



UNIVERSIDAD DE CHILE  
FACULTAD DE CIENCIAS FÍSICAS Y MATEMÁTICAS  
DEPARTAMENTO DE CIENCIAS DE LA COMPUTACIÓN

ORÁCULOS DISTRIBUIDOS EN LA BLOCKCHAIN

TESIS PARA OPTAR AL GRADO DE MAGÍSTER EN CIENCIAS MENCIÓN  
COMPUTACIÓN

MEMORIA PARA OPTAR AL GRADO DE INGENIERO CIVIL EN COMPUTACIÓN

FRANCISCO JAVIER ANDRÉS MONTOTO MONROY

PROFESOR GUÍA:  
ALEJANDRO HEVIA

MIEMBROS DE LA COMISIÓN:  
INTEGRANTE 1  
INTEGRANTE2  
INTEGRANTE3

SANTIAGO DE CHILE  
MES AÑO



RESUMEN DE LA MEMORIA PARA OPTAR  
AL TÍTULO DE  
POR: FRANCISCO JAVIER ANDRÉS MONTOTO MONROY  
FECHA: MES AÑO  
PROF. GUÍA: ALEJANDRO HEVIA

## ORÁCULOS DISTRIBUIDOS EN LA BLOCKCHAIN

Este es un resumen muy resumido



*Una dedicatoria corta. Por ejemplo, A los creadores de U-Campus*



# Agradecimientos

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# Chapter 1

## Introduction

### 1.1. Gambling

Gambling is the activity of predicting events and placing a wager on the uncertain outcome of those events, with the intent of winning money or valuable goods. A wager can be put on many different events, in a casino we find randomizing devices as dices, roulette wheels, etc. which are used to get randomize events. In other establishments we can bet on sport events, such as a horse racing, football games, etc. or the minimum temperature in Santiago during this night. Its popularity and the big amounts of money at stake inevitably entails a lot of interest on this activities. Most of the time gambling is heavily regulated and taxed, also it is usual that lotteries are owned by the state.

Internet has been making cheaper to open and operate a casino, even without complying laws from any country. This and the massive internet use, has been moving the gambling industry online[14] [8]. The global Internet gambling market was estimated to be worth US\$28.32 billion in 2012 and forecasted to rise to US\$49.64 billion by 2017[7]. However, gambling not only takes place in casinos, lotteries or betting sites, it can also involve two or more individuals with no intermediaries. In Chile friends usually bet on their favorites football teams.

Nonetheless all the different ways for placing a bet, all of the mentioned share a common obstacle, participants are required to trust in the other parties to pay if they lose. Even if the bet takes place in a physical casino, where the law can enforce the bet, is not certain the casino will be able to pay after the resolution. We might not be aware of the fact, but every time we place a bet we are implicitly trusting in a third party, either the other player or the bet site. For physical casinos this is usually not a problem, as they are regulated by the law, any misconduct can get the casino to the justice and even get its license revoked. As there is a significant cost on starting a physical casino, them are also encouraged to keep a good reputation, in order to get customers.

Friends usually are trusted people, so trusting them when gambling might not be considered an issue. Also, probably the friendship is at risk if the bet is not paid. Other option is

to get a third friend to get the money until the bet result. Online casinos on the other hand are more problematic, there are many known scam schemes, as described by Griffiths[9]. And half of the players at this sites believe the providers are cheating on them[10]. However, some of them are subject of government regulation and many have being in the business for several years, this kind of characteristics could help to indicate an online site is trustworthy.

But, what if you would like to gamble in a event that no gambling site offers nor any friend want to? Probably the internet would be the place to look for somebody willing to gamble on this event. Yet, how could you trust the potential person in order to bet with him?

## 1.2. Cryptocurrency

Digital currency refers to any currency stored and transferred electronically. A subset of the digital currencies is called virtual currencies: them are usually defined[1] as a « *unregulated, digital money, which is issued and usually controlled by its developers, and used and accepted among the members of a specific virtual community* ».

Based on the interaction of the currency with currencies outside the community there are three types of virtual currencies: The ones with almost no interaction with the outside money, this is usually the case of video games, where its currency is only valuable within the game. A second type is where the currency can be purchased directly using other currency. Here, we observe an unidirectional flow. The third type is when the flow is bi directional, the users can sell and buy the currency. A cryptocurrency is a bi directional virtual currency, that uses cryptography for security and anti-counterfeiting measures. Virtual currencies are been historically linked to cryptography, the first known investigations [3] to establish a virtual currency where lead by David Chaum, an American cryptographer. However, despite his and others effort (e-gold<sup>1</sup>, Ecash[4], DigiCash, LibertyReserve, among others), virtual currencies never where massively adopted.

