalization of market estimated at around \$ 270 billion. Beyond the blockchain, cryptocurrencies announce another innovation : digitization of value and assets. This technology offers the ability to digitally represent value and transfer it securely between individuals without any intermediary - thus constituting a sort of digital "bank note". The digital representations of value are commonly referred to as "**tokens**". Modern cryptography makes it possible to do this anonymously. This allows the creation of currencies and financial assets with digital "holders ". There are many applications. Crypto-currencies, which are monetary "tokens", are the most famous example. But any asset, real or financial, can potentially be digitized. The tokenization could prove particularly promising for scarce and illiquid assets, including valuation is penalized by the shallow depth of the market in significant proportions.

Digitization would apply particularly well to two large **asset categories** :

- **Intangible assets**, such as patents, carbon rights or even Copyrights. Given their lack of physical existence, these assets appear easier to convert to tokens, although differences in jurisdictions may make their difficult onward transfers.
- **Fungible assets**, likely to lend themselves more easily to the tokenization process, insofar as they can most often be divided into several units and where all tokens can then be associated with a general set of components interchangeable assets (for example, ten kilograms of gold).

Therefore, in an ecosystem in which Startups and development projects are conducted such as Elghazela innovation center we must create a Crypto-economic system where fungible and non-fungible assets can be exchanged efficiently.

To validate a transaction on a decentralized network, three difficulties must be resolved : First, The instability of private currencies. Second, the Liquidity Reserve (i.e Users can at any time burn/ mint their tokens on exchange of a monetary value). Finally, Conservation means the total value of bonded tokens should match the balance of reserved tokens at any time.

## 1.3 Project Context

In this section, we tried to do a study of existing projects. In order to, extract the gaps that this project attempts to work on.

### 1.3.1 Background of the project

Innovation progresses in successive waves, with acceleration phases where the dissemination of ideas generates a mobilization of initiatives, energies and funding. This is such a phase that DLT "Distributed Ledger Technologies" and blockchain technology is going through today, thanks, in part at least, to the interest and enthusiasm for cryptocurrencies.

But before that, the history of cryptocurrency begun in 2008 when the person(s) who goes by the pseudonym Satoshi Nakamoto developed the Bitcoin cryptocurrency. In 2009, they published the bitcoin's mining system to distribute their new token supply to those supporting the network nakamoto's design.

Bitcoin now operates around 305,349 transactions per 24hrs, with 1 bitcoin equals 173,801.08 Tunisian Dinar.

### 1.3.2 Overview of existing projects

An exchange is a platform that allows the purchase and / or the exchange of cryptocurrencies.

We must distinguish 2 types of exchanges :

- **Buying platforms** : these are the platforms that allow you to buy your first cryptos for euros or dollars. You therefore have the possibility of depositing fiat currencies (fiat) on these platforms. They are relatively few in number because they require fairly complex bank accreditations.
- **Exchanges** : all exchanges made are between cryptos. We exchange cryptocurrency A for cryptocurrency B. Cannot deposit fiat, however it is possible to deposit stable coins like USDT or DAI.

Here are some platform examples :

#### 1.3.2.1 eToro

eToro is a broker created in 2007 in Cyprus. It was built as a "social trading network", meaning it is possible to post messages and like or comment on messages written by millions

of other users. eToro is a broker, this word means that it acts as an intermediary between the markets and its users.

eToro is not an exchange, so it is not possible to exchange Bitcoin for Litecoin for example. Likewise, it will be impossible to withdraw bitcoins or any other cryptocurrency from the site. You will have to resell them for dollars beforehand. Indeed, the eToro platform buys the cryptocurrencies it offers you to trade and speculate on. However, you cannot (at this time) transfer these cryptocurrencies outside of eToro. You can therefore trade and speculate on the value of currencies but you will not hold your assets and will not be able to store your crypto in an external wallet. However, it is important to note that the eToro site manages forks, which is a very good thing.



FIGURE 1.3 – Logo etoro

### 1.3.2.2 Binance

Launched in September 2017 by the charismatic Changpeng Zhao, alias CZ, Binance quickly established itself as the world leader of exchanges. The reasons are simple : a clean interface, fluid, and easy to learn as shown in the figure bellow. The team in charge shows great professionalism and this is reflected in the image users have of their platform. It is not for nothing that the crypto exchange platform is number 1, users trust this exchange. It is a comprehensive exchange that enables crypto-to-crypto and crypto-to-fiat exchange. You can therefore buy your first cryptos with euros and they will be directly usable for your trading.

This platform has all the criteria you want to see on a top exchange : a clean and functional interface, an extremely fluid site that can manage up to 1,400,000 buy and sell orders per second, a professional and dynamic team which is constantly innovating, responsive and efficient support, very low transaction costs.

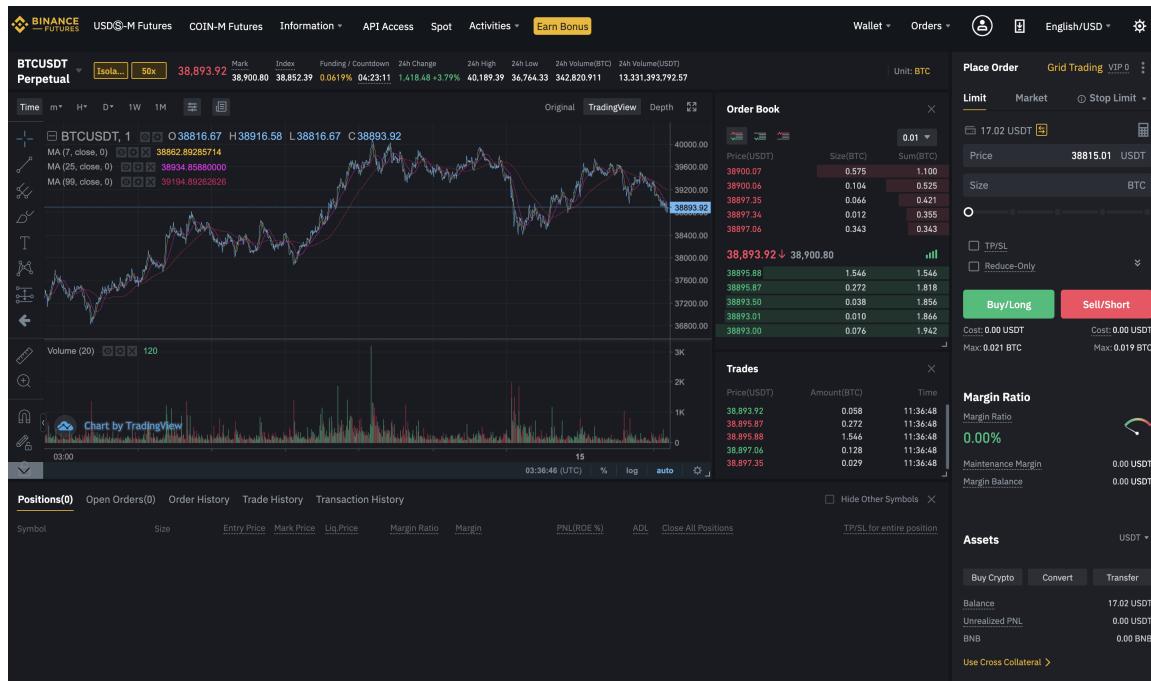


FIGURE 1.4 – Binance interface

The base fees are set at 0.1% per transaction which is low compared to the competition. Better yet, if you have BNB (Binance Coin), the platform's utility token, your fees can be paid with it and will be 0.075% per transaction. Binance is growing rapidly in many areas. The company invests heavily in the development of blockchain technology and advocates for the adoption of cryptocurrencies around the world.



FIGURE 1.5 – Logo Binance

In addition, it is not just a simple exchange platform, the company has a whole catalog of other products :

- Binance Academy : to learn more about cryptocurrencies and blockchain
- Binance Charity : the philanthropic arm of Binance that raises funds and helps populations in difficulty
- Binance Research : Provides In-Depth Analysis on Blockchain and Cryptocurrencies
- Binance Launchpad : a platform dedicated to Initial Exchange Offerings (IEOs)
- Binance Cloud : all-in-one infrastructure that allows its partners to create their own exchanges
- Trustwallet : a mobile application to manage your cryptos while giving you full control of your private keys

### 1.3.2.3 Uniswap

At the heart of decentralized finance is Uniswap, a decentralized platform that allows you to acquire ERC-20 tokens long before they arrive on centralized exchanges like Binance. The famous Ethereum wallet is often associated with it.

The Uniswap protocol was launched on November 2, 2018, when it was deployed on the main net of the Ethereum blockchain. It is developed by a small team based in New York, USA. By launching Uniswap, the team made a commitment to only use open-source technologies and to develop the decentralized web, a principle that it still respects today. Completely open source and resistant to censorship, Uniswap therefore allows the exchange of ERC-20 tokens, as well as ETH to an ERC-20, and vice versa. It also allows you to contribute to liquidity pools for any ERC-20 token, and therefore earn commissions in the form of exchange fees.



FIGURE 1.6 – Logo Uniswap

A true benchmark for decentralized finance (DeFi) aficionados, Uniswap is the preferred platform for the purchase and sale of tokens from this ecosystem.

This is because Uniswap's protocol allows anyone to create new markets, provide liquidity, and build financial applications that could not have existed before.

### 1.3.2.4 Coinbase

The Coinbase platform, founded in June 2012 by Brian Armstrong and Fred Ehrsam, is a crypto-currency exchange platform for buying, selling and storing bitcoins, ethers and litecoins. In 2016, Coinbase reached the second position in the Richtopia ranking of the 100 most influential organizations in the blockchain. In May 2017, the platform reached the record number of more than 7,400,000 users in 190 countries. Its clean interface, and its fast payment methods (notably via bank card) make this crypto-exchange the most accessible platform for beginners.

The platform has never been hacked and guaranteed its users' funds up to a certain amount close to 10,000€. For these reasons, we recommend Coinbase for the purchase of bitcoins and cryptocurrencies.



FIGURE 1.7 – Logo Coinbase

### 1.3.3 Criticism of the existing

During the study for the project, we got acknowledged to various scenarios, where, the price is always simulated per timestamps. All the exchanges are done according Time series.

Accordingly, in elGhazela innovation center we reflected to develop a model using continuous distribution token models. Such as the token bonding curve.

For now, we will define the token bonding curve as a mathematical function that defines the relationship between the price and the supply of a given asset.

## 1.4 Internship development

In this section, we will determine the total scope of the project, define or refine the objectives and develop the line of actions to be taken to achieve these objectives.

### 1.4.1 Project scope

Many of the basic technologies used by cryptocurrencies, such as distributed ledgers, cryptographic techniques and electronic signatures have been around for several decades. Innovation comes from the combination of these various techniques in an ambitious and coherent project.

Decentralization is at the heart of the ambition of cryptocurrencies, a complete break with existing monetary systems, governed by central banks and organized around banks. Cryptocurrencies offer a wider range of functionalities that provide, on the one hand, a Peer-to-Peer marketplace for goods and services and, on the other hand, a decentralized platform for the exchange of assets. This platform works with colored coins, which allow real assets (stocks, real estate, commodities) to be associated with Bitcoin addresses. The exchange of cryptocurrencies for legal tender or other cryptocurrencies has been accompanied by a diversification of market infrastructures. Indeed, the exchange platforms allowing the buying and selling of cryptocurrencies are essential to their functioning. They ensure a large part of transactions in crypto-currencies as well as the conversion of these into currencies with legal tender (and vice versa).

As such, they constitute the main interface between the world of crypto-finance and the traditional financial system. The platforms present therefore a "systemic" character in several aspects : as market infrastructures and as payment systems, it is through them that the possible disruptions and dysfunctions of the cryptocurrency sphere are transmitted to the real economy. Most security breaches and cyber-attacks also take place on trading platforms.

Platforms may offer one or more of the following services :

- The listing and exchange of cryptocurrencies against official currencies ;
- The deposit and custody of their clients' crypto-currency assets ;
- The deposit and safekeeping of the same holdings in official currencies ;
- The execution of cryptocurrency payments and transactions (payment, intermediary and market infrastructure activity).

### 1.4.2 Project Description

A crypto-economic model for a blockchain solution its main purpose is to help startups looking to raise funds by advising early adopters (i.e. founding members of the organization, devoted contributors or initial investors) what the best companies to fund using

cryptocurrency.

Our solution will manage this by maintaining both a curated and comprehensive list of ongoing and upcoming Tokens Sales (i.e Token Bonding Curve). By providing potential investors with several tiers of analysis (Predictive, prescriptive and technical analysis), we will make the entire process of funding startups via cryptocurrency much simpler and less risky.

### Specific objectives :

- Perform a comparative analysis of the existing token distribution mechanisms with an emphasis on the approaches that are applicable to continuous tokens ;
- Propose a new probabilistic model for a dynamic selection of the parameters of the bonding curves used for predictive and prescriptive analytics in the context of token distribution ;
- Assess the efficiency of the proposed model in the particular context of InnoCoin (the blockchain-enabled token used at Elgazala Innovation Center)

### 1.4.3 Internship organization

Project management requires the implementation of agile methods. To help us on a daily basis in management, planning and monitoring. In this context, we used jira software to set up the roadmap and timelines for project planning as follows :

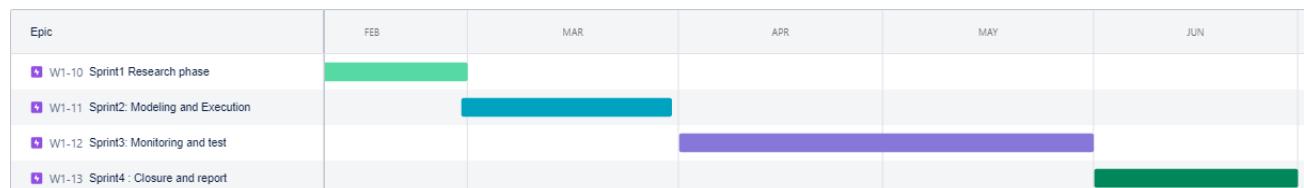


FIGURE 1.8 – Project Roadmap

**Sprint 1 : Research phase** The goal of this Phase is to Analyze all aspects of the project in order to determine if it offers any benefit to the organization as a whole. This phase lasts for the first month of the internship and at the end, the deliverable will be the project proposal.

**Sprint 2 : Modeling and Execution** The aim in this phase is to design and implement the predictive and prescriptive model and to execute it using simulated and real data.

**Sprint 3 : Monitoring and test** Now that the model is designed and validated, we need to assess its efficiency in the context of the private blockchain deployed in Elghazela innovation center.

**Sprint 4 : Closure and report** The contributions of this work are expected to be published as research articles in scientific conferences and/or journals.

## Conclusion

Despite some doubts and uncertainties, cryptocurrencies must be taken seriously. The enthusiasm they arouse helps to build - and fund - promising technologies. They ask essential and profound questions on the future of payments, money and finance in the digital age. In the above, we have discussed the general context of this project and more specifically the production environment. Likewise, we have specified the objectives of the project through forward planning which will enable us to ensure the smooth running of the work and to guarantee that deadlines are met.

In the next chapter, we will dive deeper into the realm of crypto, token distribution and engineering.

# Chapitre 2

## Crypto economics and Token engineering

### Introduction

In this chapter, we will introduce the lexicon of crypto-currencies universe, some explanations to fully understand the value of these assets and an introduction to DeFi Decentralized finance. All that acquired, we will be able to understand distributed Economic Systems. In order to finally create a data driven predictive and prescriptive system.

### 2.1 Definitions and vocabulary

#### *Blockchain :*

Blockchain is a technology for storing and transmitting information, transparent, secure, and operating without a central control body.

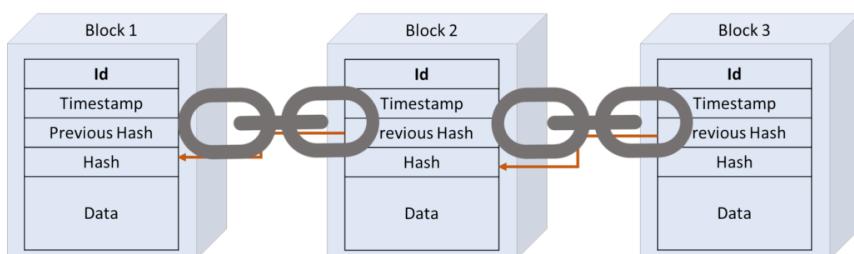


FIGURE 2.1 – Blockchain illustration

In other words, it is a database that contains the history of all the exchanges made between its users since its creation. This database is secure and distributed : it is shared by its various users, without an intermediary, which allows everyone to check the validity of the chain.

The great peculiarity of the Blockchain is its decentralized architecture, that is to say that it is not hosted by a single server but by some of the users. There is no intermediary so that everyone can verify the validity of the chain themselves. The information contained in the blocks (transactions, title deeds, contracts, etc.) is protected by cryptographic procedures which prevent users from modifying them a posteriori.

#### ***Cryptocurrency :***

An electronic currency, exchangeable in peer-to-peer (i.e., without intermediary), based on cryptographic principles and economic incentive mechanisms for the validation of transactions and the generation of the currency itself.

#### ***Token :***

A token is a digital asset that represents a certain value, power or right in a network. Tokens can be transferable, exchangeable from one individual to another without going through an intermediary, and in real time. It is not possible to duplicate them. Tokens generally make it possible to govern the relations between the participants of this network.

#### ***Tokenization :***

Registration of an asset (share, financial instrument, etc.) on a token in order to allow its management and peer-to-peer, instantaneous, and secure exchange on a blockchain infrastructure.

#### ***Smart Contract :***

A smart or a stand-alone contract, is a program or computer code whose execution does not require the intervention of a trusted third party. In the context of blockchain, it's a program that automatically activates on a distributed network when certain conditions are met on the shared ledger.

