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# **Finding Bitcoin's Creator, Satoshi Nakamoto**

*Bachelor thesis*

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**Olomouc**

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## **Declaration**

I hereby declare that I have written this Bachelor's Thesis, "Finding Bitcoin's Creator, Satoshi Nakamoto", by myself under supervision of doc. Mgr. Dan Faltýnek, Ph.D, and that all resources and literature I used are properly cited.

In Olomouc on June 22, 2022

.....

Mia Miriam Lévyová

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I would like to express special thanks to doc. Mgr. Dan Faltýnek, Ph.D. for his help, advice, and recommendations during the whole process of writing this thesis. I also want to thank my mother and partner for their encouragement and support.

## **Abstrakt**

**Název práce:** Hledání vynálezce Bitcoinu, Satošiho Nakamota

**Autor práce:** Mia Miriam Lévyová

**Vedoucí práce:** doc. Mgr. Dan Faltýnek, Ph.D.

**Počet stran:** 117

**Počet znaků:** 73 000

**Počet příloh:** 1 CD

**Abstrakt:** V této práci aplikujeme hrstku metod určování autorství na sbírku 18 textů od 9 autorů s cílem najít případnou shodu mezi Satošim Nakamotem a některým z ostatních autorů. Šest autorů jsou skuteční kandidáti na Nakamota, kteří byli v průběhu let navrženi členy komunity a badateli a dva autoři tvoří kontrolní skupinu. Každý autor bude představen a původ a povaha jeho textů bude vysvětlena. Aplikované metody určování autorství jsou: analýza hapaxů, n-gramová analýza a analýza funkčních slov. Každá metoda představuje vlastní dílčí segment. Veškeré nástroje a principy jsou vysvětleny na začátku daného segmentu, a poté jsou zobrazeny výsledky analýz ve formě dendrogramů hierarchického clusterování a tSNE map. Každý segment je zakončen interpretací výsledků.

**Klíčová slova:** Bitcoin, Satoši Nakamoto, určování autorství, autorský styl, hapax legomena, funkční slova, n-gramy, hierarchické clusterování

## **Abstract**

**Title:** Finding Bitcoin's Creator, Satoshi Nakamoto

**Author:** Mia Miriam Lévyová

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**Abstract:** In this thesis, we will apply several different authorship attribution methods on a collection of 18 texts from 9 authors. The goal is to try and find a match between the texts authored by the pseudonymous Satoshi Nakamoto and any other author. Six of the authors are genuine candidates as suggested by a number of community members and researchers, and two authors serve as a control group. Before we start with the analyses, each author will be introduced, and the nature and origin of their text samples will be explained. The utilized methods of authorship attribution are hapax analysis, n-gram analysis, and function word analysis. Each method represents its own segment. All the tools and principles are introduced at the beginning of their respective segment, followed by images showing the results in form of tSNE maps and hierarchical clustering dendrograms. Each segment ends with an interpretation of the results.

**Keywords:** Bitcoin, Satoshi Nakamoto, authorship attribution, authorial style, hapax legomena, function words, n-grams, hierarchical clustering

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# 1 Introduction

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## 1.1 What Is Bitcoin and Who Is Satoshi Nakamoto

The emergence of Bitcoin is often considered one of the most notable technological and economic advancements of the late 2000s and early 2010s. The creation of digital tokens that could act as a currency had been already attempted many times since the 1990s. Much of this effort was concentrated in a community of LA based cryptography and digital safety enthusiasts, known as Cypherpunks. Several of the people that will be mentioned throughout this paper had been active in this group for many years. It was this very community that Nakamoto first approached with his proposal titled ‘Bitcoin: A Peer-to-Peer Electronic Cash System’. The proposal sparked interest and a mere few months later, the first version of the Bitcoin software was released, and the first block was mined. In late 2009, Nakamoto established an online forum [bitcointalk.org](http://bitcointalk.org), which quickly became the main communication hub for Bitcoin users.

In December 2010, a whistleblower publication called WikiLeaks had its PayPal account restricted<sup>1</sup>, and several of the [bitcointalk.org](http://bitcointalk.org) members started speculating about Bitcoin being a potential resolution to the financial issues that the organization started facing<sup>2</sup>. After recognizing that the anonymous currency is in danger of attracting criminals and becoming a target of law enforcement, Nakamoto gave the leadership over the project to one of his long-term co-developers and somewhat unexpectedly disappeared. It should be noted, however, that the connection between the WikLeaks incident and his departure is not a 100% confirmed fact, as Nakamoto never expressly stated his reasons.

Having started off as a somewhat niche project, cryptocurrency in general, and Bitcoin in particular, has been climbing steadily into the forefront of public consciousness over the past 13 years. Despite its many fallbacks and the unfortunate realization of Nakamoto’s worries<sup>3</sup>, the general opinion of cryptocurrencies still appears to be positive as more and more people jump on it and find ways to utilize it. Inevitably, the most widely adopted way of attempting to generate income through Bitcoin has become investing in it – much like stock investments – rather than mining. Shortly after Bitcoin’s invention, other cryptocurrencies, based on similar ideals of anonymization and decentralization, sprang up and some have

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<sup>1</sup> <https://wikileaks.org/PayPal-freezes-WikiLeaks-donations.html>

<sup>2</sup> <https://bitcointalk.org/index.php?topic=1735.msg26876#msg26876>

<sup>3</sup> <https://archives.fbi.gov/archives/newyork/press-releases/2013/manhattan-u.s.-attorney-announces-seizure-of-additional-28-million-worth-of-bitcoins-belonging-to-ross-william-ulbricht-alleged-owner-and-operator-of-silk-road-website>



come very close to Bitcoin's value. The recent trend of non-fungible tokens illustrates the creativity of blockchain technology's biggest proponents.