By late 2008, using a pseudonym, was released a short whitepaper[12] with yet another virtual currency protocol specification. A few months later, during 2009 its implementation was made available as open source code. The main difference with previous implementations was its lack of a central organization, this new coin was completely decentralized. The software started to being run by some early enthusiasts and Bitcoin gave the step from an idea to an usable coin. The first years was the coins were exchanged for free among the community users. However, at some point the community was big enough and its members started to give value to the coin, then the first exchanges from and to other coins started to take place. Bitcoin transitioned into a bi directional flow virtual coin.

Then the first online exchanges between bitcoin and other currencies started to appear, the coin started to gain traction as people outside the community were able to buy and sell coins. As the money became popular, the idea was taken and a whole generation of cryptocurrencies were born. Today the market capitalization of Bitcoin (this is, the amount of money times its value in USD) is over 25,000,000,000 USD.

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<sup>1</sup><https://www.wired.com/2009/06/e-gold/>

## 1.3. Gambling using Cryptocurrencies

With cryptocurrencies getting more and more popular, it was only a matter of time until the first sites started to offer some games of chance and act as online casinos. Where the only difference with a traditional online casino was the currency on which the bet takes place. However, as any other currency online casino, any player who decided to play here is at the mercy of the casino. If the casino does not want or does not have the means to pay, there is nothing the participant can do and its money is lost. More on online casinos at subsection 1.1. The problems described for online casinos using traditional currencies apply in the same way to the new ones.

After some time, people started to see some potential on cryptocurrencies to solve some of the trust issues related to gamble. In 2014 Andrychowicz et al. proposed a two party randomized gambling protocol. Players are not required to trust each other in order to gamble, so even if the loser does not behave correctly the honest player, can get its prize. The protocol is not a representation of a casino game, but effectively allows player to gamble on a random event. Also in 2014, a group of Bitcoin enthusiasts started Orisi<sup>2</sup>, a distributed oracles system for cryptocurrency contracts. Orisi allows users to access data of the outside world from the blockchain, by using a distributed set of oracles. So instead of trusting in one instance to provide the data, the trust is placed in the majority of several different oracles. More recently, on early 2017, Winsome<sup>3</sup> was released. Advertised as a «*Provably Fair / Trustless Casino*», Winsome is an online casino where wagers are placed in a public smart contract posted in the Ethereum's blockchain. So the contract, defining the game, is enforced by the Ethereum protocol. As May 2017, they do offer two casino games, blackjack and *Roulette*, an online roulette.

Motivated to provide an option to gamble over real world events with untrusted peers. This work proposes a protocol to define the destination of an initial wage between the two player. The decision is taken by a set of oracles, which are being paid also inside the protocol to behave correctly.

## 1.4. Objectives

Design and implement a distributed protocol where real world observations can be used as blockchain transaction inputs.

### 1.4.1. Specific Objectives

1. Provide a protocol to make possible to gamble with untrusted peers over real world events.

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<sup>2</sup><http://orisi.org>

<sup>3</sup><https://www.winsome.io>

2. Provide the correct economic incentives to the protocol participants to behave correctly, so everyone incentives are aligned.
3. Implement a proof of concept of the designed protocol.
4. Debate of implications and other applications for the designed protocol.

## 1.5. Methodology

The main phases of this work will be the following:

1. Extensive review of existing proposal and implementations to solve the proposed problem or similar ones. As cryptocurrencies are a recent investigation field, this review must cover literature as well as community gathering places, such as forums and specialized blogs, magazines, etc..
2. Analysis of current solutions to the problem and similar ones.
3. Design and implementation of a protocol to solve the problem. Implementation is considered very important as the current rate of change of cryptocurrencies is considerably fast, validating the protocol within a real implementation is critical.
4. Analysis of the economic incentives of the protocol participants, to ensure protocol viability.

## 1.6. Bitcoin

Bitcoin is the first fully distributed cryptocurrency made publicly available, it was proposed in 2008 by Satoshi Nakamoto (a pseudonym) [12]. The same author shared as open source code a implementation of the protocol in January 2009. And the protocol has being running since then.