Smart contracts were conceptualized by Nick Szabo from 1994, but it was not until 2009 and Bitcoin to see their first implementation in a viable system. These autonomous contracts are now widely implemented on the specialized Ethereum platform, launched in 2015 for this purpose.

It should be noted that smart contracts form the basis of what are called decentralized applications or DApps.

#### ***Decentralized application (Dapp) :***

It is an application that runs on a decentralized network, as opposed to traditional applications that rely on centralized servers. It supports one or more smart contracts deployed on a blockchain. The front-end part (user interface) can be developed as in classic applications.

In the Ethereum blockchain ecosystem, decentralized applications are called dApps. There are over 1000 today.

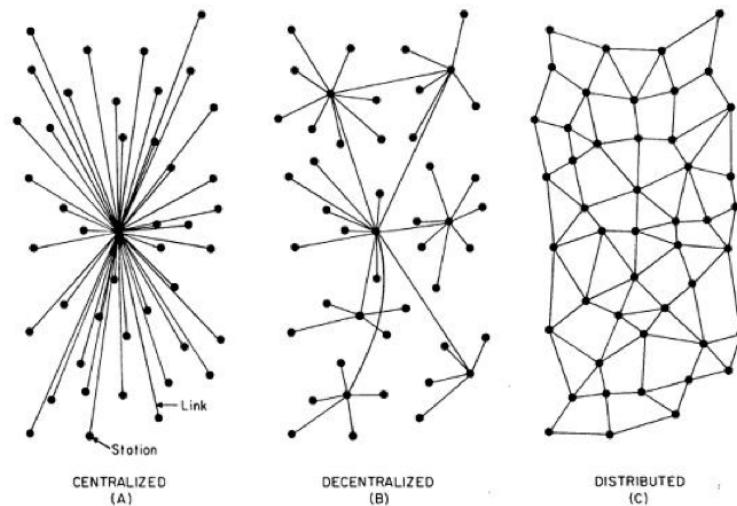


FIGURE 2.2 – The three different types of software applications

### *The technology of distributed registers (DLT) :*

These are secure registers, which can be shared simultaneously and in a synchronized manner by a multitude of participants.

### *Ethereum platform :*

Decentralized platform, based on the eponymous blockchain, which aims for the advent of a decentralized web. The Ethereum blockchain works with ether cryptocurrency. Unlike the bitcoin blockchain, which focuses on the monetary aspect, the Ethereum blockchain is designed to host a wide variety of programs, called dApps, which work with smart contracts. We talk about the Ethereum ecosystem to designate all the players who work on this platform.

### *Node :*

Computer connected to the blockchain network and using a program relaying transactions. The nodes keep a copy of the blockchain ledger and are distributed all over the world.

### *Fiat Currency*

Fiduciary money is the classic currency including coins and banknotes : euros, dollars, etc...

### *Consensus procedures :*

They allow network participants to collectively validate transactions.

## 2.2 Crypto-assets, Crypto-currencies, Digital currencies

### 2.2.1 History, nature and philosophy of cryptocurrency

Bitcoin isn't the first cryptocurrency to emerge, but the pre-Bitcoin experiments have all ended in failure. Mention may be made of DigiCash, CyberCash and E-Gold.

Cryptocurrencies were popularized thanks to Bitcoin and its creator : Satoshi Nakamoto. There are now several thousand of them, but 99% have no real use and will be quickly forgotten. They are also given the names of virtual currencies, crypto-assets, electronic currencies or digital currencies. The second most famous crypto is Ethereum with its symbol ETH. Each cryptocurrency has its symbol (ticker), that of Bitcoin is BTC.



FIGURE 2.3 – Logo bitcoin

**Part I : History, from inception to maturity** In 2007, a major financial crisis hit the world, from the most developed countries to those classified as “third world”. Several simultaneous events cause a sudden failure of much of the global financial system. The population then loses much of the confidence they had in the institutions.

And the events of the following years did nothing to improve this state of affairs : we can cite the example of the Cypriot people, who had their savings confiscated by the government and the International Monetary Fund, in part in order to reimburse debts accumulated by local bankers ...

All these events left a lasting mark on the middle and lower classes of global society, and most likely were the catalyst for the emergence of cryptocurrencies, with the advent of Bitcoin in 2008.

Indeed, on the first of November 2008, a date that will certainly go down in history, Satoshi Nakamoto publishes the Bitcoin White Paper. This stranger, or group of strangers, whose true identity remains unknown to this day, then revolutionized one of the pillars of modern society : money.

There are many definitions of Bitcoin in many media, but they are similar in different ways. Bitcoin is a peer-to-peer value transfer system, without a central control body, which relies on a consensus algorithm and a network of validating nodes. Bitcoin solves the problem of double spending through its technology, and it is in this that it is revolutionizing things. The circumstances of the economic crisis have also favored its development. From 2008, a monetary system free from all conceivable banking and political manipulation was ideal for everyone, and immediately built up a good user base.

Today, many successors, cousins and clones of Bitcoin have emerged, some more useful than others. We are therefore going to study the main cryptocurrencies existing nowadays. After the publication of Satoshi Nakamoto's white paper, many new cryptocurrencies have emerged. The first of these was Namecoin : its goal is not the decentralization of currency, but that of internet domain names. Indeed, these are mainly regulated by American authorities, a decentralized alternative would allow the advent of a freer Internet. Today, although Namecoin still exists, its network seems deserted, as evidenced by this study dated June 2015, in which it is notably explained that of the 120,000 Namecoin domain names, only 28 are actually used by their holders ...

Then came Litecoin and Ripple, two alternative currency systems to Bitcoin.

Litecoin is essentially a Bitcoin clone, but brings a new transaction validation algorithm, Script, which is still considered one of the most important crypto assets today. However, most of this importance stems from its age, as this cryptocurrency has not brought any truly innovative element at the technical level, and ultimately suffers from the same scalability problems as Bitcoin.

Ripple is also one of the crypto assets still considered important in 2018, but it has the advantage of being an entirely original creation. Indeed, it was imagined from 2004 and finally saw the light of day in 2012, thus having little in common with Bitcoin. It is indeed much more centralized, because to date, the only existing network nodes have been selected directly by the company Ripple Labs. Many also criticize Ripple for its unequal distribution : indeed, it would seem that more than half, and perhaps up to 80% of all existing Ripples are held in the hands of only one person (individual or company).

**Part II : Nature and philosophy** When Bitcoin launched in 2008, Satoshi Nakamoto's goals were relatively clear :

*His first goal was to Promote a purely peer-to-peer electronic money*

The very first words of the white paper already tell us what the main goal of Bitcoin is : the creation of purely peer-to-peer electronic money. What does this expression mean ? The answer is simple : a peer-to-peer system is a system that operates without any intermediary between the participants. Everyone is equal within the system.

Purely peer-to-peer electronic money must therefore function without banks and governments and must allow individuals to transfer value in the same way they exchange hard coins. This was not the case with the predecessors of Bitcoin seen above, since the latter operated only through servers belonging to the companies that created them. Most were anonymous and cryptographically protected, but their existence was conditioned by that of the company that created them.

However, as many crypto assets such as Ethereum, NEO or Lisk have demonstrated, it does not have to be used as money to generate value and bring something to our society. The simple fact of allowing the establishment of new processes can open the way to new professions, new modes of trade and wealth creation.

In addition, it is also not necessary to have been created as currency to be used as currency : for example, despite its status as a platform for creating tokens and smart contracts, Ethereum is very often proposed as an alternative to Bitcoin by traders who accept cryptocurrency payments.

Therefore, Crypto assets, regardless of their category, seem to all have the same goal, albeit through diverse and varied paths : it is to allow individuals to become financially independent from any outside entity. But the reality is not always that simple, and it is by delving into the problem of trust and consensus that one can determine which cryptocurrencies truly pursue this ideal.

#### *Second goal : Ensure peer-to-peer trust*

The two notions of trust and consensus, briefly mentioned in the first section, remain central to the ideal of freedom promoted by the crypto-asset revolution. Confidence, is fundamental because it is what gives any currency its value.

#### *Third goal : The problem of consensus, lacking a perfect solution to date*

As we mentioned before, consensus methods are, in cryptocurrency, the mathematical processes by which the validation of transactions is carried out. For Bitcoin, this is Proof of Work. For others, more experimental, various methods have been devised, and all have their advantages and disadvantages.

But rather than talking about technique, we're going to talk about power. Because that's what it is : the consensus method determines how power is distributed within the community. And this is where the words "centralization" and "decentralization" make their appearance : the more power is held by many people equally, the more decentralized a cryptocurrency is. And the more power is centralized, the more it is held by a small number of people.

#### *Fourth goal : Distribution, or the problem of the concentration of wealth*

## 2.3 Introduction to the Token economy

The term tokenomics (or Token economy) actually refers to everything related to the economic ecosystem of the token. This ecosystem depends on a number of characteristics of the token concerned, among which are :

- Utility of the token,
- Quantity of tokens issued over time and frequency of issuance,
- Bonus for early investors in initial fundraising,
- Distribution of tokens,
- Possible destruction of some tokens when used,
- Unicity of tokens.

For this projet we are going to focus on the first and third functions but before talking about these elements, we have to define what is Ethereum and how does this crypto work.

### 2.3.1 Ethereum, a smart contract platform

Ethereum is a blockchain-based platform that allows developers to build and deploy decentralized applications or DApps. While Bitcoin's main role is to transfer virtual currency, Ethereum's main role is to run the program for any decentralized application. Instead of investing in servers, developers will put the application on the Ethereum network.

Ethereum was created by Vitalik Buterin, a young Russian-Canadian who wanted to generalize the programmable aspect of Bitcoin. Indeed, although Bitcoin allows to realize a lot of more or less complex operations (multi-signature, payment channels, atomic exchanges, tokens, etc.), it is nevertheless too limited in terms of flexibility and scalability. Ethereum represents an evolution of Bitcoin that is supposed to improve its contractual functions, sometimes at the expense of its decentralization and short-term stability.

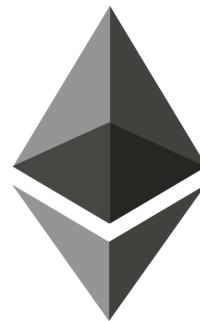


FIGURE 2.4 – Logo Ethereum

The main role of this platform is to execute what are called smart contracts, also known as autonomous contracts.

A smart contract, or intelligent contract, is simply a computer program whose execution does not require the intervention of a trusted third party. In the context of blockchain, this is a program written in Solidity that can perform operations when certain conditions are met on the ledger.

### 2.3.2 Definition of a token

A token is a digital asset that represents a certain value, power or right in a network. Tokens can be transferred, exchanged from one individual to another without going through an intermediary, and in real time. It is not possible to duplicate them.

Tokens are generally used to govern the relationships between the participants of this network.

Thanks to the blockchain technology, and more particularly to the Ethereum technology, it is possible to create tokens for all types of purposes.

For example, it is possible to issue tokens that provide certain rights such as voting rights or property rights. The purpose of each token is chosen and customized by its creators, through a smart contract constituted at the time of creation of the token.

Hence, it is possible to create your own programmable currency on the Ethereum network without any particular knowledge of blockchain technology. The currency created is managed by a smart contract that most often follows the ERC-20 'Ethereum Request for Comments' standard : this is why we speak of ERC-20 token.

These tokens are also used to raise funds through Initial Coin Offering (Per example) as we will see in the next in this chapter.

### 2.3.3 Characteristic of the tokens

#### 2.3.3.1 Utility of the token

The very first characteristic that influences the price and sustainability of the system is naturally the usefulness of the tokens. Indeed, many tokens only serve as an alternative means of payment to access a service. The price of the tokens depends on the value of the service provided. As a rule, tokens designed in this way have a stable price, since the service itself always has the same value. And this is good : if the tokens become too expensive, there is no point in paying for the service with them, and the token ecosystem collapses.

#### 2.3.3.2 Quantity of tokens issued over time and frequency of issuance

This is probably the most important element of all : how much tokens exist, and how is it increasing ?

First, it is important to know that in the case of crypto-assets whose total quantity is steadily increasing, if inflation is too high, the tokens tend to be devalued very quickly. Many models are overly optimistic and bet on a rapid adoption of the system. When these predictions are wrong, the amount of tokens increases but the number of users remains the same. This makes the business model unattractive to those wishing to invest for the long term. And similarly, crypto-assets that do not have a well-defined maximum number of tokens in circulation may have overly optimistic models.

It can also happen that the initial quantity of tokens is very large : when it exceeds hundreds of billions, the tokens often have such a low value that they give the impression that they are attractive to buyers. Crypto-assets with outliers measured in hundreds of billions are therefore, quite regularly, designed in this way to fool investors who do not understand the concept of total capitalization. This usually doesn't bode well if there are other features of the token that are problematic, but it's not, in and of itself, proof that something is up.

### 2.3.3.3 Rewards of early investors

One of the problems with ICO tokens is the multiplication of bonuses representing impressive amounts. If some private investors have the possibility to buy, before the public, tokens twice cheaper, it is guaranteed that they will immediately make the price plunge at the opening of the trading, and make the public panic which will sell at a loss. This happens regularly, and results in a large part of the public being left out in the cold, condemned to hold on to crypto-assets that have lost more than half their value in a week.

### 2.3.3.4 Distribution of tokens

The distribution of tokens at the time of their issuance can have quite significant negative effects on the development of a system. In particular, when the team takes a large percentage of the existing tokens, or when they offer a large portion to their "advisors" and other partners. Ideally, all of the chips are offered to the public, but in some cases, the team keeps astronomical quantities... In a way, this is like printing money. Holders are naturally tempted to sell everything they have as soon as possible, and are not necessarily encouraged to contribute to the project.

However, there is really no defined maximum percentage, as each project is completely different from the others. The amount has to be assessed, again, on a case-by-case basis.

### 2.3.3.5 Destruction of tokens after use ( TOK burn)

Some tokens, when used, have a more or less negligible part destroyed by the system. This reduces the quantity of existing tokens, and at the same time, the influence of inflation which lowers prices over time. This mechanism is interesting because it increases the value of the tokens, but we must not forget that for this to happen, the network must be used. And if it sits idle, then the tokens are not destroyed. Again, many crypto assets are very optimistic in their predictions and end up disappointing many investors.

### 2.3.3.6 Unicity of tokens

After the development of the famous ERC-20 tokens, another kind of tokens appeared, designed to be unique, and correspond each to a different thing. That is, for example, some token ecosystems are centered around a video game. These games allow players to acquire tokens representing a virtual object, such as a gun, that their character may have use for. The economic system of these tokens leaves a lot of room for speculation, since the value depends on the popularity of the associated game, in this case. For example, if Valve turned all of its Counter Strike weapon skins into Ethereum tokens, the tokens would be popular with the public.

### 2.3.4 The Evolution of Token Distribution Models

There are many ways to obtain tokens :

- Initial Coin Offering (ICO) : these are fundraisers that allow blockchain startups to sell tokens related to their project, in exchange for other valuable assets (Bitcoin, Ethereum...) in order to finance their projects. The tokens sold usually allow to obtain a voting right, to use a service (like decentralized applications) ...
- By maintaining the network through the validation of transactions, or other tasks performed such as sharing storage space (Sia, Filecoin ...)
- For free thanks to airdrops, free tokens offered to those who request them,
- By going to exchange platforms to buy these tokens.

The following figure represents the evolutionary phases of cryptocurrency distribution :



FIGURE 2.5 – The Evolution of Token Distribution Models

**2013-2017 – Initial coin offering ICO and SAFT sales :** As the cryptocurrency started to gain its place in the industrial and economic world, ICO came on the scene as a new way to distribute tokens and to launch new blockchain projects. Stakeholders were able to support the launch new protocols by contributing cryptocurrency by the early adopters/ early developers in return for Tokens.

Initial Coin offerings (ICOs) are a new, faster and cheaper way to raise funds. Originally thought of as a way to launch a new cryptocurrency, it is also a way to fund a project or a foundation and accelerate the funding of innovation. This new financing system has been in existence for more than 4 years and experienced a strong acceleration in 2017. Faced

with the questions raised by ICOs, the scale of the phenomenon and the new risks that are appearing, regulations are evolving in many countries. In addition, standards of good practice are emerging. The implementation of an ICO project requires many complementary skills to be brought together in a very short time. The underlying trust necessary for any transaction must be maintained throughout the process so that the expected success is achieved.

An ICO consists of issuing existing tokens on a blockchain, either by introducing a new blockchain, or by using the blockchain of an already existing cryptocurrency, such as Ethereum for example.

The funds raised generally finance the development and marketing efforts necessary for the success of the project to which the tokens are attached. The aim is for the use of the token to grow, which increases its value and allows investors during the ICO to make a profit. One of the key goals is to benefit from the network effect. The use of the project description in the form of a "white paper" has developed.

**2018 – Initial Exchange offerings IEO and airdrops** After the dust settled on the wave of crypto. In 2018, new projects have begun to emerge in this field to disassociate with ICOs. Just like the ICO, the concept of the IEO "Initial Exchange offerings" is to create a utility token on a blockchain. This token is therefore supposed to have a utility within the service imagined by the startup : it can be the means of carrying out transactions within a mobile application for example. Or, if the company is an exchange, the token can be used to reduce exchange fees, like Binance's BNB.

When you participate in an IEO, **you speculate on the value of the token**, a value that must ultimately derive from its usefulness. In principle, this investment is made according to the imagined future use. As with all nascent fields, there are a lot of projects that fail and therefore it is very risky to participate in an IEO. However, by being among the first investors, one can make a considerable profit if the project gains popularity, as evidenced by the 1000% gain of the IEO participants of the BTT.

Generally speaking, the motivations for participating in an IEO (and the underlying risks) are roughly the same as for the ICO.