The deep dive into Bitcoin's underlying ideas and technology would be a long one and is not the purpose of this paper. While the topic is intriguing and the ideas and ideologies behind the currency go decades back, I will, for the purposes of this paper, assume basic knowledge on the part of readers, and focus my research solely on the texts analyzed. The only real paper trail left by Nakamoto are his writings, as he seems to have made sure to remove his name or any real clues to his identity from anything relating to Bitcoin. The amount of his writings is, however, quite substantial, and seems to hold a lot of potential for analysis. Therefore, I have decided to collect as many writings from Nakamoto as possible and, after doing the same with a handful of Nakamoto candidates, will compare them to each other using some of the most promising authorship attribution techniques modern corpus linguistics has to offer. The people discussed in this work will be introduced without bias, and information will be given about their connection to Bitcoin or other cryptocurrencies. The goal of this paper is to speculate on (and, if possible, identify) the author of a collection of writings.

## **1.2 Introduction to Authorship Attribution**

Authorship attribution is the field of linguistics focused on analyzing texts and attempting to find matches in authorial styles. This can be done through many means, and new theories and approaches are being tested all the time. Some of these new approaches will also be used in this research. Juola (2008) speaks about different approaches to authorship attribution in terms of traditional (or classical) and non-traditional (or modern) methods. The modern methods rely on mathematical and statistical calculations that use a set or multiple sets of linguistic features, such as vocabulary, syntactic properties (function words, punctuation, etc.), regional spellings, layout preferences, typos, rare words and many more. Upon feeding the extracted information to any number of specialized computer programs, we can get the output data represented visually by dendrograms or cluster maps. These modern types of analyses have become more and more common since computing is now available to almost anyone, but correctly interpreting the results can be a challenge and they are best combined with other types of analyses.

The traditional methods have been, as the name suggests, in use for hundreds of years. While it is impossible to definitively present the first cases of attempted authorship attribution, it can be assumed that people have considered the possibility of plagiarism ever since language has existed. In ancient Rome, it was common for leaders' speeches and letters to be authored by someone else. Such was the case with emperor Nero's speeches which were likely written by his teacher Seneca. This and

other examples of ancient authorship attribution are further explored in Baum's 2017 article "Content and Form: Authorship Attribution and Pseudonymity in Ancient Speeches, Letters, Lectures, and Translations—A Rejoinder to Bart Ehrman."

It would be erroneous to claim to that the classical approaches were not statistical in nature. On the contrary, some of the most historically explored attributes have been, for example, measuring the average sentence or word length (Kruh, 1988 & Yule, 1938) or distribution and use of function words (Mosteller & Wallace 1963). One of the most well documented cases of pre-computing authorship attribution has been the examination of The Federalist Papers, written in the years of 1787 and 1788. The 12 disputed papers are now more or less universally attributed to one of the three writers based entirely on statistical methods.

### 1.3 Previous Studies

There have been multiple studies done on the topic of Satoshi Nakamoto's identity, but none I could find appeared very well documented. A 2017 paper by Michael Chon of Georgetown University<sup>4</sup> compared a set of suspected authors to the Bitcoin white paper and Nakamoto's known email correspondences, using n-gram analysis, semantic similarity analysis and classification algorithms. Unfortunately, the study does not fully list the nature and origin of the texts used for comparison and very few details of the methodology are mentioned. Furthermore, there is no mention of whether control samples were included in the analyses. Nonetheless, the paper concludes that Nakamoto's emails are linguistically the closest to the financial cryptographer Ian Grigg's writings, while Nick Szabo's writing style is notably similar to the Bitcoin white paper. Nick Szabo is an American computer scientist and cryptographer who, like many of the other candidates, has been close to the Bitcoin project from early on.

Another, earlier exploration of the authorship of Bitcoin was posted on a website called LikeInAMirror.com in 2013.<sup>5</sup> This work is often cited and seems to be the best known. The author, Skye Grey, explores the frequency of certain chosen phrases across other research papers on the internet and finds that Nick Szabo's blog posts, as well as his Bit Gold proposal<sup>6</sup>, have an unusually high amount of common traits. The article concludes that the likely identity of Nakamoto is Nick Szabo.

A research report published in the form of an online article in 2018 designates Gavin Andresen as the likely Nakamoto<sup>7</sup>. The author, Troy Watson, compares

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<sup>4</sup> Chon, M. "Stylometric Analysis: Satoshi Nakamoto". 2017: Georgetown University, USA.

<sup>5</sup> <https://likeinamirror.wordpress.com/2013/12/01/satoshi-nakamoto-is-probably-nick-szabo/>

<sup>6</sup> <http://unenumerated.blogspot.com/2005/12/bit-gold.html>

<sup>7</sup> <https://zycrypto.com/opinion-satoshi-gavin-andresen-stylometric-pca-using-burrows-delta/>

60 most common words (Principal Component Analysis) and 4-grams (Burrows' delta) per author to see how much they overlap. The same researcher published a follow-up article 5 months later<sup>8</sup>, where he continues to apply more statistical methods, this time combining Burrows' delta with randomly sampled distance ranges of most used words in order to create more accurate results. I will be using a similar method of creating a number of distance maps from randomly chosen Bag of Words out of the more than 20,000-word-long corpora for each author. The outcome of this study was again that Gavin Andresen is the best candidate.