Nevertheless, Bitcoin is not the first idea of electronic cash. The idea of electronic cash has been present within the cryptographic community since at least 1983, when Chaum [3] proposed a system for anonymous payments. And the attempts kept going for other three decades, hundreds of paper have been published with improvements of e-cash schemes[2]. So, why is Bitcoin so popular and achieved the notority that three decades of academic research on the field could not achieve?

Barber et al.[2] suggest a few key points to explain why was Bitcoin the first electronic currency to take off.

1. No central point of trust. Bitcoin is a fully distributed system, there are no trusted entities in the system. The only assumption is that the majority of the network participants are honests. Every previous proposal had a central trusted entity for critical tasks, as preventing double spending and coin issuance.



2. Predictable money supply. The money supply is minted at a defined and transparent rate, defined from the beginning of the protocol.
3. Transaction irreversibility. Bitcoin transactions quickly become irreversible. This is a big difference with credit cards, where chargebacks has been using largely to commit frauds.

Bitcoin has not stopped to gain massive popularity and attention from the press. Mainly because its market capitalization (over USD 360000000000), and some illegal activities it has been using to as ransom to retrieve victim's data encrypted for malicious software, or as exchange medium in one of the most famous online black market, closed in 2013 by the FBI.

The main technical advance in Bitcoin is its database, the **blockchain**[5][13]. The blockchain is a distributed database formed by an always growing list of blocks, where each block contains the data to be stored, a timestamp and a link to a previous block. Its fully distributed nature allows bitcoin to lack a central authority.

### 1.6.1. Blockchain

It works as the bitcoin's ledger, it keeps record of all transactions and coin generation that had ever taken place in the protocol. It is completely distributed and public, anybody can participate in the protocol and get a copy of it. This makes simple to prevent double spending and be sure the received coins are valid, as anybody can examine where each coin came from.

As any other distributed system, the blockchain must resolve the consensus problem [6]. Get all the participants to agree on the data. This is a fundamental problem to any distributed system. In the the blockchain anybody with an internet connection can be part of the protocol, so solving this problem is quite challenging. Some authors argue the blockchain is the first practical solution to the Byzantine Consensus problem [11] [15].

Proof of work is the algorithm used by the bitcoin blockchain to seek consensus. Each entity trying to add data to the database must proof it has done some required work. This algorithms was designed originally to fight the email spam, by requiring the sender of an email to prove a small work was done in order to send the email[**dwork1992pricing**]. This is achieved by using a hard to calculate, but easy to check function. This way the receiver or the mail server can easily check if the sender did the required work, however this work was much harder. The difficulty of a work is defined by the amount of computational power required to get it done.

The atomical piece in the blockchain is the block. Each valid block carries with itself a proof of work, so every entity trying to get a valid block into the database tries to solve a puzzle to get this proof. This process is called mining, therefore the entities mining to get a valid block are called miners. By design a block must be produced every 10 minutes, so the work required to mine a block is a ajusted periodically to met this goal.

The proof of work consists in building a block with a hash under a threshold value, so the

	0	1	2	3	4	5	6	7
0	Magic no				Blocksize			
8	Version Number				Hash Previous Block			
16	Hash Previous Block (cont)							
40	Hash Previous Block (cont)				Hash Merkle Root			
48	Hash Merkle Root (cont)							
72	Hash Merkle Root (cont)				Timestamp			
80	Target difficulty				Nonce			
88	Transaction counter and Transactions.							
...								

Figure 1.1: Block structure

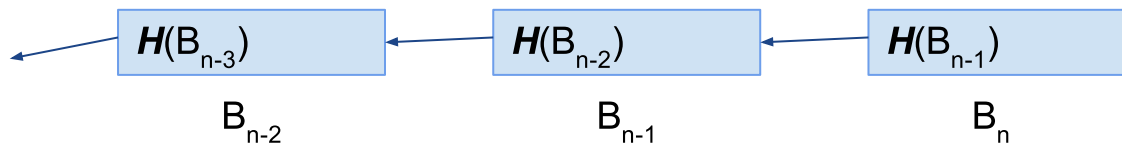


Figure 1.2: Blocks linked to each other in the blockchain

miners should reorder and change the block until the hash fulfill the requirement. There is not a known algorithm to do this in a better way than brute force, so the only method to get a hash that mets the criteria is to try with different block configurations, there are some bytes of nonce, a timestamp and transactions to be changes to get different hashes.