Another point is that An Airdrop occurs when a team wishes to promote the launch of a new cryptocurrency. They will then offer tokens periodically and in a controlled manner to people who fulfill a specific set of characteristics (example be an active member on a forum and put in his signature the link of the website of the cryptocurrency in question).

**2019 – Auctions** Regardless of the abbreviation, most token sales were historically offered at a fixed price to prospective purchasers. There had been some experimentation with different pricing models including Gnosis's auction or Ethereum's own increasing price ICO. CoinList introduced a Dutch auction mechanism to facilitate a fairer and more accurate price discovery.

**2020 – Liquidity Farming, Stake drops, and Community Sales** These are programs in which users make their funds available to enable token trading on swap platforms, such as on Uniswap. The users then earn the fees generated on the pool.

## 2.4 Token bonding curve $TBC$

Now that the ICO trend is winding down, a new method of token distribution appears : **the continuous token bonding curve**.

### 2.4.1 Definition of TBC

The idea behind bonding curves was invented separately in a couple of different corners of the crypto space and operated under multiple names for the first few months of its existence. At first it was called Smart Tokens according to Bancor his approach was to use them in the Automated Market Makers (AMM) to help bootstrap low-liquidity markets and order-books. The second usage was in curation markets as popularized by Simon De La Rouviere. In 2019, the first decentralized oracle platform Zap Protocol was launched. Providing access to data providers and other services through algorithmic token generation. The major objective of this crypto economic primitive is to create a protocol-based incentive systems that enable coordination of network participants to achieve shared goals. Tokens incentivize players in an economic game towards an outcome that are mutually beneficial. Actually, token bonding curves are a mathematical function that represents the relationship between tokens price and supply.

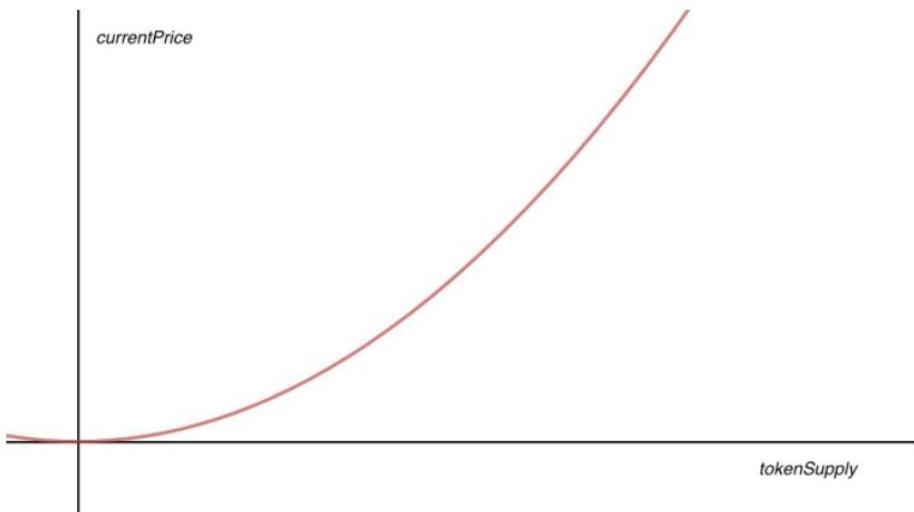


FIGURE 2.6 – Exponential token bonding curve graph  $\text{currentPrice} = \text{tokenSupply}^2$

As shown in the graph above, the price increases as the total supply increase. When a person has purchased the token, each subsequent buyer will have to pay a slightly higher price for each token, generating a potential profit for the earliest investors. As more people find out about the project and buying continues, the value of each token gradually increases along the bonding curve. Early investors who find promising projects early, buy the curve-bonded token, and then sell their token back can earn a profit in the future.

### 2.4.2 Curve shapes and usages

In this section, we will explore some of the most popular functions of the token bonding curves such as linear, polynomial, sub-linear and S-curve while mentioning the use cases of each.

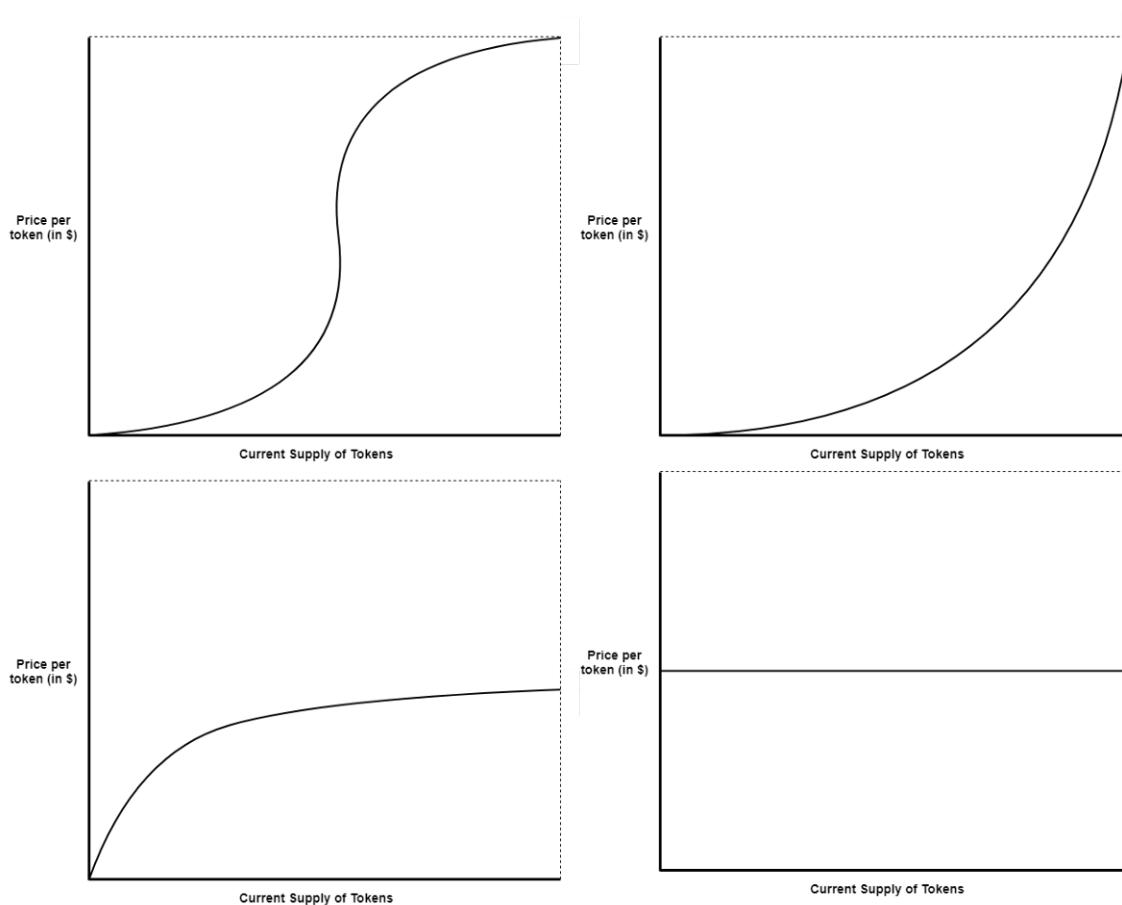


FIGURE 2.7 – Different shapes of token bonding curve

\*(Going from top left to bottom right) Sigmoid, quadratic curve, negative exponential curve, linear (non-increasing) curve

Before explaining each function apart lets take a look on what to consider when designing a TBC.

- Investors who participate to a TBC expect to make a good return.
- Early adopters will be incentivized higher than late adopters.
- The growth of a token's underlying project is likely to follow an *S* or *log* functions where growth accelerates quickly and then decelerates as a project reaches maturity and stability.
- Expect token supply to grow up at least 5-10x from their inception
- There is a predicted amount of capital developers can reasonably expect to attract across a token's lifetime.

## Linear Curves

$$y = mx + b$$

or in this case  $price = m * tokenSupply + b$  Where  $m$  describes the slope and  $b$  is the price at  $tokenSupply = 0$

In this function, the token price growth stays steady due to  $m$ . If  $m=0$ , the graph is completely constant like in Figure below, the price and the supply of the token are independent from each other. This horizontal linear function is appropriate for stable or pegged tokens.

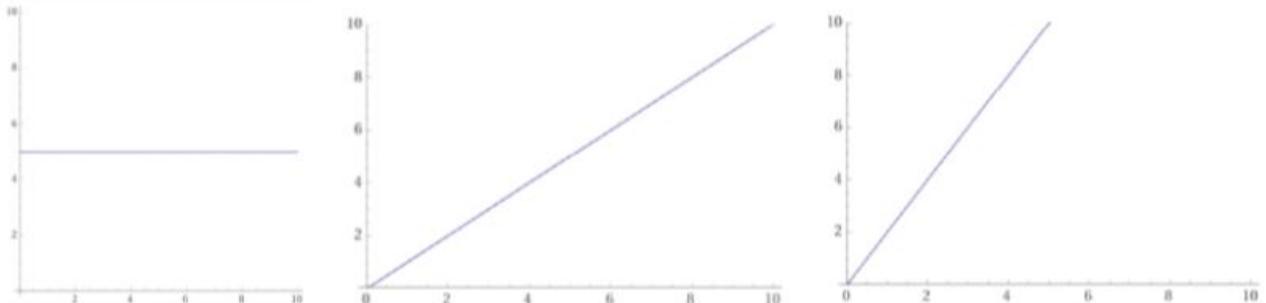


FIGURE 2.8 – Linear TBC

\*  $price = 5$ ,  $price = tokenSupply$ , and  $price = 2 * tokenSupply$  respectively. While all three are linear, the first is constant at the price of 5, and the third curve increases the price at double the rate of the second.

This model is appropriate for small businesses but they are not good for large-scale projects as they don't provide enough control and incentivization.

### Polynomial Curves

$$y = ax^n \text{ or price} = a * \text{tokenSupply}^n \text{ where } n > 1$$

The larger the  $a$  and  $n$  are the more aggressive the growth will be.

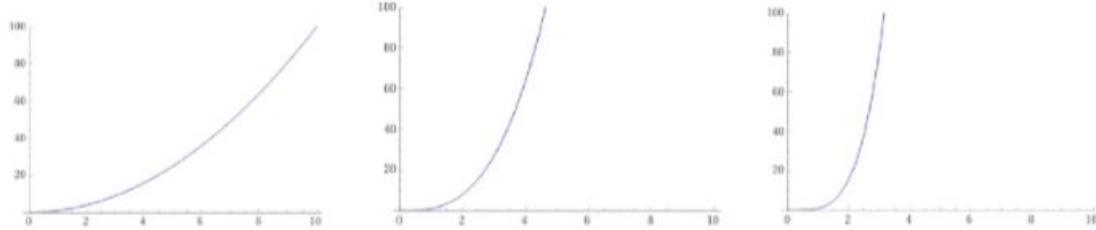


FIGURE 2.9 – Polynomial Curves

\* $\text{price} = \text{tokenSupply}^2$ ,  $\text{price} = \text{tokenSupply}^3$ ,  $\text{price} = \text{tokenSupply}^4$  respectively.

The core behaviors around these functions are that they grow slowly in the beginning, gain acceleration as they progress, and speed up to very aggressive rates.

### Sub-linear Curves

$$\text{price} = \log_b(\text{tokenSupply}) \text{ where } b \text{ is the base}$$

Or,  $\text{price} = \text{tokenSupply}^n$  where  $n < 1$

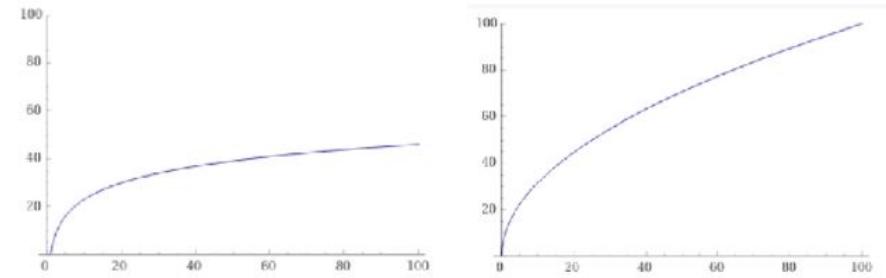


FIGURE 2.10 – Sub-linear Curves

$\text{price} = 10 * \log(\text{tokenSupply})$  and  $\text{price} = 10 * \text{tokenSupply}^{1/2}$  or  $\text{price} = 10 * \sqrt{\text{tokenSupply}}$ , respectively.

Logarithmic curves rise very quickly in the beginning, slowly decelerate their rate, and then eventually stable out.

*This curve immediately rewards early investors who take the risk on a project.*  
In this project we will use this type of curve.

### S-Curve (Sigmoid curve)

$$\text{price} = \frac{1}{1 + e^{-c_1 * (\text{tokenSupply} - c_2)}}$$

They move slowly in the beginning mirroring the time it takes a project to find its footing, grow aggressively in the middle similar to the growth phase in a project, and eventually settles out again once it reaches a certain level of maturity.

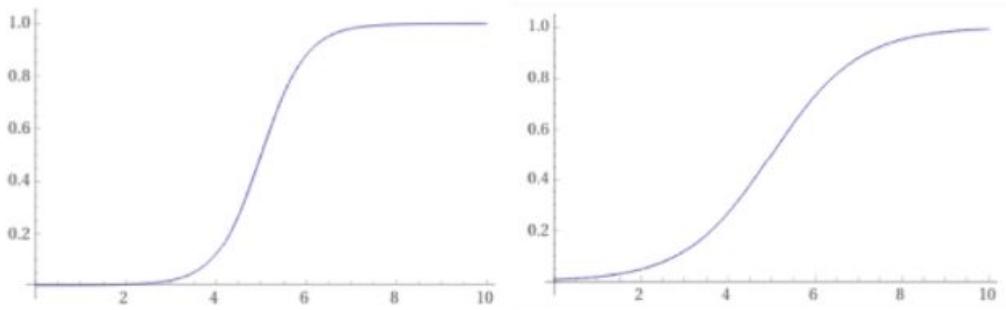


FIGURE 2.11 – The S-shaped graphs

$$\text{price} = \frac{1}{1 + e^{-2(x-5)}} \text{ and } \text{price} = \frac{1}{1 + e^{-1(x-5)}}, \text{ respectively.}$$

This model can attract early, potentially large, investors to claim a stake while the price is low and movement is stable (therefore less slippage).

### 2.4.3 Bonding Curve Price Formulas

We can compute the Continuous Token's current price as follows :

$$\text{ContinuousTokenPrice} = \frac{\text{ReserveToken Balance}}{\text{ContinuousTokenSupply} * \text{ReserveRatio}}$$

## 2.5 Introduction to Cryptocurrency Trading

Trading is the act of buying an asset at a price A and selling it at a price B. The objective is to sell at a price (B) higher than the purchase price (A). There are other trading strategies such as betting on the decline of an asset, which is called a short.

In the following we will present an introduction to crypto-currency trading. We will discuss concepts such as technical analysis, fundamental analysis and trading indicators.

### 2.5.1 Technical analysis

Technical analysis aims to predict or anticipate the price movements of an asset based on its past movements. This is done using mathematical tools (fundamental sciences). Indeed, it's a method of analysis to evaluate the price movements of an asset, looking at the data collected during trading activities. The relationship between price and volume is analyzed. These are the two most important pieces of information in technical analysis, most indicators are based on these two variables only. For this, it is necessary to use graphs such the followings :

#### 2.5.1.1 The bar graph (OHLC)

This format allows you to provide more detail on price variations within your time unit. One bar = one day, one week, or one hour depending on what you have chosen as your TU.



FIGURE 2.12 – The bar graph (OHLC)

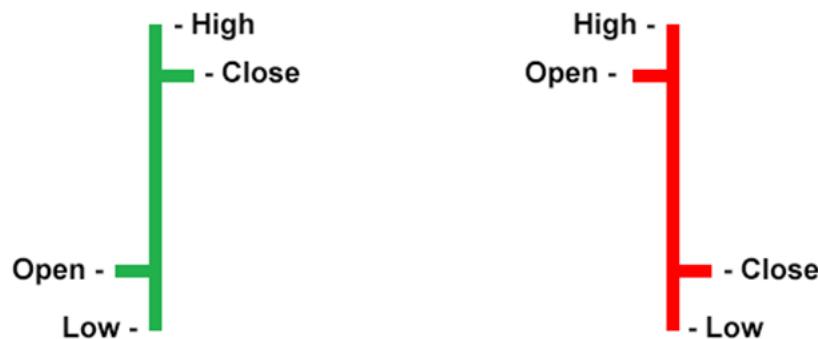


FIGURE 2.13 – OHLC

- **High** : the highest price reached in the time unit
- **Low** : the lowest price reached in the time unit
- **Open** : the opening price of the time unit
- **Close** : the closing price of the time unit

When the closing price is higher than the opening price, it is considered a bullish bar (green or white). When it is the opposite, it is considered a bearish bar (in red or black).

### 2.5.1.2 The Candlestick Chart

Candlesticks provide the same information as the bar chart but in a different form.



FIGURE 2.14 – The Candlestick Chart

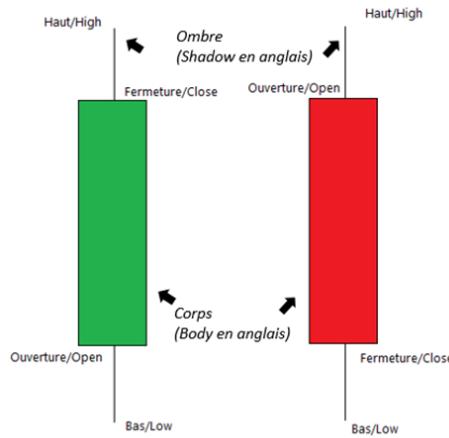


FIGURE 2.15 – OHLC2

The rectangle represents the body of the candle, which is the difference between the opening and closing price. The vertical line (the shadow) represents the highest and lowest price of the session.