Unfortunately, none of these studies are documented well enough to be replicable, so they cannot be scrutinized in a meaningful way. While the methods used are described in enough detail (such as with the Troy Watson study), the main issue that arises is that we do not know exactly what texts were used. More thorough research is therefore necessary.

## 2 Practical Part

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### 2.1 Sample Collection and Manipulation

It appears that neither of the previous studies utilized Nakamoto's enumerated posts on [bitcointalk.org](https://bitcointalk.org). This research will take the previous studies' conclusions into consideration and, by including the forum posts, expand on them in order to hopefully achieve more precise results. The majority of my text analyses will be focused on these large samples collected from the forums. Exception to this are the cryptocurrency proposals by Nakamoto, Nick Szabo, and Adam Back, as well as the samples from Craig Steven Wright's and Nick Szabo's websites, as these two were never officially active on the forums. Each author has at least two sets of text in order to better illustrate the differences between the various authors. Wright's writings are taken from his website's blog post section. The chosen blogs touch on Bitcoin or similar topics and will only be used in analyses where the difference in form would not influence the result. Nick Szabo's website consists entirely of essays on a variety of topics but the chosen texts, once again, all explore economics and cryptocurrency.

All the texts were stripped of any website links and computer code or equations. During sample collection, the forum's emoticons were automatically rewritten into the emoticon's name, such as "Smiley", "Wink", "Grin", "Shocked" and "Tongue". I converted these into ":", ";)", ":D", ":O" and ":P" respectively to prevent them from being counted as words. More complicated or less common emojis were left out completely. Some posts have been edited to remove sentences or

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<sup>8</sup> <https://zycrypto.com/bootstrapped-gavin-satoshi-nakamotos-identity-revealed/>

paragraphs that are too technical, as those might have influenced the results. Messages containing mostly code or equations, such as the following post from Nakamoto<sup>9</sup>, were completely left out:

```
Some sample pseudocode using the new Accounts based commands in 0.3.18.
```

```
print "send to " + getaccountaddress(username) + " to fund your account"  
print "balance: " + getbalance(username, 0)  
print "available balance: " + getbalance(username, 6)  
[...]
```

## 2.2 Introducing the Authors

### 2.2.1 Satoshi Nakamoto

Satoshi Nakamoto is Bitcoin's pseudonymous creator. There are speculations that Nakamoto might actually be multiple individuals (Chon, 2017). For this research, I will be using forum posts originating from his account<sup>10</sup> divided into two sets, and the original Bitcoin white paper.

```
Total number of forum posts used: 202 (102 + 100)
```

```
Combined length: 23,969 words (11,730 + 11,239)
```

Despite the fact that Nakamoto himself has claimed to be of Japanese origin<sup>11</sup>, it seems, at the very least, that he has spent a substantial amount of time in an English-speaking environment, as his English language skills are near flawless. Nakamoto's general writing style is rather formal and contains very few typos, even in the somewhat casual environment of the online forums. He uses very few emoticons<sup>12</sup>, <sup>13</sup> or colloquial acronyms, and the acronyms he does use are capitalized. "WTF? How did we get on that? AFAIK, the only e-mail is if you tell the forum to do notifications, and I guess the wiki registration."<sup>14</sup> Notably, he uses British English ("Bitcoin is still very new and has not been independently *analysed*."<sup>15</sup>) and two spaces after sentences.

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<sup>9</sup> <https://bitcointalk.org/index.php?topic=2202.msg28947#msg28947>

<sup>10</sup> <https://bitcointalk.org/index.php?action=profile;u=3>

<sup>11</sup> <https://p2pfoundation.ning.com/m/profile?screenName=0ye0gncqg772o>

<sup>12</sup> <https://bitcointalk.org/index.php?topic=391.msg3308#msg3308>

<sup>13</sup> <https://bitcointalk.org/index.php?topic=199.msg1679#msg1679>

<sup>14</sup> <https://bitcointalk.org/index.php?topic=338.msg6307#msg6307>

<sup>15</sup> <https://bitcointalk.org/index.php?topic=7.msg264#msg264>

## 2.2.2 Craig Steven Wright

Craig Steven Wright is a UK based Australian computer scientist. He is known for declaring himself as the person behind the Satoshi Nakamoto pseudonym, so I have included him in this research as a potential candidate. As mentioned earlier, the samples of his writing are taken from the “Bitcoin and Blockchain Tech” section of his website. Some of the articles have been shortened in order to fit more articles covering a wider range of crypto currency related topics. We have two sets of texts from this author. Throughout this paper, I will mostly be referring to him by his initials: CSW.

The first set contains the following articles: *Bitcoin Mining: Consistency and the Distribution of Transactions* (2016), *Bitcoin White Paper Statement of Jan 29, 2021* (2021), *The cult of Decentralisation* (2018), *The myths of Bitcoin* (2018), *Bitcoin and Contracts* (2018), *Why is Bitcoin Open Source?* (2018), *Hoarding and Bitcoin* (2018), *Strategic Advantage and Finding Opportunities* (2021), *Cryptocurrency and the Law of the Horse* (2020) and *Is Code Really Law?* (2020).