The structure of a Bitcoin block is show In the figure 1.1, the fields with the light purple background represents the block header, the data hashed to get the block's hash. The transactions are indirectly hashed in the Merkle Root<sup>4</sup>.

characterisitic A block holds the basic operations in the protocol, the transactions. The proof of wo A block is a

The blockchain does not introduce a new primitive or idea to solve all of the mentioned problems, it does use existing tools in an innovative way to. To keep a consistent history the blocks are linked using the hash of the previous block, this prevents tamper on past data.

As it is public, every transaction can be verified by any protocol participant.

The blockchain is a chain of blocks were each of them keeps a link to the previou also fully

<sup>4</sup>A **Merkle Tree** is a tree in which each non leaf node is labeled with the hash of its children's labels. In the block each transaction is mapped into tree's leaf. So the root of this tree hashes all the transactions

distributed. In bitcoin

# Chapter 2

## Preliminaries

### 2.1. Previous Work

#### 2.1.1. Distributed oracles

##### Orisi

Orisi[orisiwhitepaper] is a distributed system for bitcoin smart contracts that relies in multiple oracles to bring information from outside of the blockchain. It allows its users to transfer money from one address to another when a condition is met.

Both players agree on 7 oracles to be used to decide the transfer, usually chosen from “The Oracle List”, a curated list with oracles. But could also be chosen from any other place the players want. Then, a multisignature address is generated to store the money while the bet takes place. A multisignature address is defined by  $m$  addresses and a required number  $n$  ( $n < m$ ) of them to sign. A valid signature for a multisignature address is generated by using at least  $n$  out of the  $m$  addresses defining it.

The multisignature address generated will store the money until the oracles decide where the transaction goes. To avoid the oracles sending the money to themselves the multisignature transaction include the address of the receiver, so we want a  $1 + (n \text{ of } m)$ , where the extra signature is from the receiver. As this kind of transaction is not considered standard<sup>1</sup>, Orisi uses a biggest multisignature address, where instead of using  $n$  out of  $m$  oracles, it adds more receiver keys. Requiring  $m + 1$  signatures of  $2m - n + 1$ . With this configuration the oracles are not able to move the money by themselves, and at least one signature from the receiver is required.

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<sup>1</sup>Non standard is recognized as a valid transaction by everyone, however by the time this article was written only about the 5% of the mining power will not process it. Including this transaction in the blockchain will take on average much more time than a standard one.

### 2.1.2. Trustless distributed casino

#### Winsome.io

In may 2016 Rouleth[**winsomeio**] was launched as a distributed application on the ethereum network. Offering its players a “provably-fair”, real money roulette. Later, in early 2017, also using the ethereum network “BlockJack” was launched, the first playable blackjack game on the Ethereum mainnet.

Winsome.io is the instance where these games are enclosed, it offers unique advantages over traditional casinos (physical and virtual), like trustless, and complete control over the funds the entire time while playing. It does work in a distributed fashion using smart contracts, publicly availables for everyone’s scrutiny.

Winsome.io provides its users trustless gambling over random events, by using the ethereum network as backend. It have been quite successful, it is one of the most popular decentralized applications on the Ethereum Network.

### 2.1.3. Secured data feeds

#### Oraclize

Oraclize[**oraclizeit**] provides an interface for using data fetched from a web site in the ethereum blockchain, it works with arbitrary URLs or queries in certain web services, as “Wolfram Alpha”<sup>2</sup>. It provides an Authenticity Proof of the data gathered, so the user can check the data provided by the interface was generated by the source and have not been tampered.

#### Town Crier

Town Crier[**zhang2016town**] is an authenticated data feed system for the ethereum blockchain, as oraclize it works as a bridge between web feeds, and the blockchain. It uses an Intel technology called “Software Guard Extensions”[**costan2016intel**], than provide some execution guarantees of the software executed by hardware protected areas. This protects the execution of the data feed even with the the host OS, BIOS or any other piece of the machine compromised.

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<sup>2</sup>Wolfram Alpha is a knowledge engine, able to answer queries rather than provide links to data sources, as a search engine does.

# Chapter 3

## Primero

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**Definición 3.1** (ver ) *Definición definitiva*

$$\frac{d}{dx} \int_a^x f(y) dy = f(x).$$

# Chapter 4

## Segundo

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# Conclusión

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Figure 4.1: Logo de la Facultad

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Campo 1	Campo 2
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Table 4.1: Tabla 1

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