Candles are an aid to vision, they are simple to interpret when you start. In addition, we will study the formations of groups of candles, these formations can act as signals to buy or sell a crypto-currency.

### 2.5.1.3 The Line Chart

The line chart is a simple representation of the price, its evolution is represented by a line that connects the closing prices of the sessions. The duration of the session depends on the time unit (TU) you have chosen at the top of the chart.



FIGURE 2.16 – The Line Chart

On this chart we are on a daily time unit, each point on the curve corresponds to the price of Bitcoin against the dollar at 23 :59 each day.

### 2.5.2 Long, Short, Bullish and Bearish attitudes

- **Bullish attitude** : (Attitude Haussier in French) The term bullish means that the expectation that a crypto-asset will increase in value. —Long position.  
In the case of a bullish market, or, by contraction, a bull, a rise in prices is expected. The term bullish can be applied to all kinds of financial assets (stocks, commodities, bonds, etc.).
- **Bearish attitude** : (Attitude Baissière in French) Refers to a downward market trend or negative investor sentiment. In this configuration, the prices of stocks or other financial assets fall and a further decline is expected. A drop of more than 15% in the stock market indexes is considered to be a sign of entering a bear market. It is then better to let the storm pass. —Short position.

## 2.6 Comparison between Technical Analysis (TA) and Fundamental Analysis (FA)

Technical analysis allows to highlight a trend, supports and resistances of the price or a pattern. This analysis will allow you to determine with more or less precision the strategies to follow in order to profit (or to minimize your losses) from the volatility of a price. A graphical analysis curve can allow you to identify the different assumptions in order to know how the price will behave. This analysis is made of indicators that most often use psychology and mathematics. It is a pragmatic approach to analysis based on carefully selected indicators. This analysis will therefore provide you with a visual report through which you can make a decision. However, the indicators used will not take into account information such as : growth potential, the real value of the asset or the impact of the network. While technical analysis focuses on asset price and price history, fundamental analysis brings together a list of indicators and information on a broad area. This is done in order to get a concrete overview of the health of a project/company. The indicators used in a fundamental analysis are related to the overall project under study. For example : the team behind the project, the idea, the community, the business model... But we also use more complex data indicators, such as : on-chain (network/blockchain) activity analysis, social sentiment...

## 2.7 Strategy Indicators

While the movement of crypto-currencies is often chaotic, the business of trading digital currencies can be very lucrative if you use the right tools. Of course, every trader has a trading strategy specific to their availability, risk management, level of experience and financial goals. However, there are some popular technical indicators for successfully trading crypto-currencies. These indicators can indeed allow you to make sense of the price action and predict its potential evolution. In the following we will study three of the most common indicators used by traders that will be useful in the rest of the project.

### 2.7.1 Moving averages

The moving average is a very popular indicator for traders. You should find it on most exchange charts. It is possible to implement a simple trading strategy using this indicator.

When we look at a price chart, all the variations appear clearly and can "pollute" the vision or the analysis. The moving average is used to erase these variations to have a smoother curve. This curve shows the average price over a period of time, which is called the length.

**For example :** in 1D (one candle = 1 day) a moving average length of 20 corresponds to the average price of the last 20 days. On 1H (one candle = 1 hour), it will be the last 20 hours.



FIGURE 2.17 – Moving averages (at 20 in red line and one at 40 in blue)

The shorter the length, the more it reacts to variations, the longer it is, the smoother the result will be and the curve will "lag" the price. Note how the red one follows the price

more than the blue MA.

We consider that we are in an uptrend when the shortest MAs are above the longest, and in a downtrend when the longest MAs are above the shortest.

Note that the source of the price can be changed, by default the moving average takes into account the closing price of candles.

They can also act as resistances and supports, they are then said to be dynamic because these levels follow the price unlike the horizontal formats.

**How does it work ?** Moving averages work best on trending crypto-currencies (bullish or bearish) and on large time units (TUs), most indicators often prove ineffective when the price is stuck between two levels or on small TUs.

MA-20 acts as a buy/sell signal, if the price is in an upward trend and the price is above MA-20 it is a buy signal. Conversely, if the price is falling and the price is below it is a sell signal.

## 2.7.2 Bollinger bands

Bollinger Bands are an analytical tool that was invented by the American John Bollinger. It is an essential indicator that every trader must have in his toolbox. They allow you to have a reliable and quick opinion on the volatility of a price.

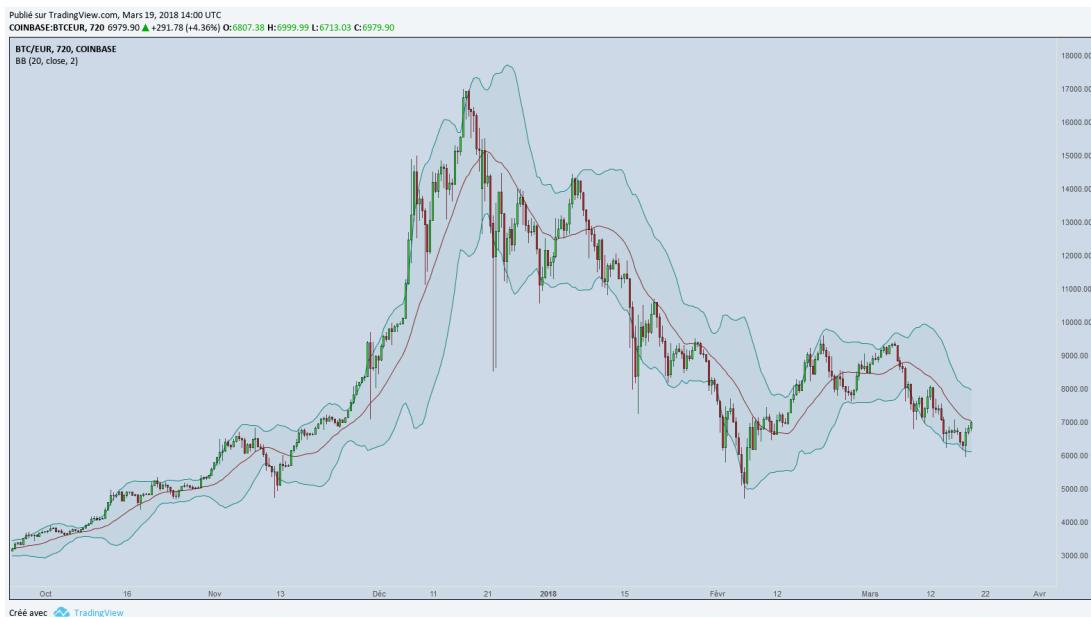


FIGURE 2.18 – Bollinger bands

**How does it work ?** These bands are composed of three moving averages (MA). The middle one is a simple moving average, usually smoothed over 20 periods. The standard deviation is then applied to obtain the other two.

To put it simply, the price will stay between the two bands, and we can consider them as dynamic resistances and supports. Moreover, the shape of the bands allows us to know if we are in a calm or active market.

When the bands move apart, it means that volatility is increasing and that we are in an active market. We will then tend to see large price movements. On the contrary, when the bands are rather contracted, then it is considered that the volatility is low and the market is calm.

So when the market is calm, the price will tend to bounce from the upper band to the lower band. It is therefore quite easy to anticipate the next price movements and play on the bounce as with supports.

It is also possible to play the breakout, for this, we wait to see the bands contract strongly. This is often a signal before the price takes a direction. If the price goes above the middle band during the release of the contraction then it is a **buy signal**, if it is below it is rather a **sell signal**.



FIGURE 2.19 – Two examples of breakout with Bollinger bands

### 2.7.3 Relative Strength Index *RSI*

RSI stands for Relative Strength Index is a trading indicator from the oscillator family, it helps to identify the strength of a market and whether it is **overbought or oversold**. It is one of the most used oscillators, it will be very often included on crypto-currency trading platforms in ours too.

$$RSI = 100 - \frac{100}{1 + \frac{\text{bullish average}}{\text{bearish average}}}$$

The RSI is calculated as a ratio of the average rise to the average fall over a given period (the length).

By default, the length of the RSI is 14, so its amplitude depends on the time unit of your chart. On a 1-minute chart, the last value of the RSI will take into account the last 14 minutes. On a 1 day chart, the last 14 days, etc.

The RSI value is always between 0 and 100. If there are more strong rises, the RSI will be above 50 for the period. And if there are more strong declines, it will be below 50 over the period.

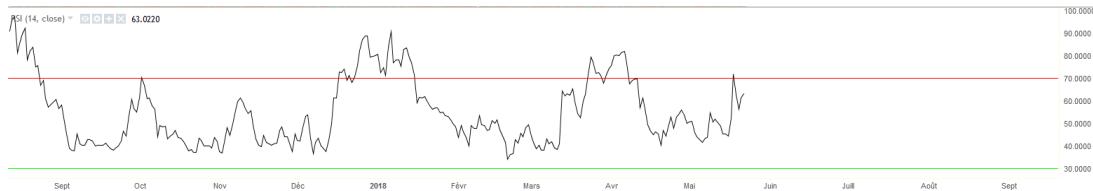


FIGURE 2.20 – Reading an RSI graph

We delineate two zones corresponding to the state of the market. The upper band, between 70 and 100 corresponds to the overbought zone, it is delimited by the red line on the image, in this case **we should enter into a short position**. The lower band is between 0 and 30 and corresponds to the oversold zone, delimited by the green line, **it is common to open a long position (buy the stock)**.

## Conclusion

We have seen in this chapter that there are methods of funding Blockchain startups such as ICOs, IEOs and bonding curves. These methods allow interested parties to raise cryptocurrencies (like Bitcoin or Ether) to launch a project. These funding systems have radically changed the way funds are raised. However, in order to establish a win-win situation, investors need to use strategy indicators hence what we call technical and fundamental analysis. So how to apply these techniques, what data is needed to build a trustful prescriptive and predictive system in order to advice and enhance traders to invest.

# Chapitre 3

## Business understanding

### Introduction

Throughout this chapter, we will approach the preliminary phase that serves to prepare the ground for the implementation of our solution. This part will be evident in order to achieve our objectives through the extraction of functional and non-functional needs, the technical study and the conceptual aspect.

### 3.1 Project Requirements and assumptions

Our project entitled " Development of a Crypto-economic model for a block chain solution using the continuous token models" is Crypto-asset platform, it is also a resource for start-ups looking to raise money with cryptocurrency by making it possible for early adopters to know what the best companies to fund in exchange of a certain amount of tokens. As part of the implementation of this solution we have defined the following requirements and assumptions.

Scraping data, transforming and loading it into a centralized, document-oriented database.

Collection and extraction of data from a Block chain solution.

Users should be able to create an account and login.

The model should predict the price evolution over total token supply.

Early investors and interested parties should find a prescriptive trading strategy.

Users should find a dashboard containing all the crypto existing in the project.

Visualizing Token Bonding curves.

Dynamically generate strategy indicator.

Presents the projects that stills in the hatch phase and projects in open phase.

## 3.2 Project Terminology

### 3.2.1 Business, Commercial terminology

Fund startups with cryptocurrency  
Incentivize/reward Early adopters  
Attract and enhance investors/project founders to invest.  
Provide users with prescriptive information so that they can make the best investment and increase company funds

### 3.2.2 Data mining terminology

Now that the business objective is elucidated, it is time to translate it into data science applied to finance issues.

Help users make decisions regarding the best trading strategy to follow by presenting an Predictive overview of all the project.  
Predict how the crypto price will evolve over Cryptocurrency total supply.  
Build a deep Leaning model and refine parameters this model will be deigned for the implementation of the trading strategy.  
Design a machine learning regression algorithm for the native bonding curve.

## 3.3 Work environment

In order to plan the project rigorously, it is essential to evaluate beforehand the tools, techniques and resources to be used in order to know how long each phase will take :

### 3.3.1 Ressources

**Personnel** : The company has a intern in a final year project specialized in data science for finance supervised by the technical director of the Innovation center.

**Data** : Data is collected in real time from a python library and transformed into a documents database with mongoDB

**Informatics** : Lenovo ideapad, Windows 10 Professional, 7th generation i5 processor, 12 GB RAM, 64bit operating system.

### 3.3.2 Initial assessment of tools and techniques

**Python** : An open source, interpreted and interactive object-oriented programming language. It is the most widely used in the field of Data Science thanks to its data manipulation and modeling libraries. For the implementation of our solution, we used several python libraries such as Sanpy, matplotlib, pandas, numpy, plotly, Dash, Flask, cadCAD, sklearn, keras, tensorflow...



FIGURE 3.1 – Logo Python

app all in one environment.

**Anaconda** : an open source distribution that is the easiest and most efficient way to do data science with Python.

**PyCharm** : A Python IDE for professional developers. PyCharm allows you to access the command line, connect to a database, create a virtual environment and manage your version control system all in one place, saving you time by not having to constantly switch between windows. We set conda python 3.7 as interpreter and we created jupyter notebooks, python files and Flask web



FIGURE 3.2 – Logo MongoDB



FIGURE 3.3 – Logo Flask

**MongoDB** : is a document-oriented database management system that can be distributed to any number of computers and does not require a predefined data schema.

**Flask** is an open-source micro framework for web development in Python. It is classified as a microframework because it is very lightweight. Flask aims to keep the core simple but extensible. It does not integrate an authentication system, a database abstraction layer or a form validation tool. [?]

## Conclusion

In this chapter, we have covered all the perspectives related to business and data science needs. We will now move on to the data understanding phase.

# Chapitre 4

## Data understanding and preprocessing

### Introduction

The pillar of building a predictive, even prescriptive, blockchain-based system is understanding and preprocessing the data this phase is essential to obtain reliable results.

### 4.1 Data Collection and understanding

Data analytics is a science that, when applied to cryptocurrency valuation, helps to refine fundamental analysis. In classic data analytics we find financial, social and technical data. This practice applied to cryptos goes as far as deconstructing the activity of a network.

We will use two data types, external and internal, from the following python libraries respectively :

**SanAPI** short for Santiment API in order to access real-time or historical data.

**cadCAD** short for Complex Adaptive Dynamics Computer-Aided Design an open-source python library

#### 4.1.1 About Santiment data API

Santiment aims to be a data and content platform for the crypto-currency market. The goal is to transform the distribution of financial information on the crypto-currency market, centralize market monitoring, news, ICOs, interviews, all on one platform.

To extract data from this api we can apply three methods :

Scraping data with san python library after setting an API key, generated from an account.

Sansheets Google Spreadsheets plugin for importing Santiment data.

San Charts download data directly from the platform as a csv or an excel file

### *Data from SanCharts*



FIGURE 4.1 – Scraping Ethereum data from SanCharts

After creating a santiment account, we will be able to select the crypto-currency we want from the list of existing projects on the platform, then a specific list of metrics for that project will appear and we will select what we want.

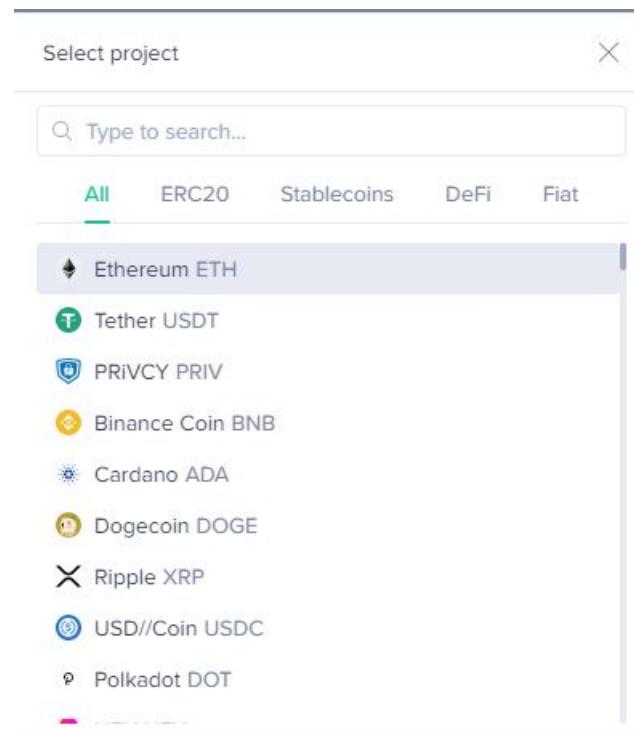


FIGURE 4.2 – Select project

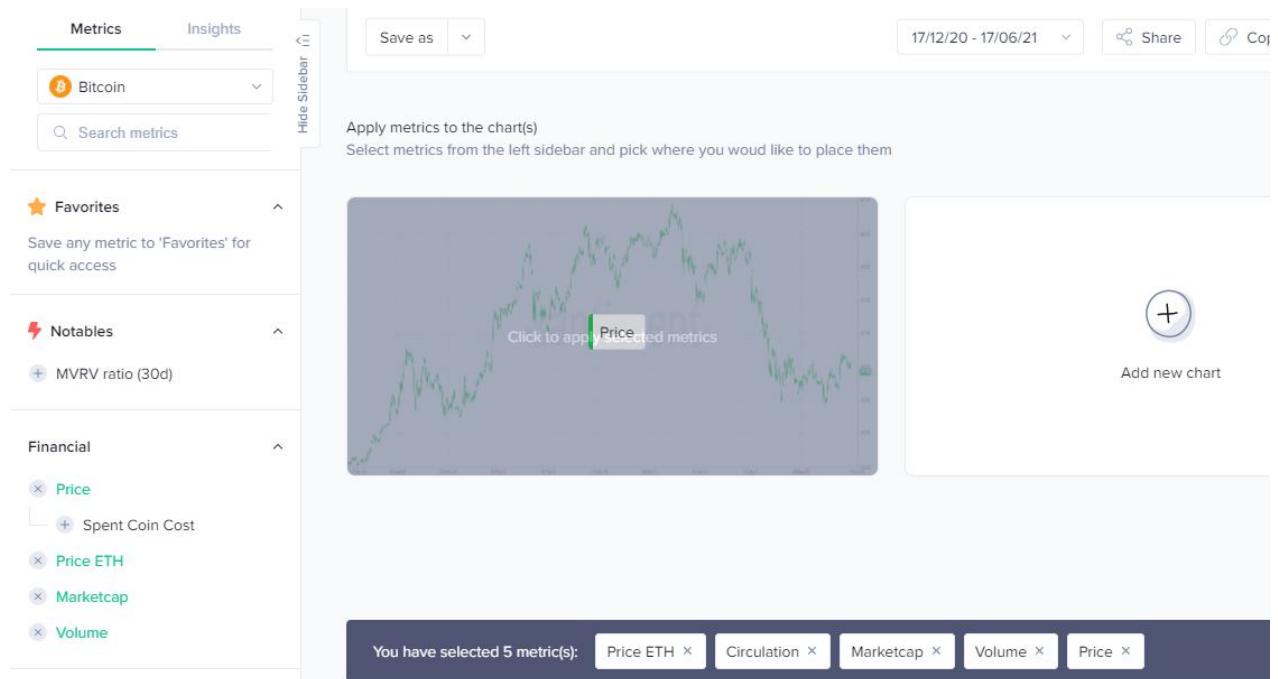


FIGURE 4.3 – Select metrics

We can now download the generated csv file and will obtain the following dataframe :