The second set contains the following articles: *How Bitcoin Won the Race...* (2021), *Bitcoin as a Security* (2021), *Security, the Blockchain, and Hashed Headers...* (2021), *The Library Analogy* (2021), *Offline Addressing* (2021), *About Coinbase* (2021), *Bitcoin’s Model of Capitalism* (2020) and *Open Source and Liability* (2021).

Total number of articles used: 18 (10 + 8)

Combined length: 23,640 words (11,916 + 11,724)

Craig Steven Wright writes in British English (“It may seem altruistic and *honourable*”<sup>16</sup>) and uses rather formal language. However, given the nature of the source of his writings, we cannot take this as a reliable baseline. While I do believe that all his articles are authored by himself, it is very likely that he reviews and edits all of them before their publication, which potentially strips them of some authorial markings. There are few to no typos or errors in his samples. It is worth noting that he does not use two spaces between sentences – something which appears to be a learned habit for Nakamoto. Wright has started a Twitter account<sup>17</sup> in February of 2022, which might supply us with enough samples of his more casual texts for future research.

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<sup>16</sup> <https://craigwright.net/blog/bitcoin-blockchain-tech/how-bitcoin-won-the-race/>

<sup>17</sup> [https://twitter.com/Dr\\_CSWright](https://twitter.com/Dr_CSWright)

### 2.2.3 Gavin Andresen

Gavin Andresen is another potential Nakamoto candidate. Andresen is an American software developer. He has been close to the Bitcoin project from its early stages and before Nakamoto left, he gave Andresen the role of lead developer. I will be using two sets of texts from this author, both taken from his account on [bitcointalk.org](https://bitcointalk.org)<sup>18</sup>.

Total number of forum posts used: 237 (119 + 118)

Combined length: 23,528 words (12,068 + 11,460)

Gavin Andresen writes in American English (“designed so that *aluminum* smelting plants can also mine bitcoins”<sup>19</sup>) and, while not very formal or academic (“Thought it might be interesting for *y’all*”<sup>20</sup>), his posts seem carefully written and leave very few typos or misspelled words. Andresen tends to format his texts, using bold letters<sup>21</sup> and strikethrough<sup>22</sup>. He uses dashes very often and, notably, stylizes them as “--”. When he highlights words, he writes them in uppercase<sup>23</sup>, and he also capitalizes “PS” and “PPS”<sup>24</sup>.

### 2.2.4 Hal Finney

Hal Finney was an American cryptographer and software developer. His interest in creating cryptocurrency predates Bitcoin. As early as 2004, Finney created a system of generating digital proof-of-work tokens, called Reusable Proofs of Work (RSPW). After Nakamoto’s proposal was published in the Cypherpunk mailing list, Finney became a major proponent of the currency’s potential and became one of the first people to work on Bitcoin with Nakamoto and was the recipient of the very first Bitcoin transaction of 10 BTC. Finney has rejected the numerous theories that he is Nakamoto<sup>25</sup> all the way up till his death in 2014. I will be using two sets of texts authored by Finney, both taken from his posts on [bitcointalk.org](https://bitcointalk.org)<sup>26</sup>.

Total number of forum posts used: 267 (129 + 138)

Combined length: 23,138 words (11,486 + 11,652)

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<sup>18</sup> <https://bitcointalk.org/index.php?action=profile;u=224>

<sup>19</sup> <https://bitcointalk.org/index.php?topic=180020.msg1885226#msg1885226>

<sup>20</sup> <https://bitcointalk.org/index.php?topic=187595.msg1942435#msg1942435>

<sup>21</sup> <https://bitcointalk.org/index.php?topic=176684.msg9408094#msg9408094>

<sup>22</sup> <https://bitcointalk.org/index.php?topic=58579.msg691432#msg691432>

<sup>23</sup> <https://bitcointalk.org/index.php?topic=1013053.msg11003988#msg11003988>

<sup>24</sup> <https://bitcointalk.org/index.php?topic=941331.msg10803460#msg10803460>

<sup>25</sup> <https://www.forbes.com/sites/andygreenberg/2014/03/25/satoshi-nakamotos-neighbor-the-bitcoin-ghostwriter-who-wasnt/>

<sup>26</sup> <https://bitcointalk.org/index.php?action=profile;u=2436>

Hal Finney wrote in American English (“to adapt network *behavior* from that information”<sup>27</sup>). His writing style as well as his tone was neutral. Some typos appeared in his posts (“I’m trying to *implemment*”<sup>28</sup>), but they were not common. Although he used emoticons, their appearances were infrequent<sup>29</sup> and when he used colloquial acronyms, they were capitalized<sup>30, 31</sup>. However, unlike most other authors in this research, he usually wrote “btc” (Bitcoin) in lowercase<sup>32, 33</sup>.