	Date	Volume	Price BTC	Price ETH	Circulation	Circulation (1d)	Circulation (30d)
0	2020-09-12T00:00:00.000Z	1656.0	0.000016	0.000443	83337000.0	1000.000128	450301.949191
1	2020-09-12T04:00:00.000Z	1045.0	0.000015	0.000427	83337000.0	1000.000128	450301.949191
2	2020-09-12T08:00:00.000Z	1036.0	0.000016	0.000434	83337000.0	1000.000128	450301.949191
3	2020-09-12T12:00:00.000Z	1513.0	0.000015	0.000416	83337000.0	1000.000128	450301.949191
4	2020-09-12T16:00:00.000Z	1264.0	0.000015	0.000410	83337000.0	1000.000128	450301.949191

FIGURE 4.4 – Ethereum (ETH) dataframe

- **Volume** : Daily Transaction Volume.
- **Price BTC** : Bitcoin Prices.
- **Price ETH** : Ethereum prices.
- **Circulation** : Token circulation since its creation.
- **Circulation 1d** : Token circulation over the past day.
- **Circulation 30d** : Token circulation over the past month.

## *Scraping data with SAN Python library*

We also extracted data on all existing projects and grouped them by market segment to determine which market is getting the most attention.

marketSegment	name				slug				ticker				totalSupply											
	count		unique		top		freq		count		unique		top		freq		count		unique		top		freq	
	AI	16	16	PATHHIVE	1	16	16	translateme-network-token	1	16	16	CTXC	1	16	14	10000000000	3							
Adult	2	2	SpankChain	1	2	2	spankchain	1	2	2	SPANK	1	2	2	10000000000	1								
Advertising	10	10	TouchCon	1	10	10	adx-net	1	10	10	TOC	1	10	10	61000000	1								
Ardor	1	1	Ignis	1	1	1	ignis	1	1	1	IGNIS	1	1	1	999449694	1								
Art	2	2	Artnfinity	1	2	2	artnfinity	1	2	2	AT	1	2	2	100000000	1								
Binance	9	9	CryptoBonusMiles	1	9	9	blind-boxes	1	9	9	AIOZ	1	9	8	1000000000	2								
Bitcoin	6	6	Lightning Network	1	6	6	lightning-network	1	6	6	ZNT	1	1	1	18712918	1								
Bitshares	1	1	DEEX	1	1	1	deex	1	1	1	DEEX	1	1	1	87811933.4135	1								
Blockchain Network	58	58	Hero Node	1	58	58	digibyte	1	58	57	TON	2	55	46	100000000	3								
Blockchain Service	66	66	EosBLACK	1	66	66	syncfab	1	66	66	BLACK	1	64	50	1000000000	8								
Cloud Computing	19	19	MassGrid	1	19	19	ankr	1	19	19	ARPA	1	19	18	1000000000	2								
Cloud Storage	12	12	Filecoin	1	12	12	shift	1	12	12	SHIFT	1	12	11	0	2								
Communication Network	3	3	SpaceChain	1	3	3	blockmesh	1	3	3	BMH	1	3	3	2000000000	1								
Cryptocurrency	153	153	Stealth	1	153	153	nano	1	153	153	HC	1	153	148	1000000000	4								
Data	38	38	Big Data Protocol	1	38	38	owndata	1	38	38	BBN	1	38	29	1000000000	8								
DeFi	194	194	Alchemist	1	194	194	index-cooperative	1	194	193	LOCK	2	147	99	0	23								
Decentralized Exchange	50	50	Ellipsis	1	50	50	nectar	1	50	50	TRADE	1	48	35	1000000000	7								
Derivatives	1	1	KINE	1	1	1	kine	1	1	1	KINE	1	1	1	0	1								
E-Commerce	8	8	ARAW	1	8	8	araw	1	8	8	ARAW	1	8	8	70000000	1								
EOS	5	5	pEOS	1	5	5	fio-protocol	1	5	5	MEETONE	1	4	4	10000000000	1								
Education	3	3	WOLLO	1	3	3	wollo	1	3	3	EDU	1	3	3	15000000000	1								
Energy	12	12	Robotina	1	12	12	gridplus	1	12	12	EWT	1	12	11	10000000000	2								
Entertainment	25	25	Like	1	25	25	likecoin	1	25	25	CMIT	1	25	23	10000000000	3								
Ethereum	162	162	Business Credit Alliance Chain	1	162	162	props	1	162	161	SPX	2	154	117	10000000000	13								

FIGURE 4.5 – Summary statistic of all projects

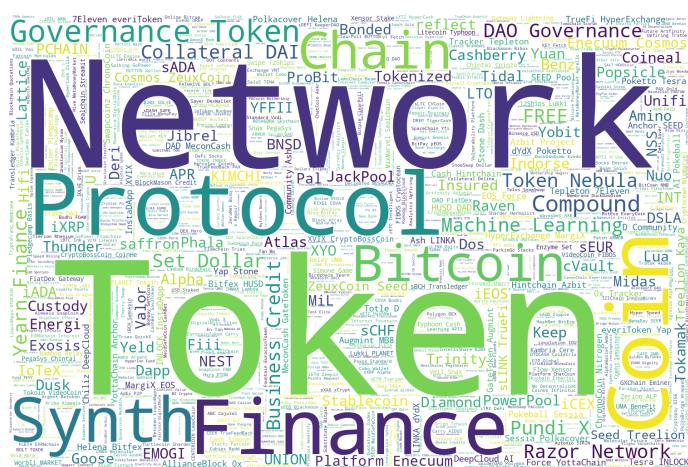


FIGURE 4.6 – Word Cloud

### *Scraping data with Sansheets*

To use this scraping method, we had to add Sansheets to our Google Sheets. To do this, we opened a new spreadsheet where we found the "Get add-ons" option in the top navigation bar.

We searched for Santiment in the search bar menu, Santiment Data appears as a result and we were able to install it for free.

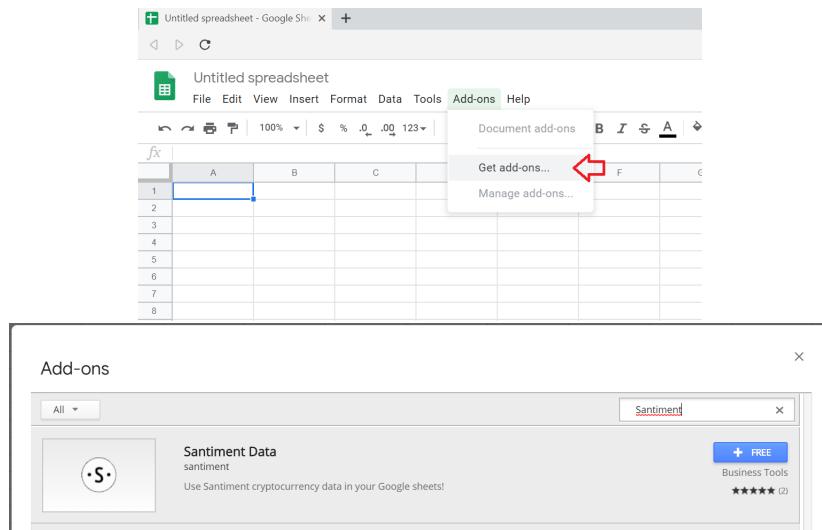


FIGURE 4.7 – SanSheets installation

The next step will be enabling Sansheets for the spreadsheet and getting access to more data by adding the API key.

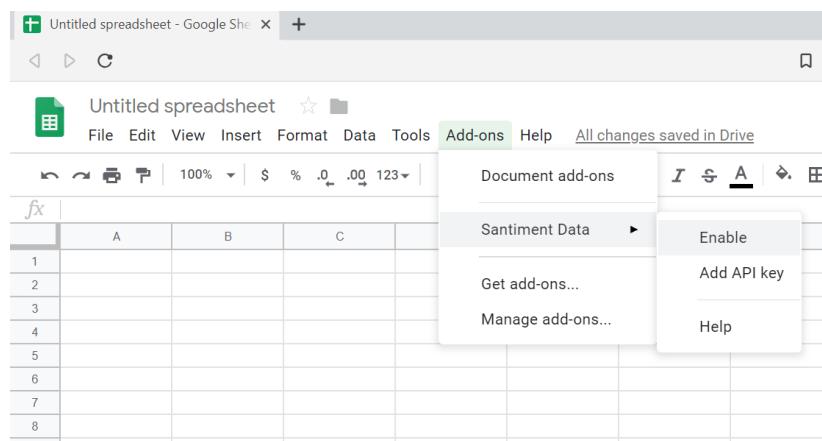


FIGURE 4.8 – Enabling Sansheets for the spreadsheet

SAN presents a large list of functions on its website. For our project, we have chosen the following metrics :

A	B	C	D	E
#NOM?	Open Price USD	High Price USD	Low Price USD	Close Price USD
1				
2 2015-08-07	2,83162	3,53661	2,52112	2,77212
3 2015-08-08	2,79376	2,79881	0,714725	0,753325
4 2015-08-09	0,706136	0,87981	0,629191	0,701897
5 2015-08-10	0,713989	0,729854	0,636546	0,708448
6 2015-08-11	0,708087	1,13141	0,663235	1,06786
7 2015-08-12	1,05875	1,28994	0,883608	1,21744
8 2015-08-13	1,22224	1,96507	1,17199	1,82767
9 2015-08-14	1,81092	2,26188	1,75475	1,82787
10 2015-08-15	1,80289	1,87724	1,57098	1,6889
11 2015-08-16	1,68435	1,69524	1,08981	1,56603
12 2015-08-17	1,58119	1,58119	1,18534	1,20361
13 2015-08-18	1,2153	1,33116	1,08705	1,08705
14 2015-08-19	1,16693	1,31799	1,16693	1,25886
15 2015-08-20	1,25118	1,5333	1,24833	1,46492
16 2015-08-21	1,47752	1,55642	1,3528	1,39529
17 2015-08-22	1,39629	1,47641	1,35268	1,37923
18 2015-08-23	1,375	1,4097	1,29777	1,35259
19 2015-08-24	1,34559	1,36278	1,23127	1,23127
20 2015-08-25	1,22861	1,24182	1,12865	1,14019
21 2015-08-26	1,13279	1,20248	1,06183	1,15998
22 2015-08-27	1,16981	1,18883	1,13729	1,1477
23 2015-08-28	1,14766	1,20779	1,1205	1,19138

FIGURE 4.9 – Ethereum OHCL data

As we mentioned in the second chapter, OHCL is the acronym for the opening, high, low and closing prices of a stock during a trading session. We will be using these four variables to study the price of the crypto over the long term in more detail and thus identify the most profitable investment strategy.

#### 4.1.2 Collect blockchain transaction data

The output of this action is a pickle that will be used as an input parameter when implementing the cadCAD model. This phase is crucial when implementing blockchain-based systems in order to analyze the change in behavior of significant variables given mint or burn events. In our case, we will focus on the supply and price of UNI and Ether. Therefore, this part involves the calculation of the initial variables and the implementation of the logic for calculating the changes over the events.

The result is a dataframe that we saved as a github gist :

```

timestamp,token_delta,eth_delta,logIndex,UNI_delta,event,token_balance,eth_balance,UNI_supply
2021-02-13 15:00:00,328.88197272902386,3.4073846154225875,1,33.47577294352898,,328.88197272902386,3.4073846154225875,33.47577294352898
2021-02-13 15:35:26,800.0,1.392726440360485,69,33.37935218497189,mint,1128.8819727290238,4.800111055783073,66.85512512850087
2021-02-13 15:37:05,100.19304745914647,-0.2,10,0.0,ethPurchase,1229.0750201881784,4.6001110557830724,66.85512512850087
2021-02-13 15:38:05,166.81778649541184,-0.5,35,0.0,ethPurchase,1395.8928066835822,4.1001110557830724,66.85512512850087
2021-02-13 15:39:08,46.36656941697624,-0.2,6,0.0,ethPurchase,1442.2593761005585,3.9001110557830723,66.85512512850087
2021-02-13 15:39:52,56.1568538637681,-0.3,30,0.0,ethPurchase,1498.4162299643265,3.6001110557830724,66.85512512850087
2021-02-13 15:40:42,23.475442111882035,-0.15,16,0.0,ethPurchase,1521.8916720762086,3.4501110557830725,66.85512512850087
2021-02-13 15:40:45,108.50240952697689,-1.0,34,0.0,ethPurchase,1630.3940816031854,2.4501110557830725,66.85512512850087
2021-02-13 15:42:06,85.21751517637175,-1.5,4,0.0,ethPurchase,1715.6115967795572,0.9501110557830725,66.85512512850087
2021-02-13 15:42:27,-50.418549320410705,1.0,4,0.0,tokenPurchase,1665.1930474591466,1.9501110557830725,66.85512512850087
2021-02-13 15:43:45,-50.19304745914646,0.6767461204350917,78,0.0,tokenPurchase,1615.0,2.6268571762181643,66.85512512850087

```

FIGURE 4.10 – Uniswap transaction data as a github Gist

### 4.1.3 CadCAD Library

The fundraising process for startups can be divided into different phases, from the submission of the project idea until the contributions reach the company. In this context, the hatching period is measured in days, and will allow Trusted Seed members an appropriate amount of time to invest their funds.

To process data issued from this phase we used data collected from Uniswap transactions simulated using cadCAD model.

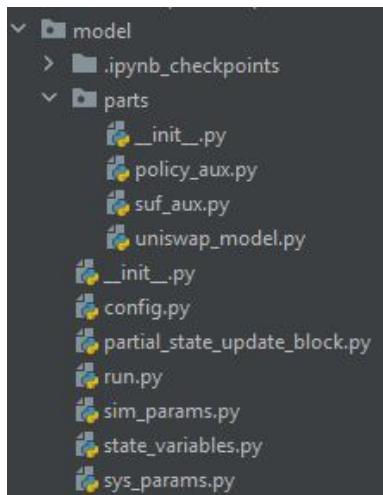


FIGURE 4.11 – cadCAD Model structure

#### *cadCAD Model structure :*

There are a parts folder and 6 files in model folder : **config.py** which contains the simulation configurations , aggregating the partial states and the state variables;

**partial\_state\_update\_block.py**, which contains the partial state update blocks and how they update the state variables ;

**state\_variables.py**, which defines the model's state variables

**run.py**, which runs the simulation.

The initial parameters and hyperparameters of the system are defined in **sys\_params.py** and helper functions, plots, etc. are in **utils.py**.

and we obtained the following results :

	ETH_balance	RAI_balance	UNI_supply	price_ratio	run	simulation	subset	timestep	liquidity_event
0	4.800111	1.128882e+03	73.6122	0.0	1	0	0	1	False
1	4.800111	1.202882e+03	73.6122	0.0	1	0	0	2	False
2	4.800111	1.401882e+03	73.6122	0.0	1	0	0	3	False
3	4.800111	1.576882e+03	73.6122	0.0	1	0	0	4	False
4	4.800111	1.774882e+03	73.6122	0.0	1	0	0	5	False
5	4.800111	1.937882e+03	73.6122	0.0	1	0	0	6	False
6	3.800111	2.487882e+03	73.6122	0.0	1	0	0	7	False
7	2.800111	4.133882e+03	73.6122	0.0	1	0	0	8	False
8	2.800111	4.133882e+03	73.6122	0.0	1	0	0	9	True
9	3.800111	3.048882e+03	73.6122	0.0	1	0	0	10	False
10	4.800111	2.415882e+03	73.6122	0.0	1	0	0	11	False
11	4.800111	2.490882e+03	73.6122	0.0	1	0	0	12	False
12	4.800111	2.767882e+03	73.6122	0.0	1	0	0	13	False
13	4.800111	2.767882e+03	73.6122	0.0	1	0	0	14	True
14	4.800111	3.264882e+03	73.6122	0.0	1	0	0	15	False
15	4.800111	3.890882e+03	73.6122	0.0	1	0	0	16	False
16	4.800111	3.890882e+03	73.6122	0.0	1	0	0	17	True
17	4.800111	3.890882e+03	73.6122	0.0	1	0	0	18	True

FIGURE 4.12 – Model results

**Analysis :** In what follows we will compare the simulated data to real ones in order to evaluate how well our model works.

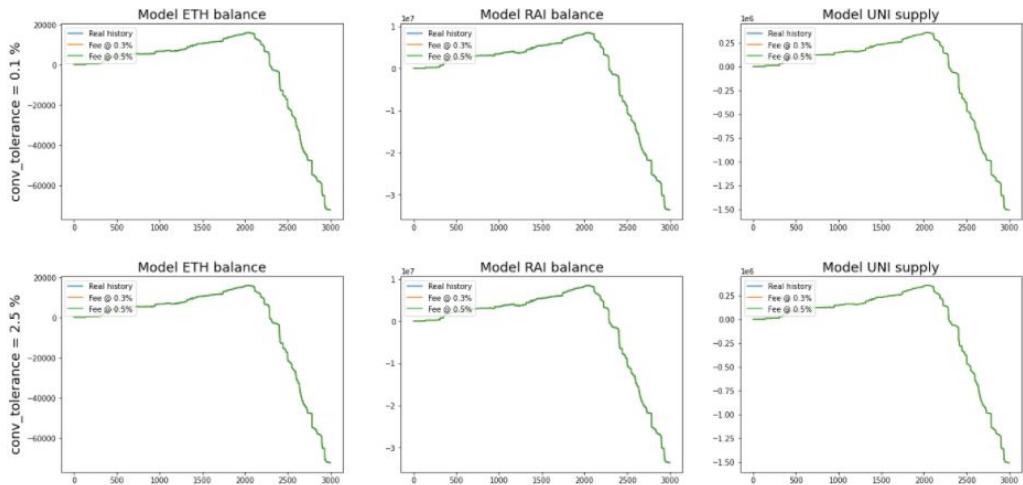


FIGURE 4.13 – Result evaluation

## 4.2 Data preparation

This task includes constructive data preparation operations such as date manipulation and missing value manipulation. We have transformed all the date variables into datetime64 type and we deleted the rows containing missing values. We also deleted unuseful columns such as price\_ratio, simulation and subset. Then we saved the result into mongoDB collections.

Collection Name	Documents	Avg. Document Size	Total Document Size	Num. Indexes	Total Index Size	Properties
Bitcoin_prices	2,926	173.2 B	494.9 KB	1	4.0 KB	
Ethereum_data	2,095	107.0 B	218.9 KB	1	32.0 KB	
ProjectBancor	1,167	141.0 B	160.7 KB	1	28.0 KB	
ProjectChainLink	1,167	141.0 B	160.7 KB	1	28.0 KB	
ProjectUniswap	177	141.0 B	24.4 KB	1	20.0 KB	
ProjectdeepcloudAI	571	141.0 B	78.6 KB	1	20.0 KB	
Projecttether	1,167	141.0 B	160.7 KB	1	28.0 KB	
Uni_data	3,000	134.7 B	394.6 KB	1	44.0 KB	

FIGURE 4.14 – MongoDB Collections

## 4.3 Data preprocessing

Normalizing a dataset is a common requirement for many machine learning estimators : they can misbehave if the individual features do not resemble (more or less) the standard normally distributed data. To do this, we used *MinMaxScaler* from the *sklearn.preprocessing* library.

After normalizing the data, we need to sample it using pandas. This library has many built-in options for resampling, and we can even define our own methods. Here are some of the most common methods we have used for resampling : range median Median of values in time range min Minimum ohlc Opening value, highest value, lowest value, closing value. Below we will sample the bitcoin OHCL data by year, month and week, we will need this sampling later in the technical analysis phase.

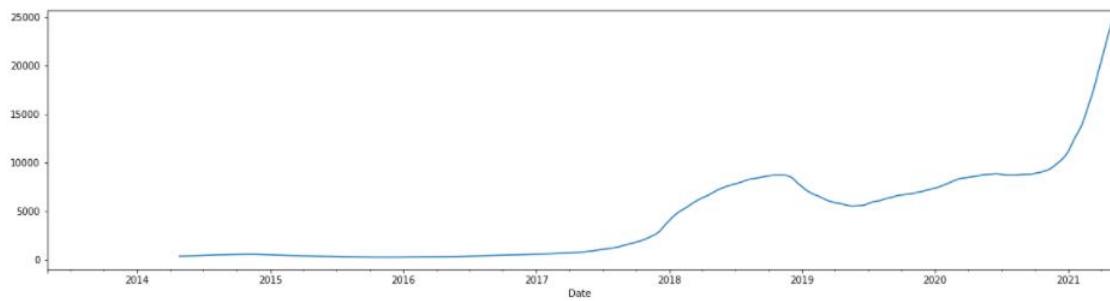


FIGURE 4.15 – Rolling by year

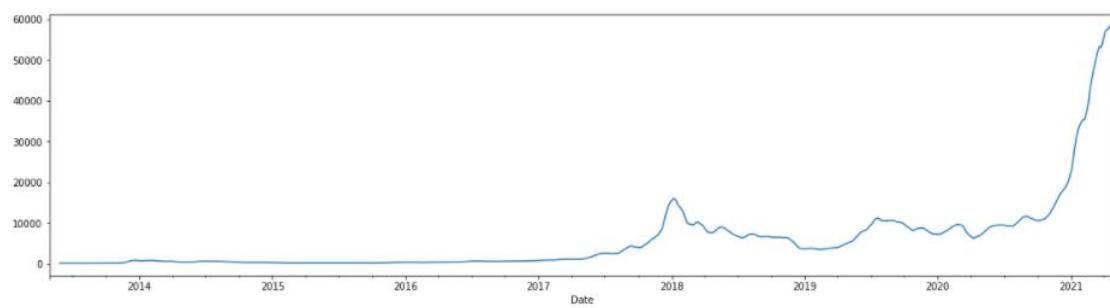


FIGURE 4.16 – Rolling by month

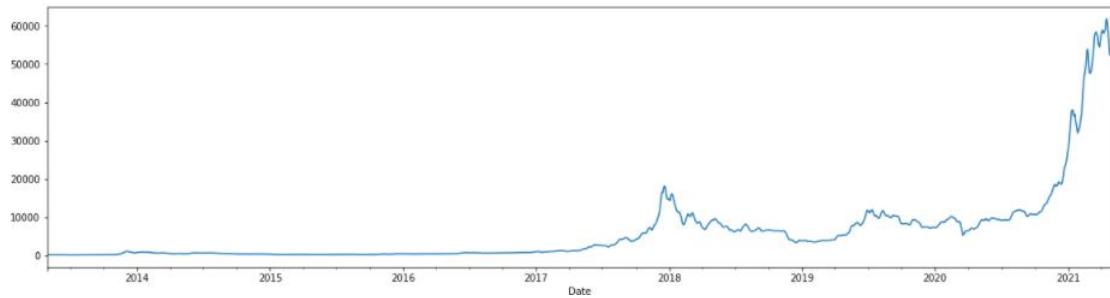


FIGURE 4.17 – Rolling by week

## Conclusion

Choosing the right attitudes to follow while investing is not as easy as it sounds. There are many things to consider before making a decision. To ensure the best predictive and analytical results, we have seen in this chapter how the data should be pre-processed. Now that the data is ready, we will move on to the main phase of the CRISP methodology followed in this project, namely modeling.

# Chapitre 5

## Realization : Modeling, Testing and Deployment

### Introduction

Modeling is the phase in which our work begins to bear fruit. After collecting, cleaning and preprocessing all the necessary data, the last part of this project is to create the most adequate model that will answer the business problems encountered during the "Business Understanding" phase. In this section, the development of various techniques used will be discussed and explained in detail. The construction of various models will allow us to choose the best model according to our data and our business needs.

### 5.1 Regression Algorithms

In this section, two machine learning algorithms will be reviewed and discussed, both belonging to the category of supervised regression algorithms since it fits with our business requirements, that is, score prediction and risk assessment.

To make these learning algorithms clear, we will begin with a brief introduction to the learning methods for each model.

#### 5.1.1 Linear Regression

Linear regression is a machine learning algorithm that consists in finding the best function to define an output variable (the item to be predicted) from one and only one explanatory input variable (the predictor) - this is why it is called univariate regression, as opposed to multivariate models, which take into account several explanatory variables.

Graphically, the aim is to find the best possible line that can explain a model  $(x, y)$ . This function is of the form  $Y = BO + XB1 + E$ , where  $Y$  is the response,  $BO$  is the intercept,  $X$  is the explanatory variable,  $B1$  is the slope (the value of change of  $X$  when it increases by one unit), and finally  $E$  is the statistical error.

**Implementation of the model** As already indicated in the data mining phase, our dataset has no missing values because the data is pre-processed. All that remains to do is the division of training and testing data and the assignment of the target column.

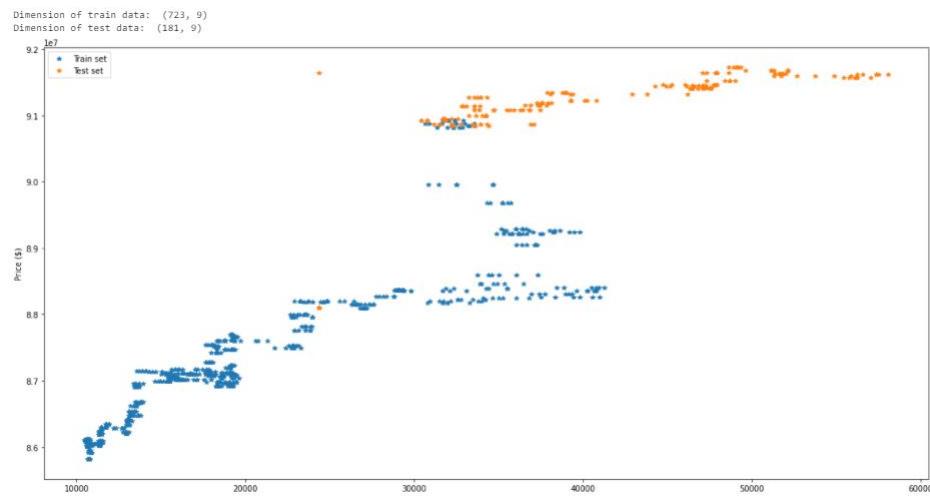


FIGURE 5.1 – Train/Test Data

Ethereum Price and coin circulation over last 60 days, actual vs. predicted (from trained linear model)

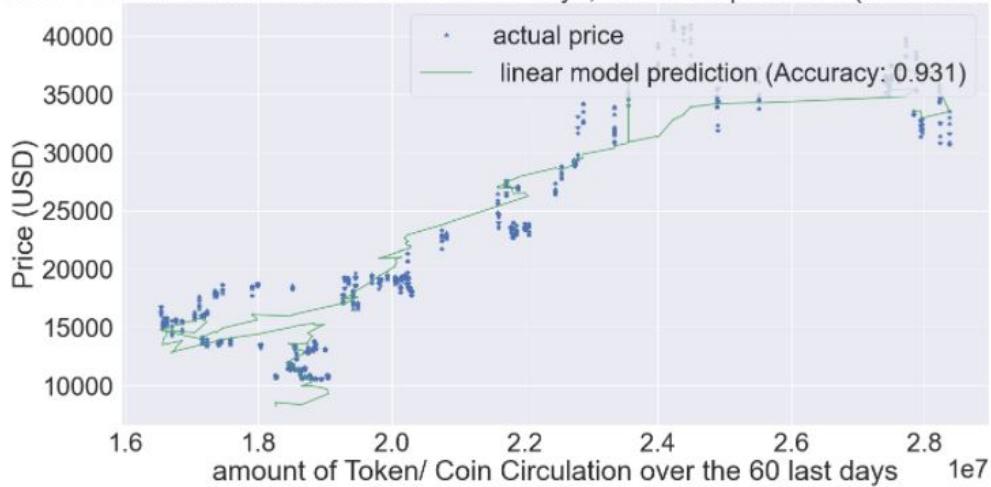


FIGURE 5.2 – Linear regression Result

As illustrated in the figure above linear model prediction  $accuracy = 0.931$ .

### 5.1.2 Ridge Regression

It is a linear regression with a quadratic constraint on the coefficients. It is useful when the variables are highly correlated, which is the case with our data as illustrated in the heatmap below :

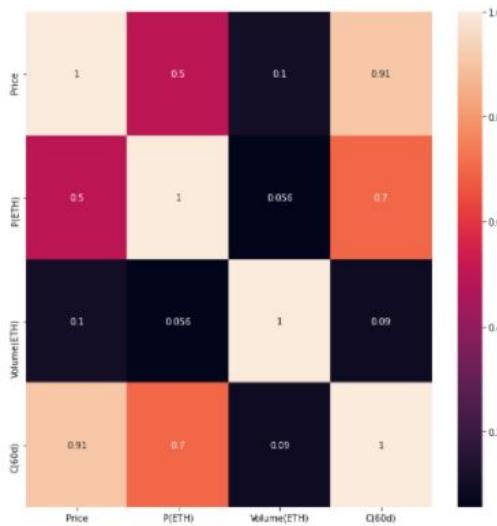


FIGURE 5.3 – Seaborn Correlation Heatmap

We can see from the figure above that there is a linear trend between the prices (price of Ether and dollar) and the quantity of Token in circulation over the last two months ; the correlation coefficient is equal to 0.7 and 0.91 respectively. As the amount of tokens increases the prices does too, which is the principle of the bonding curves.

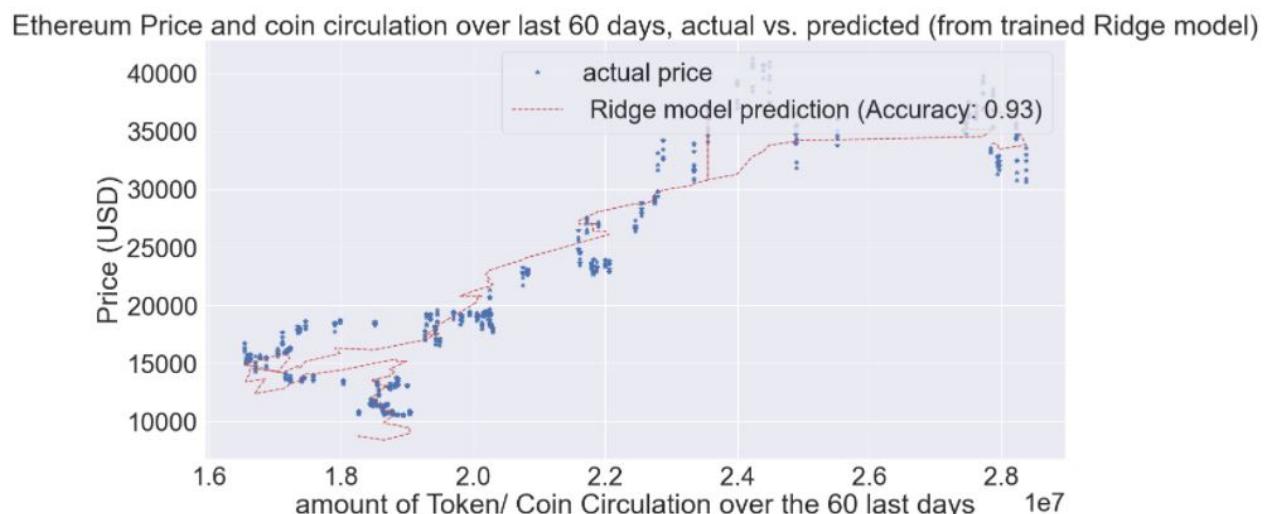


FIGURE 5.4 – Ridge regression Result

## 5.2 Recurrent neural networks *RNN*

Neural networks are today the state of the art for various machine learning tasks. They are widely used for example in the fields of computer vision (image classification, object detection, segmentation...) and automatic language processing (automatic translation, speech recognition, language models...). or as in our case for the prediction of crypto prices changes.

We used a particular variant of neural networks, LSTM, for Long Short-Term Memory. This family of models, particularly adapted to sequential data, allowed us to predict the next change in our bonding curve.

### 5.2.1 Long-term short-term memory *LSTM*

The idea behind this choice of neural network architecture is to divide the signal between what is important in the short term through the hidden state (analogous to the output of a simple RNN cell), and what is important in the long term, through the cell state. Thus, the global functioning of an LSTM can be summarized in 3 steps :

Detecting relevant information from the past, taken from the cell state through the forget gate ;

Selecting, from the current input, those that will be relevant in the long term, via the input gate. These will be added to the cell state which acts as a long term memory ;

Pick from the new cell state the important short term information to generate the next hidden state through the output gate.

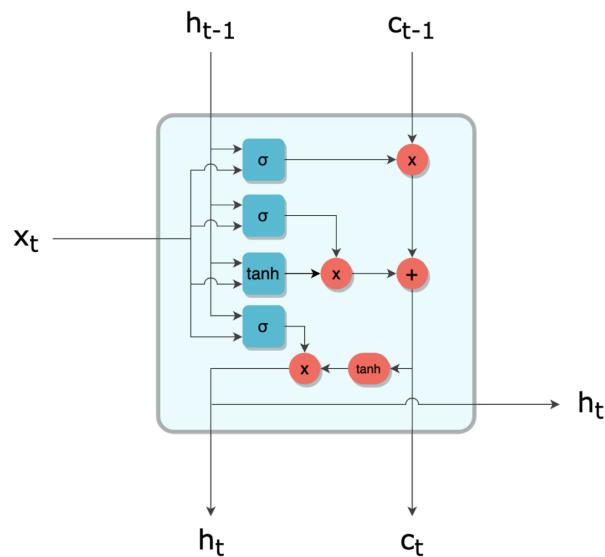


FIGURE 5.5 – Simplified representation of an LSTM cell

### 5.2.2 Building the Model

In this section, we will Implement an *RNN* to predict Crypto prices and percent change per day. The data is inputed as an *xlsx* file. We transformed data from  $(num\_days * num\_features)$  to  $(num\_days - window\_size * num\_days * num\_features)$  where *window\_size* is equal to 50. Then we normalized the result via dividing each value in the window by the first value of the window and then subtracting one (.i.e [4,3,2] into [0, -0.25, -0.5]). The unnormalized bases are kept to compare the model's predictions of prices with the true prices.