## 2.2.5 Adam Back

Adam Back is a British cryptographer. He invented the proof-of-work technology that Bitcoin would go on to utilize, releasing a paper in 2002 titled “Hashcash - A Denial of Service Counter-Measure” where he outlined its functionality and mentioned its potential future use for cryptocurrencies. There have been speculations that he might be the personality behind the Satoshi Nakamoto pseudonym, fueled largely by a series of three YouTube videos by Barely Sociable, who concludes, among other reasons, that Back’s writing style is similar to that of Nakamoto<sup>34</sup>. Despite this, Back has gone on record to deny these assertions<sup>35</sup>. I will be using two sets of forum posts originating from Back’s bitcointalk.org account<sup>36</sup>.

Total number of forum posts used: 96 (37 + 59)

Combined length: 23,898 words (12,194 + 11,704)

Being British, Adam Back uses British English in his writing (“forsee the problems of flash renting and *realise*”<sup>37</sup>). His style is rather informal and includes many typos and misspellings: “it is hard to change code with \$ billions of *irrescindable* ecash sitting on it so core changes have *focussed* on maintenance”<sup>38</sup>. He uses contractions but largely leaves out apostrophes: “Well I *dont* think *thats* as dangerous a problem as corporate control by a long way.”<sup>39</sup> Back ends almost every message in the forums by signing his first name. When he writes postscripts, he uses the lowercase acronym “ps”<sup>40</sup>. He uses a moderate amount of emojis<sup>41</sup> and colloquial

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<sup>27</sup> <https://bitcointalk.org/index.php?topic=3311.msg46756#msg46756>

<sup>28</sup> <https://bitcointalk.org/index.php?topic=3238.msg45461#msg45461>

<sup>29</sup> <https://bitcointalk.org/index.php?topic=176432.msg1877928#msg1877928>

<sup>30</sup> <https://bitcointalk.org/index.php?topic=3414.msg48309#msg48309>

<sup>31</sup> <https://bitcointalk.org/index.php?topic=3293.msg46396#msg46396>

<sup>32</sup> <https://bitcointalk.org/index.php?topic=4608.msg70095#msg70095>

<sup>33</sup> <https://bitcointalk.org/index.php?topic=1833.msg43863#msg43863>

<sup>34</sup> <https://www.youtube.com/watch?v=XfcvXOP1b5g>

<sup>35</sup> <https://www.bloomberg.com/news/articles/2020-06-02/latest-satoshi-nakamoto-candidate-buying-bitcoin-no-matter-what>

<sup>36</sup> <https://bitcointalk.org/index.php?action=profile;u=101601>

<sup>37</sup> <https://bitcointalk.org/index.php?topic=68655.msg10034261#msg10034261>

<sup>38</sup> <https://bitcointalk.org/index.php?topic=68655.msg10040315#msg10040315>

<sup>39</sup> <https://bitcointalk.org/index.php?topic=180020.msg1887754#msg1887754>

<sup>40</sup> <https://bitcointalk.org/index.php?topic=906865.msg9965116#msg9965116>

<sup>41</sup> <https://bitcointalk.org/index.php?topic=180020.msg1887984#msg1887984>

acronyms (both capitalized<sup>42</sup> and non-capitalized<sup>43</sup>), comparatively more so than Satoshi Nakamoto. However, much like Nakamoto, he writes two spaces after each sentence. Back's posts are, on average, much longer than the other authors (from the online forum) I have included in this research.

## 2.2.6 Mike Hearn

Mike Hearn is a British software developer who worked for Google before quitting to focus on his contributions to the Bitcoin project. He had been a part of its development since its early stages and has had conversations with Nakamoto<sup>44</sup>, until his departure in 2016<sup>45</sup>. I included him in this paper because of his involvement in Bitcoin's early development, and because his activity on Bitcoin the forums<sup>46</sup> throughout the years has provided us with a sizeable sample of his writings. Thus, I will be using two sets of text samples in this research.

Total number of forum posts used: 243 (149 + 94)

Combined length: 23,752 words (11,995 + 11,757)

Mike Hearn writes in British English ("Someone refactors code written by someone else and *uninitialised* data creeps in"<sup>47</sup>). He occasionally uses emoticons<sup>48</sup>, sometimes stylizing them as ":-)"<sup>49, 50</sup>. When he writes colloquial acronyms, he switches between lowercase<sup>51</sup> and uppercase<sup>52</sup> with no apparent preference for or the other. He sometimes stylizes Bitcoin, somewhat unusually, as "BitCoin"<sup>53, 54</sup>, but not exclusively<sup>55</sup>.

## 2.2.7 Nick Szabo

Nick Szabo is a computer scientist, cryptographer, and the author of a pre-Bitcoin concept for digital currency Bit Gold<sup>56</sup>, which is believed to be one of Bitcoin's inspirations<sup>57</sup>. However, the project was not cited in the Bitcoin white paper. There have been suspicions of Szabo being Nakamoto, partially fueled by the analysis by

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<sup>42</sup> <https://bitcointalk.org/index.php?topic=707237.msg8171477#msg8171477>

<sup>43</sup> <https://bitcointalk.org/index.php?topic=180020.msg1884645#msg1884645>

<sup>44</sup> <https://plan99.net/~mike/index.html>

<sup>45</sup> <https://blog.plan99.net/the-resolution-of-the-bitcoin-experiment-dabb30201f7>

<sup>46</sup> <https://bitcointalk.org/index.php?action=profile;u=2700>

<sup>47</sup> <https://bitcointalk.org/index.php?topic=889427.msg9959874#msg9959874>