The first 90% of the data is used as the training set, and the last 10% will be used is the testing set. A list of the prices before each day  $Y_{\text{test}}$  is drawn from will be compiled in order to generate statistics about the model's predictions.

We can now define the structure of the model as follows :

- Three layers RNN with 0.2 dropout at each layer a solution against overfitting in the training data.
- Our model will have 284,299 trainable parameters throughout all of its layers.
- We choosed Adam Optimizer as its optimization function.
- The loss function is mean squared error.
- We used also linear activation function in our model to determine the output of each neuron in the model. The linear activation function is simply defined as  $f(x) = x$ .
- The model will use Keras's Sequential model with Bidirectional LSTM layers.

```
Model: "sequential_1"
=====
Layer (type)          Output Shape         Param #
=====
bidirectional_3 (Bidirection (None, 49, 98)      21168
dropout_2 (Dropout)    (None, 49, 98)          0
bidirectional_4 (Bidirection (None, 49, 196)     154448
dropout_3 (Dropout)    (None, 49, 196)          0
bidirectional_5 (Bidirection (None, 98)           96432
dense_1 (Dense)        (None, 1)              99
activation_1 (Activation) (None, 1)              0
=====
Total params: 272,147
Trainable params: 272,147
Non-trainable params: 0
=====
None
```

FIGURE 5.6 – LSTM Model Summary

### 5.2.3 Testing the Model

The models given  $x$  values as a testing dataset, will predict normalized prices ( $y\_predict$ ). Then, both the predicted values and the real values will be unnormalized and stored in two arrays. Those two arrays are unnormalized by looping through the predicted and true values. Then the result is multiplied by a corresponding number in the unnormalized\_bases array. So, the unnormalization process is the exact reverse of the normalization process. Finally, a plot is created of the unnormalized real values and the unnormalized predicted values.

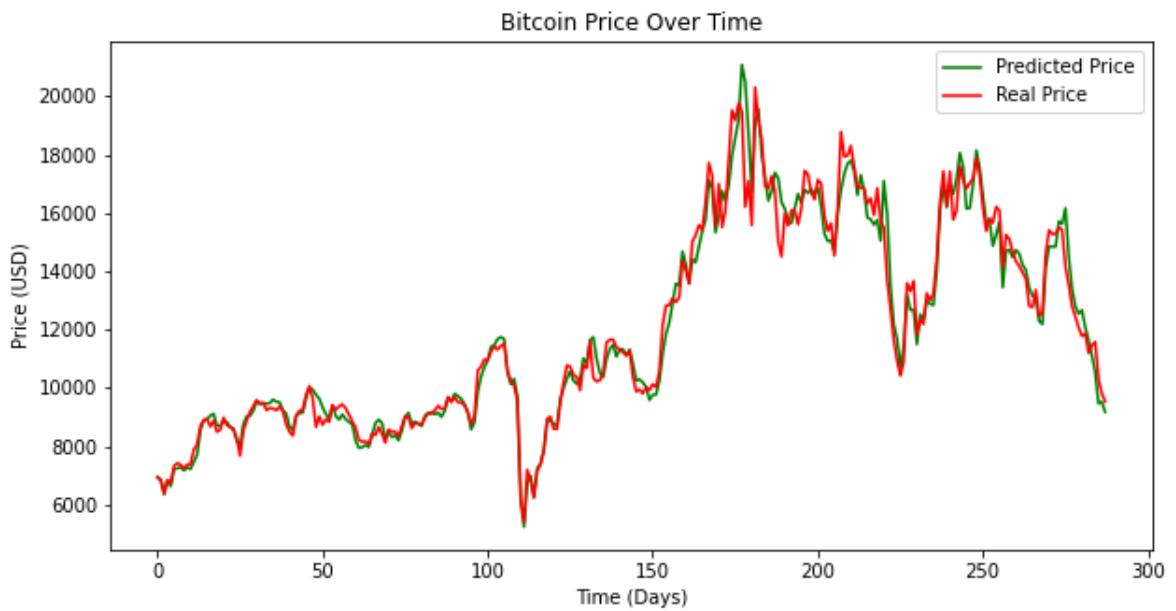


FIGURE 5.7 – Bitcoin Predicted VS Real prices over time

### 5.2.4 Evaluating Changes in Price

Below we will present two graphs, the first plot is the model's predicted change in price each day against the real change in price daily. The second figure is the percent change per day. The percent increases of the predicted values and the real values are calculated by subtracting the value from the day before from the predicted/real value then dividing the result by 1+the value from the day before. The predicted change in price is stored in delta\_predict, while the real change in price is stored in delta\_real. These two tensors are then graphed together to visualize the difference between predicted and real change in price for bitcoin throughout the testing period. The plot will represent the percent change in bitcoin price each day.

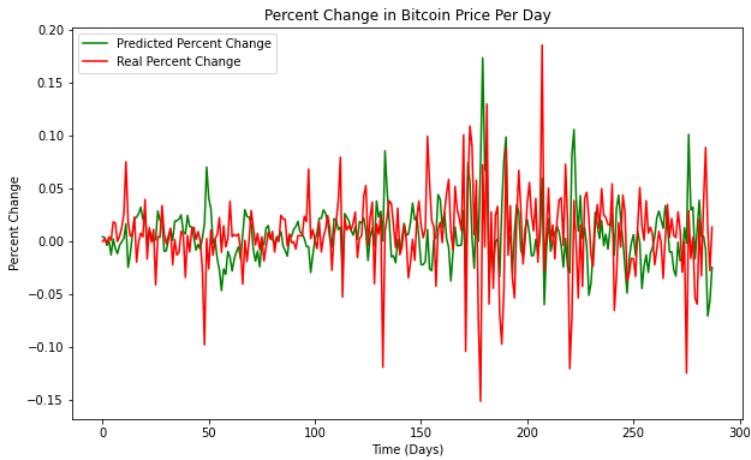


FIGURE 5.8 – Percent Changes Bitcoin price over Time

### 5.2.5 Process the Percent Change in Price

The percent change in price will be treated as follow if there is an increase in price then we will represent it by a 1, and if the price decrease or that there is no change is it then represented by a 0. These binary values will be stored in arrays `delta_predict_1_0` and `delta_real_1_0`. This procedure is done by looping through the values of the real and predicted percent change arrays. If a value is greater than 0, a 1 is stored in a new array. Otherwise, a 0 is stored in the new array. This function is very useful in order to understand how well the model did, we can use it also to gather statistics about the model's performance.

### 5.2.6 Comparing Predictions and Real Data

The binary categories computed in the previously is now used to compare predicted and real data. It will be used to find the number of : True positives (TP), False positives(FP), True negatives (TN) and False negatives(FN) These can then be used to further This will be done by looping through both binary arrays at once and getting the corresponding values. If the real value is a 1 and the predicted value is a 1, that index will be counted as a true positive. If the real value is a 1 and the predicted value is a 0, that index will be counted as a false negative. If the real value is a 0 and the predicted value is a 0, that index will be counted as a true negative. If the real value is a 0 and the predicted value is a 1, that index will be counted as a false positive.

Prediction outcome confusion matrix			
	p	n	total
p'	TP 114	FN 82	P'
actual value			
n'	FP 53	TN 39	N'
total	P	N	

**Calculating Statistics** Statistics being calculated include :

**Precision** : How often the model gets a true positive compared to how often it returns a positive.

$$\text{Precision} = \frac{\text{TP}}{\text{TP} + \text{FP}}$$

**Recall** : How often the model gets a true positive compared to how often it should have gotten a positive.

$$\text{Recall} = \frac{\text{TP}}{\text{TP} + \text{FN}}$$

**F1 Score** : The weighted average of recall and precision

$$\text{F1-score} = \frac{2 * \text{precision} * \text{recall}}{\text{precision} + \text{recall}}$$

**Mean Squared Error** : The average of the squares of the differences between predicted and real values

$$MSE = \frac{1}{N} \sum_{i=1}^N (f_i - y_i)^2$$

where  $N$  is the number of data points,  $f_i$  the value returned by the model and  $y_i$  the actual value for data point  $i$ .

True positives: 114  
 False positives: 53  
 True negatives: 39  
 False negatives: 82

Precision: 0.6826347305389222  
 Recall: 0.5816326530612245  
 F1 score: 0.628099173553719  
 Mean Squared Error: 0.004578551765858444

FIGURE 5.9 – Model Statistics

## 5.3 Strategy indicators implementation

Up to this part of the report, we have understood the meaning of strategy indicator : their utility, types and how to interpret each of them graphically and theoretically. In this section, we will see how we can integrate these indicators in our project context.

### 5.3.1 Moving averages calculus

To take full advantage of the capabilities of moving averages, it is best to combine several averages of different lengths. The crossings and relative positions of the MAs will allow us to identify buy or sell signals. As explained in the figure below :

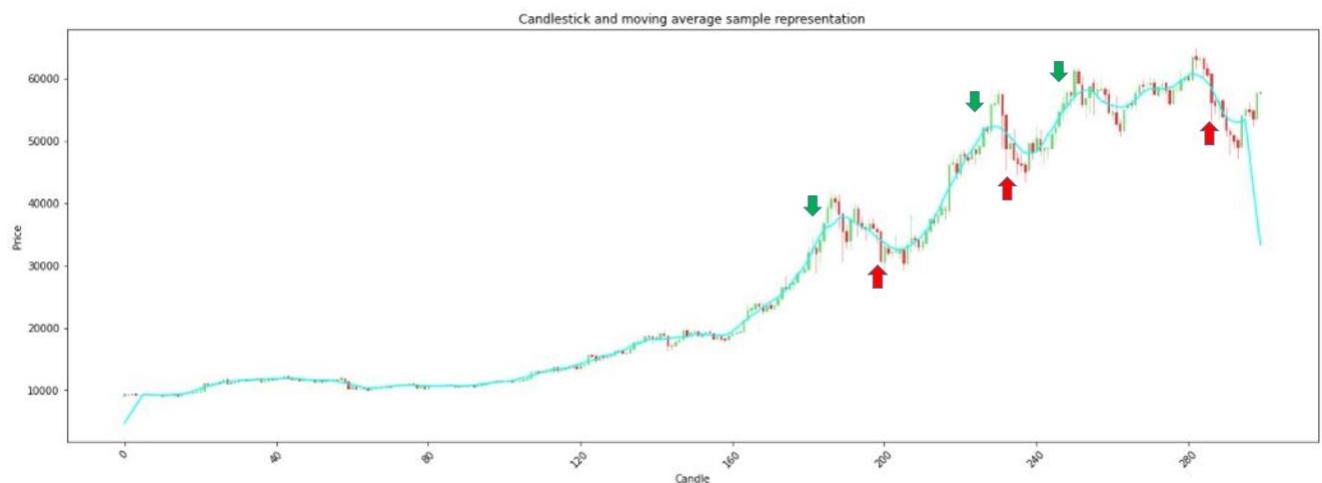


FIGURE 5.10 – Candlestick and Moving Averages sample representation

The green arrows means that the price is going to exceed the MA-20 ; an ascending bullish attitude it's a **buy signal**.

Red arrows represent future bearish attitude : the price is going to descend below MA-20 it is a **sell signal**.

### 5.3.2 Bollinger bands calculus

Bollinger Bands provide a clear picture of the trend and the level of volatility. Being based on moving averages it is said to be a "lagging" indicator, it does not allow to position oneself with certainty before a price movement.

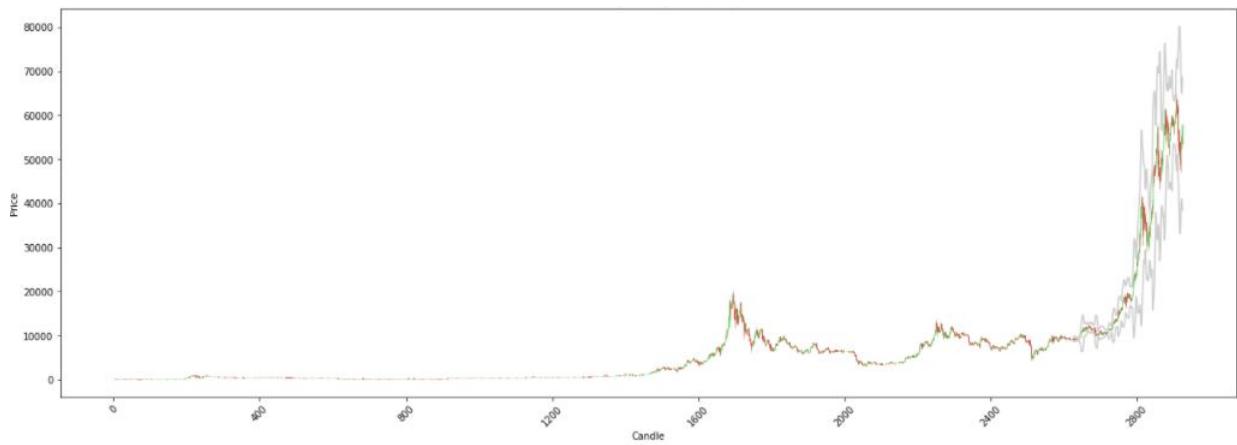


FIGURE 5.11 – Candlestick and Bollinger bands sample representation

### 5.3.3 Calculating the RSI

As seen previously, the RSi tells us if we are in an overbought or oversold position. When overbought, traders should expect a reversal. The RSI can remain overbought for a long time and the price continues to rise, so traders should wait for the RSI to cross back over (from above) the overbought zone before selling (Case.1. Figure.5.12). In oversold territory, the opposite is true. A crypto-currency in this zone is worth watching as it is more likely to go up again. To buy, traders should will wait for the RSI to cross back through (from below) the oversold zone (Case.2. Figure.5.12).



FIGURE 5.12 – RSI Interpretation

**Relative Strength Index RSI python implementation** The result seen in the graph above were calculated due to a python code. The output is a Dataframe (Figure 5.13) But

	Date	Open Price USD	High Price USD	Low Price USD	Close Price USD	Average_Price	Previous_Close_Price	Gain/Loss	RSI
1926	2018-08-06	7062.941821	7166.550000	6890.538260	6951.800000	7017.957520	6753.120000	198.680000	63.549485
1927	2018-08-07	6958.321544	7146.560000	6748.240000	6753.120000	6901.560386	6305.800000	447.320000	55.611952
1928	2018-08-08	6751.405514	6751.405514	6226.220000	6305.800000	6508.707757	6568.230000	-262.430000	48.244854
1929	2018-08-09	6305.994875	6627.282178	6249.070000	6568.230000	6437.644263	6184.710000	383.520000	50.870393
1930	2018-08-10	6569.652054	6591.260000	6122.549366	6184.710000	6367.042855	6295.730000	-111.020000	34.508661
1931	2018-08-11	6183.898557	6457.837566	6109.030000	6295.730000	6261.624031	6322.690000	-26.960000	35.830854
1932	2018-08-12	6283.650000	6409.850000	6237.500000	6322.690000	6313.422500	6296.335456	26.354544	38.544510
1933	2018-08-13	6331.496189	6537.050000	6217.175680	6296.335456	6345.514331	6199.710000	96.625456	33.922289
1934	2018-08-14	6287.660000	6287.940000	5970.303918	6199.710000	6186.403479	6308.520000	-108.810000	26.946952
1935	2018-08-15	6221.422605	6589.077398	6221.420000	6308.520000	6335.110001	6334.730000	-26.210000	30.406285
1936	2018-08-16	6300.021626	6482.578776	6276.410000	6334.730000	6348.435100	6580.853018	-246.123018	33.308347
1937	2018-08-17	6335.001830	6582.502026	6324.970000	6580.853018	6455.831719	6423.760000	157.093018	36.881973
1938	2018-08-18	6583.430000	6618.308389	6351.628883	6423.760000	6494.281818	6507.462067	-83.702067	27.880771
1939	2018-08-19	6423.435523	6538.568152	6359.440154	6507.462067	6457.226474	6308.530000	198.932067	27.948771
1940	2018-08-20	6500.510000	6536.920000	6293.691145	6308.530000	6409.912786	6488.760000	-180.230000	19.283884
1941	2018-08-21	6301.070000	6500.870000	6298.240000	6488.760000	6397.235000	6376.710000	112.050000	20.327373
1942	2018-08-22	6486.250000	6816.792083	6310.110000	6376.710000	6497.465521	6534.880000	-158.170000	39.193349
1943	2018-08-23	6385.128143	6551.043393	6371.340000	6534.880000	6460.597884	6715.372976	-180.492976	50.016546
1944	2018-08-24	6541.866661	6719.960000	6498.640000	6715.372976	6618.959909	6763.190000	-47.817024	56.491945
1945	2018-08-25	6719.950000	6789.630000	6700.960000	6763.190000	6743.432500	6707.260000	55.930000	62.756298
1946	2018-08-26	6759.099153	6774.750000	6620.750000	6707.260000	6715.464788	6884.640000	-177.380000	59.564082
1947	2018-08-27	6716.297647	6884.640000	6673.916444	6884.640000	6789.873523	7096.280000	-211.640000	64.041465
1948	2018-08-28	6894.467323	7114.175680	6882.340000	7096.280000	6996.815751	7047.160000	49.120000	71.858659
1949	2018-08-29	7087.060818	7115.321844	6964.581967	7047.160000	7053.531157	6978.230000	68.930000	69.654172
1950	2018-08-30	7045.941130	7072.690000	6834.017776	6978.230000	6982.719726	7037.580000	-59.350000	62.415043

FIGURE 5.13 – RSI result

before we could apply the RSI formula, we had to first calculate the gain or loss of each date from the previous date. we made sure that our data was sorted from the latest date to the earliest date, then we added the closing price shifted up by one row as a new column. This new column represents the closing price of the previous date. we then subtracted the closing price from the previous date from the reference date's closing price to derive the gain or loss. Then we iterated through each row in the data frame to calculate the respective RSI with a for loop. The `DataFrame.iterrows()` functionality in pandas produces the row index and the row data for each iteration.

## 5.4 Testing and Defining strategy scenarios

What we want is to detect if the price is going to increase or decrease on the next day so we can buy or short on the previous day. ( advice the investors to call or put ).

### 5.4.1 Defining our backtesting strategy

Now that we have calculated our RSI indicator for each day, and we merge them with the OHCL DataFrame we can define our strategy.

The strategy will be included in the long column. If the RSI of the day is below 30 and we are crossing the 30 from below, we will have 1 in the column. The 1, will indicate that we are long in the stock. Otherwise, we will have a 0. Meaning that we are not holding the stock for that particular day.

	Date	Open Price USD	High Price USD	Low Price USD	Close Price USD	Average_Price	Previous_Close_Price	Gain/Loss	RSI	long	total
2826	2021-01-22	30618.762249	33807.212423	28953.372751	33005.763562	31596.277746	32067.642882	938.120680	32.623033	1.0	-31933.432882
2827	2021-01-23	32741.768427	33352.211246	31514.443406	32067.642882	32419.016490	32289.378087	-221.735205	25.955884	1.0	-32155.168087
2828	2021-01-24	32022.829173	32938.766322	31106.685770	32289.378087	32089.414838	32366.393049	-77.014962	28.113503	1.0	-32232.183049
2829	2021-01-25	32305.821331	34801.245899	32159.855168	32366.393049	32908.328862	32569.849557	-203.456508	19.026881	1.0	-32435.639557
2830	2021-01-26	32102.076534	32794.549590	31030.265966	32569.849557	32124.185412	30432.547079	2137.302478	18.957944	1.0	-30298.337079
2831	2021-01-27	32523.758256	32523.758256	29370.644443	30432.547079	31212.677009	33466.096358	-3033.549279	16.825863	1.0	-33331.886358
2832	2021-01-28	30440.309635	33858.310992	30040.676224	33466.096358	31951.348303	34316.387650	-850.291292	16.858605	1.0	-34182.177650
2833	2021-01-29	33739.902727	38372.031221	32064.814187	34316.387650	34623.283946	34269.521542	46.866109	19.105728	1.0	-34135.311542
2834	2021-01-30	34398.205238	34825.109710	33019.040754	34269.521542	34127.969311	33114.357748	1155.163794	20.419856	1.0	-32980.147748
2835	2021-01-31	34103.749316	34271.035731	32316.802839	33114.357748	33451.486408	33940.894809	-826.537062	14.784640	1.0	-33806.684809
2836	2021-02-01	32945.667872	34622.941270	32387.177898	33940.894809	33474.170462	35510.289037	-1569.394228	18.315351	1.0	-35376.079037
2837	2021-02-02	33567.289266	35857.523925	33567.289266	35510.289037	34625.597873	37472.090104	-1961.801067	18.579832	1.0	-37337.880104
2838	2021-02-03	35510.821213	37472.090104	35443.982726	37472.090104	36474.746037	36926.064465	546.025639	17.774260	1.0	-36791.854465
2839	2021-02-04	37683.919794	38548.925330	36329.440186	36926.064465	37372.087444	38144.306863	-1218.242398	17.495957	1.0	-38010.096863
2840	2021-02-05	36939.483047	38205.436519	36698.077269	38144.306863	37496.825924	39266.010735	-1121.703872	15.459207	1.0	-39131.800735
2841	2021-02-06	38195.580956	40815.564098	38195.580956	39266.010735	39118.184186	38903.441480	362.569255	16.027230	1.0	-38769.231480
2842	2021-02-07	38963.167128	39620.662902	37446.153885	38903.441480	38733.356349	46196.463719	-7293.022240	13.956591	1.0	-46062.253719
2843	2021-02-08	38845.565402	46196.463719	38080.922765	46196.463719	42329.853902	46481.104236	-284.640517	31.704077	1.0	-46346.894236
2844	2021-02-09	46346.347692	47899.587725	45166.960045	46481.104236	46473.499925	44918.184492	1562.919744	45.659020	1.0	-44783.974492
2845	2021-02-10	46430.393468	47125.338413	43909.731633	44918.184492	45595.912002	47909.331195	-2991.146703	40.901966	1.0	-47775.121195
2846	2021-02-11	44682.822173	48447.695341	44192.115623	47909.331195	46307.991083	47504.851183	404.480012	51.572520	1.0	-47370.641183
2847	2021-02-12	48080.818400	48700.082693	46424.977818	47504.851183	47677.682524	47105.517473	399.333711	52.216802	1.0	-46971.307473
2848	2021-02-13	47397.506590	47980.183198	46392.282333	47105.517473	47218.872399	48717.290211	-1611.772739	51.761514	1.0	-48583.080211
2849	2021-02-14	47184.522405	49485.173112	47119.390111	48717.290211	48126.593960	47945.056832	772.233379	57.027063	1.0	-47810.846832
2850	2021-02-15	48696.536660	48875.571611	46347.477092	47945.056832	47966.160549	49199.871344	-1254.814511	47.111784	1.0	-49065.661344

FIGURE 5.14 – Trading strategy result

The first line of code on the long column, ensures that we will have a 1, if RSI is below 30. The second line of code, ensures that we will have 0 if the RSI is above 70. Then, finally, the third line of code, will ‘forward fill’ and propagate the last valid observation forward to get rid of the nan. Above three lines will ensure that we only go long when we cross the line from below 30.

### 5.4.2 Putting it all together

What we have done now is that we have applied strategy indicators on the LSTM predicted price to generate a future prescriptive trading strategy and advise users to buy or sell. And we obtained the following results :

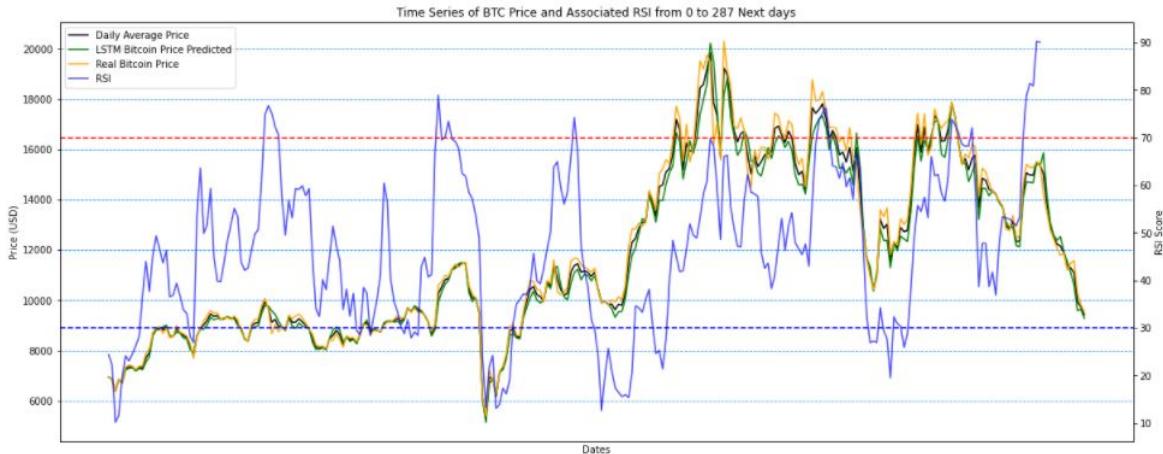


FIGURE 5.15 – Time Series of BTC Prices (Predicted and real) and Associated RSI

	Real Bitcoin Price	LSTM Bitcoin Price Predicted	Average_Price	Delta price change	Previous_Close_Price	Gain/Loss	RSI	long	total
188	15022.610360	16457.945312	15740.277836	-0.010907	15533.738281	924.207031	62.235632	1.0	-8579.590820
189	14509.203898	15533.738281	15021.471090	0.022018	15516.960938	16.777344	58.568941	1.0	-8562.813477
190	15988.946330	15516.960938	15752.953634	0.056324	15068.462891	448.498047	58.181307	1.0	-8114.315430
191	15567.294870	15068.462891	15317.878880	-0.044568	14936.964844	131.498047	57.689572	1.0	-7982.817383
192	16090.050825	14936.964844	15513.507834	-0.040234	15487.470703	-550.505859	45.951271	1.0	-8533.323242
193	16080.832256	15487.470703	15784.151480	-0.070727	16069.368164	-581.897461	42.523994	1.0	-9115.220703
194	15609.777145	16069.368164	15839.572655	-0.025616	15639.233398	430.134766	43.641310	1.0	-8685.085938
195	16165.241268	15639.233398	15902.237333	-0.010469	16221.416992	-582.183594	38.305173	1.0	-9267.269531
196	17446.542945	16221.416992	16833.979969	-0.007573	16538.660156	-317.243164	41.127274	1.0	-9584.512695
197	17320.567202	16538.660156	16929.613679	-0.016727	16441.681641	96.978516	47.247526	1.0	-9487.534180
198	16696.960954	16441.681641	16569.321297	-0.036231	16075.710938	365.970703	53.067707	1.0	-9121.563477
199	16468.863426	16075.710938	16272.287182	-0.021747	16322.226562	-246.515625	46.302326	1.0	-9368.079102
200	17137.123296	16322.226562	16729.674929	-0.012847	15951.009766	371.216797	51.456955	1.0	-8996.862305
201	17003.025274	15951.009766	16477.017520	-0.009423	14981.580078	969.423688	54.264748	1.0	-8027.432617
202	15884.608726	14981.580078	15433.094402	-0.033288	14591.304688	390.275391	47.886542	1.0	-7637.157227
203	15390.374164	14591.304688	14990.839426	-0.042300	14615.883789	-24.579102	46.705572	1.0	-7661.736328
204	15642.208052	14615.883789	15129.045921	-0.027484	14231.387695	384.496094	45.427245	1.0	-7277.240234
205	14533.657059	14231.387695	14382.522377	-0.040011	15467.118164	-1235.730469	47.638294	1.0	-8512.970703
206	16138.407711	15467.118164	15802.762937	-0.025349	16545.300781	-1078.182617	42.992782	1.0	-9591.153320
207	18778.590108	16545.300781	17661.945445	0.045021	16946.066406	-400.765625	56.853485	1.0	-9991.918945
208	17930.521943	16946.066406	17438.294174	-0.081211	17213.619141	-267.552734	68.724841	1.0	-10259.471680
209	17965.240176	17213.619141	17589.429658	-0.035676	17333.921875	-120.302734	73.672085	0.0	-10379.774414
210	18296.767641	17333.921875	17815.344758	-0.004756	16890.712891	443.208984	75.239465	0.0	-9936.565430

FIGURE 5.16 – Result for prescriptive analysis (Prediction+ Strategy indicators)

## 5.5 Web Application deployment

After determining the trading strategies, we will use the results obtained in order to provide traders with a better visualisation. Using flask we created theses dashboards :

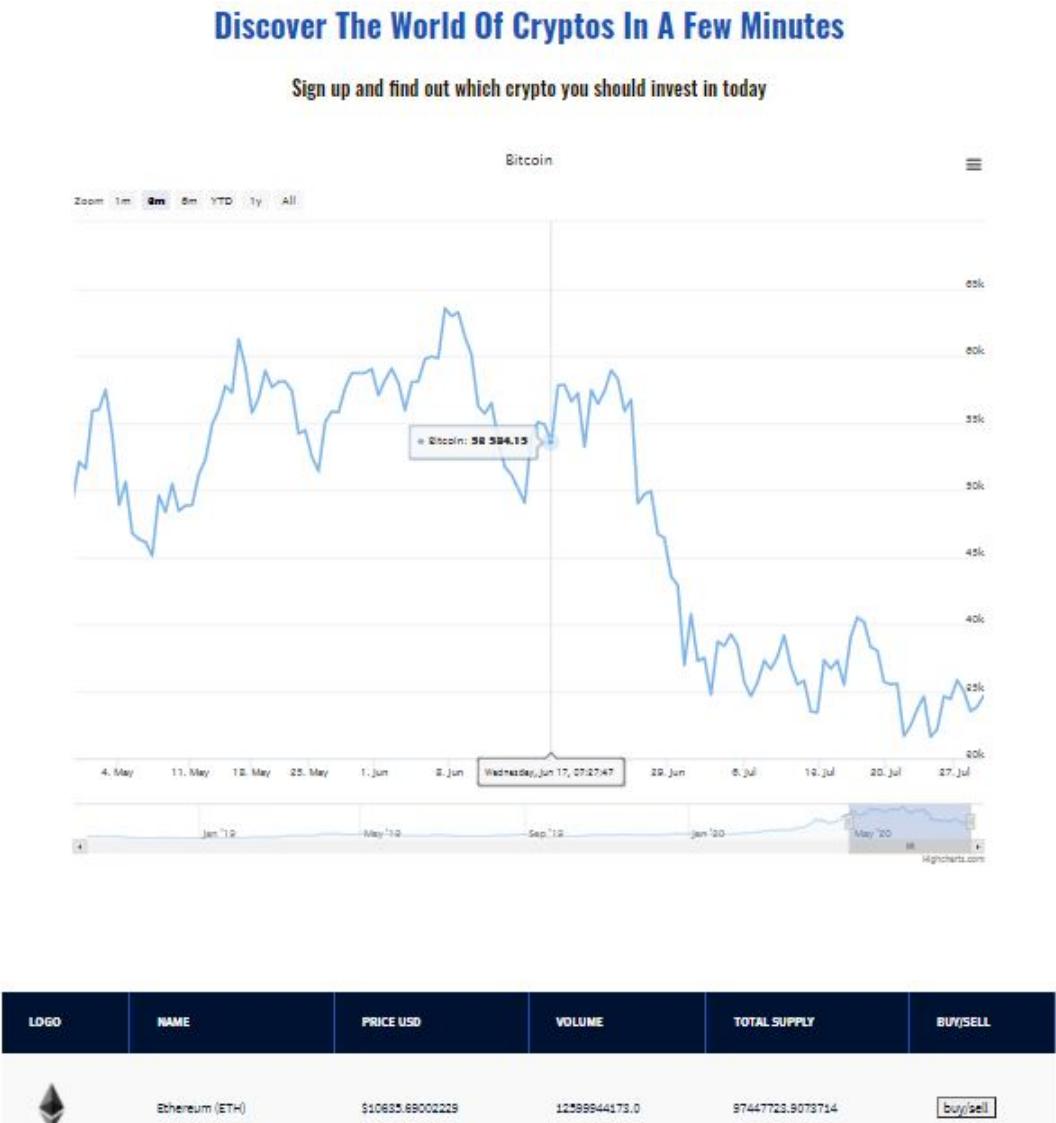


FIGURE 5.17 – Dashboard n1 : Home page

**Dashboard n1 : Home page** : Users will find in the first page informations about all the cryptocurrencies used in this project.



FIGURE 5.18 – Dashboard n2 : Crypto Markets

**Dashboard n2 : Crypto Markets** In this page we created two Bonding curve representing the process of funding startups(pre-launch phase) and crypto exchanges overtime.



FIGURE 5.19 – Dashboard n3 : Trading strategies

**Dashboard n3 : Trading strategies** A third page summarizing the techniques and models used in this project and displaying the advices.

## Conclusion

We can say that the completion of this "Deployment" task represents the success of our project. We have met all the business objectives determined in the first phases. We were able to deliver a complete version of the project while respecting the deadlines previously indicated. We can therefore confirm the success of the adoption of CRISP-DM as a project methodology given its effectiveness and the excellent quality of the solution obtained.

# Conclusion

Crypto-currencies simultaneously aim to : **change** the forms of money (by detaching it from the banking system) ; **transform** its nature (from public to private) ; and **revolutionize** its management (from centralized to decentralized).

The French ecosystem, for example, in terms of crypto-currencies and related services is particularly dynamic. Although France has few exchange platforms and ICOs are still relatively low in number and amount, France has been able to develop leading companies, particularly in the field of crypto-currency storage, with *Ledger*, a company born in Vierzon and specializing in the production of "cold wallets", claiming to be a potential Unicorn. In addition, numerous decentralized application projects based on blockchain and cryptocurrencies have emerged in France, attesting to the dynamism of its ecosystem, driven by a number of well-known start-ups. The fundraising efforts of these new companies, such as Ledger (\$75 million), Centrifuge (\$3.8 million), iEx.ec (\$12.5 million) and Stratum (\$7.8 million) are a perfect illustration.

Although it is still difficult to have a precise vision of this emerging ecosystem, there are nevertheless some enlightening indicators that we tried to use some of them in this project. The projects developed in France are also generating new jobs in the country : the number of jobs created by the French crypto-finance ecosystem increased tenfold between 2016 and 2017, rising from around 15 to nearly 160. The majority of these jobs are in the telecommunications (58%, including Atos, Orange and Safran) and the finance sector (20%, including Natixis, Banque de France and Société Générale). The jobs created in these different sectors are mainly internship offers (58%, 36% are open-ended contracts) and are, in all cases, almost exclusively for specialized technical profiles specialized technical profiles : developers, architects, etc. The large companies in the conventional economy are also looking to develop teams (5 to 15 people) dedicated to dedicated to crypto-currencies and related applications.

Our country is still very far from realizing such a revolution. And that's because of the legislative, political and economic barriers that young entrepreneurs face as soon as they publish their project patent. What we need are gigantic revolutionary steps that open the doors and brains to the capabilities of these technologies.