<sup>48</sup> <https://bitcointalk.org/index.php?topic=3014.msg42066#msg42066>

<sup>49</sup> <https://bitcointalk.org/index.php?topic=4494.msg66238#msg66238>

<sup>50</sup> <https://bitcointalk.org/index.php?topic=4512.msg66727#msg66727>

<sup>51</sup> <https://bitcointalk.org/index.php?topic=279420.msg2985510#msg2985510>

<sup>52</sup> <https://bitcointalk.org/index.php?topic=278237.msg2980722#msg2980722>

<sup>53</sup> <https://bitcointalk.org/index.php?topic=4459.msg65736#msg65736>

<sup>54</sup> <https://plan99.net/~mike/satoshi-emails/thread1.html>

<sup>55</sup> <https://bitcointalk.org/index.php?topic=189792.msg1985840#msg1985840>

<sup>56</sup> <http://unenumerated.blogspot.com/2005/12/bit-gold.html>

<sup>57</sup> <https://bitcointalk.org/index.php?topic=5371.msg79009#msg79009>



Skye Grey, which was later cited in several other articles<sup>58, 59</sup>. The texts I will be using in my analyses were all collected from Szabo's personal website<sup>60</sup>, and divided into two sets.

The first set contains the following articles: *The Justice Department vs. the United States Constitution* (2005), *Robot Law* (2006), *Real options analysis for space projects* (2007), *Bilinear group cryptography* (2007), *Money and the problem of cooperation* (2007), *Blind signatures* (2007), *Smart contracts watch* (2007), *Exit and freedom* (2007) and *Bitcoin, what took ye so long?* (2011).

The second set contains the following articles: *Bit gold markets* (2008), *Origins of the joint-stock corporation* (2005), *Smart contracts expand credit opportunities* (2006), *Inflation expectations, gold, and oil* (2008), *The tax collector's problem* (2009), *Of wages and money: cost as a proxy measure of value* (2011) and *The dawn of trustworthy computing* (2014).

Total number of articles used: 19 (9 + 7)

Combined length: 23,597 words (11,840 + 11,757)

Nick Szabo writes in American English ("Genetic influences on *behavior* are adaptations to the social problems"<sup>61</sup>). Since his writings originate from his personal website, they are more similar in style to CSW, so his use of complicated sentence structures is not necessarily indicative of how he would write in the more casual setting of the Bitcoin forums. He often uses parentheses, more so than Craig Steven Wright does in his blogs. Similarly to Gavin Andresen, Szabo habitually writes dashes as "--". His blogs contain occasional typos: "I propose a class of surface or other physical condition and *correspondong* class(es) of sensors [...] The idea is to replace these with *deductiions* from physical evidence that can be gathered by sensors."<sup>62</sup>

### 2.2.8 Control samples

As control samples, I will be using texts authored by two randomly forum users from [bitcointalk.org](http://bitcointalk.org). Their usernames are BitcoinFX<sup>63</sup> and grifferz<sup>64</sup> and since they were never suspected of being Nakamoto, they are not expected to be similar to his authorial style. As with all the previous authors, I have collected two sets from each.

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<sup>58</sup> [https://www.huffpost.com/entry/the-mysterious-disappearance\\_2\\_b\\_7217206](https://www.huffpost.com/entry/the-mysterious-disappearance_2_b_7217206)

<sup>59</sup> <https://techcrunch.com/2013/12/05/who-is-the-real-satoshi-nakamoto-one-researcher-may-have-found-the-answer/>

<sup>60</sup> <http://unenumerated.blogspot.com>

<sup>61</sup> <http://unenumerated.blogspot.com/2007/08/money-and-problem-of-cooperation.html>

<sup>62</sup> <http://unenumerated.blogspot.com/2006/11/robot-law.html>

<sup>63</sup> <https://bitcointalk.org/index.php?action=profile;u=30>

<sup>64</sup> <https://bitcointalk.org/index.php?action=profile;u=2522>

### **Bitcoin FX:**

Total number of forum posts used: 169 (86 + 83)

Combined length: 23,166 words (12,523 + 10,643)

BitcoinFX is an anonymous forum user. He uses emoticons on a regular basis<sup>65</sup> and writes colloquial acronyms in lowercase<sup>66</sup>. Despite claiming to be from the United Kingdom, he seems to write mostly in American English: “We can't *initialize* a *decentralized* network, unless more people decide to participate.”<sup>67</sup> . However, his style is somewhat uncommon. Commonly uses the wrong spelling of homophonic words: “*their* are less than 5 players,”<sup>68</sup> “You should *bare* in mind.”<sup>69</sup> And occasionally make grammatical errors, such as using the wrong voice: “This 2nd Bitcoin address is only *know* to the service provider.”<sup>70</sup> However, the most interesting feature of his writing style is his consistent use of space before the punctuation mark at the end of a sentence: “I'm hardly a troll, although you gotta love the trolls, right ? [...] I love (to hate) Bitcoin !”<sup>71</sup> “They might not even know every holder themselves !?”<sup>72</sup> This way of using punctuation is most common in French.

### **Grifferz:**

Total number of forum posts used: 212 (105 + 107)

Combined length: 23,374 words (11,819 + 11,555)

Grifferz is another anonymous forum user. His profile states he is from the United Kingdom, and his spelling throughout his post history matches this (“I am not *criticising* him for being a newbie.”<sup>73</sup>) His posts are usually relatively short. He favors using bold text<sup>74</sup> and italics<sup>75</sup> to highlight certain words. He occasionally uses emoticons<sup>76</sup>. He uses colloquial acronyms rather rarely, but when he does, he writes them in uppercase letters<sup>77</sup>.

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<sup>65</sup> <https://bitcointalk.org/index.php?topic=34.msg206#msg206>

<sup>66</sup> <https://bitcointalk.org/index.php?topic=34.msg196#msg196>

<sup>67</sup> <https://bitcointalk.org/index.php?topic=951753.msg11904001#msg11904001>

<sup>68</sup> <https://bitcointalk.org/index.php?topic=80.msg698#msg698>

<sup>69</sup> <https://bitcointalk.org/index.php?topic=239649.msg2545355#msg2545355>

<sup>70</sup> <https://bitcointalk.org/index.php?topic=79.msg697#msg697>

<sup>71</sup> <https://bitcointalk.org/index.php?topic=172664.msg1840382#msg1840382>

<sup>72</sup> <https://bitcointalk.org/index.php?topic=206123.msg2162807#msg2162807>

<sup>73</sup> <https://bitcointalk.org/index.php?topic=462873.msg5118140#msg5118140>

<sup>74</sup> <https://bitcointalk.org/index.php?topic=477103.msg5277499#msg5277499>

<sup>75</sup> <https://bitcointalk.org/index.php?topic=554313.msg6048118#msg6048118>

<sup>76</sup> <https://bitcointalk.org/index.php?topic=520075.msg5754985#msg5754985>

<sup>77</sup> <https://bitcointalk.org/index.php?topic=470240.msg5189599#msg5189599>

### 2.3 The Hapax Method

Hapax legomena (singular hapax legomenon), are words that appear only once per text. Most of the time, these are mere typos, but they can also say a lot about their author. Rarely used words can help connect one author to multiple texts, since a rare word appearing across multiple works can point to more than just a coincidence. This metric is more efficient and accurate in larger bodies of text; with the length of 3,000 words or more, the hapax method is up to 99% accurate (Faltýnek & Matlach, 2021).

For these analyses, I have used the online tool QUITA<sup>78</sup> and its Bag of Words analysis function. Cosine dissimilarity was used to compare all 18 plain text files, so 2 files per author (Figures 1a & 1b). All the results are presented in the form of Hierarchical clustering dendrograms using Ward's method (Ward, 1963), and tSNE (t-distributed stochastic neighbor embedding) maps (Hinton & Roweis, 2002).

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<sup>78</sup> <https://kol.ff.upol.cz/quita>

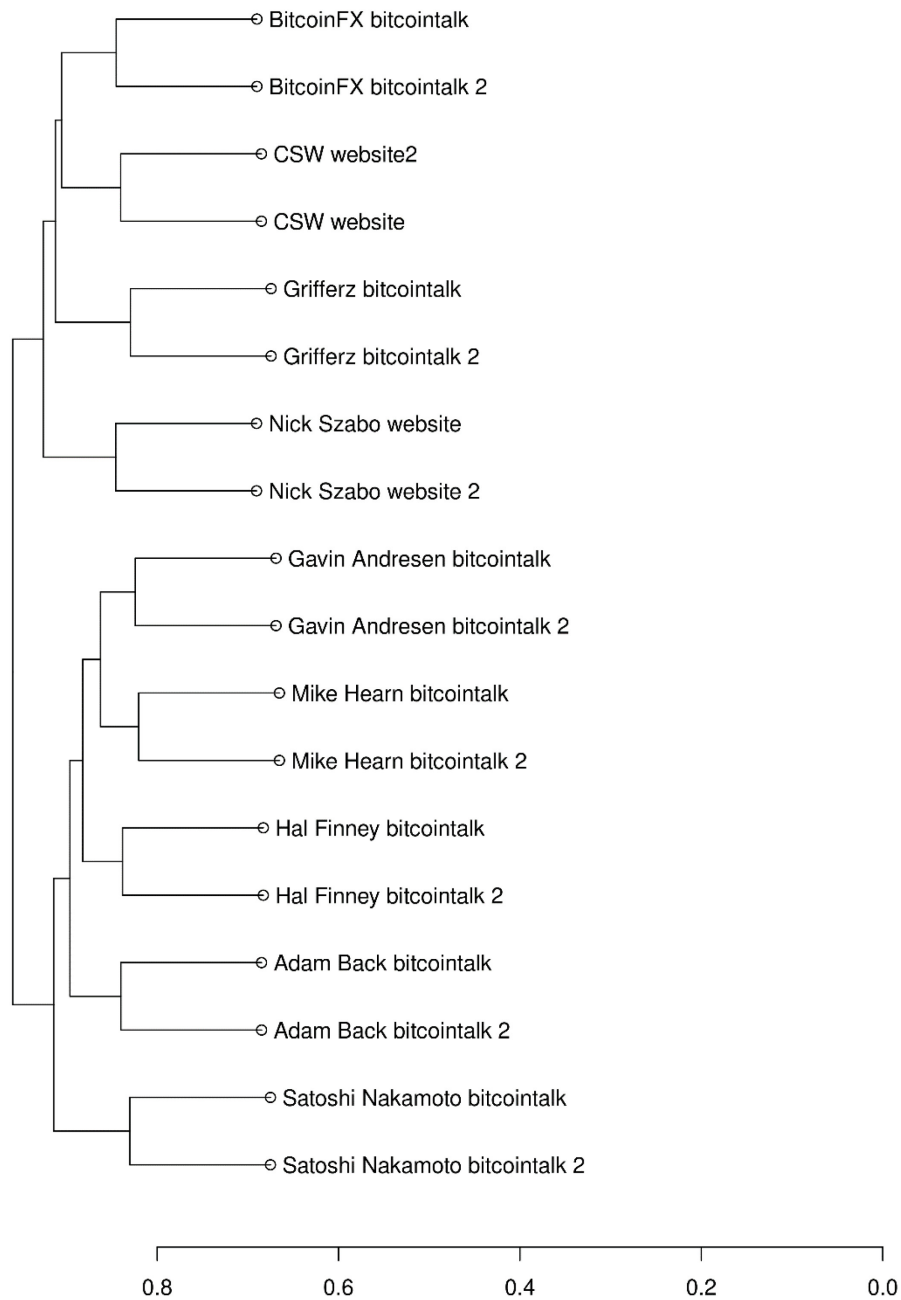
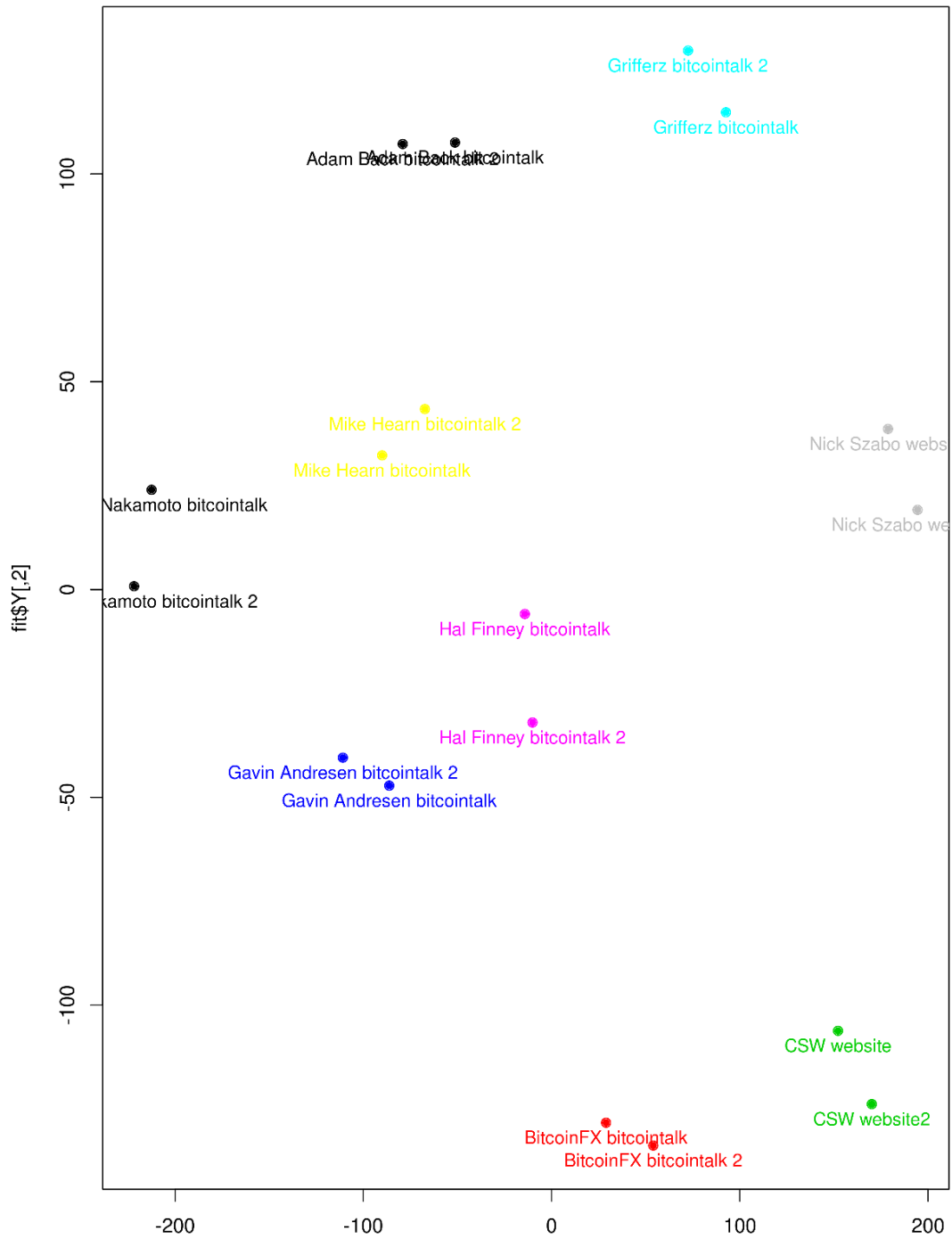


Figure 1a

*The result of a hapax analysis of all 18 samples from 9 authors, tokenized and unreduced, portrayed as a hierarchical clustering dendrogram. Cosine dissimilarity was used to calculate the differences between each author. The samples on one branch are the closest to each other, increased dissimilarity is portrayed by higher amounts of branch divisions between samples (e.g., Satoshi Nakamoto and BitcoinFX).*

Figure 1b



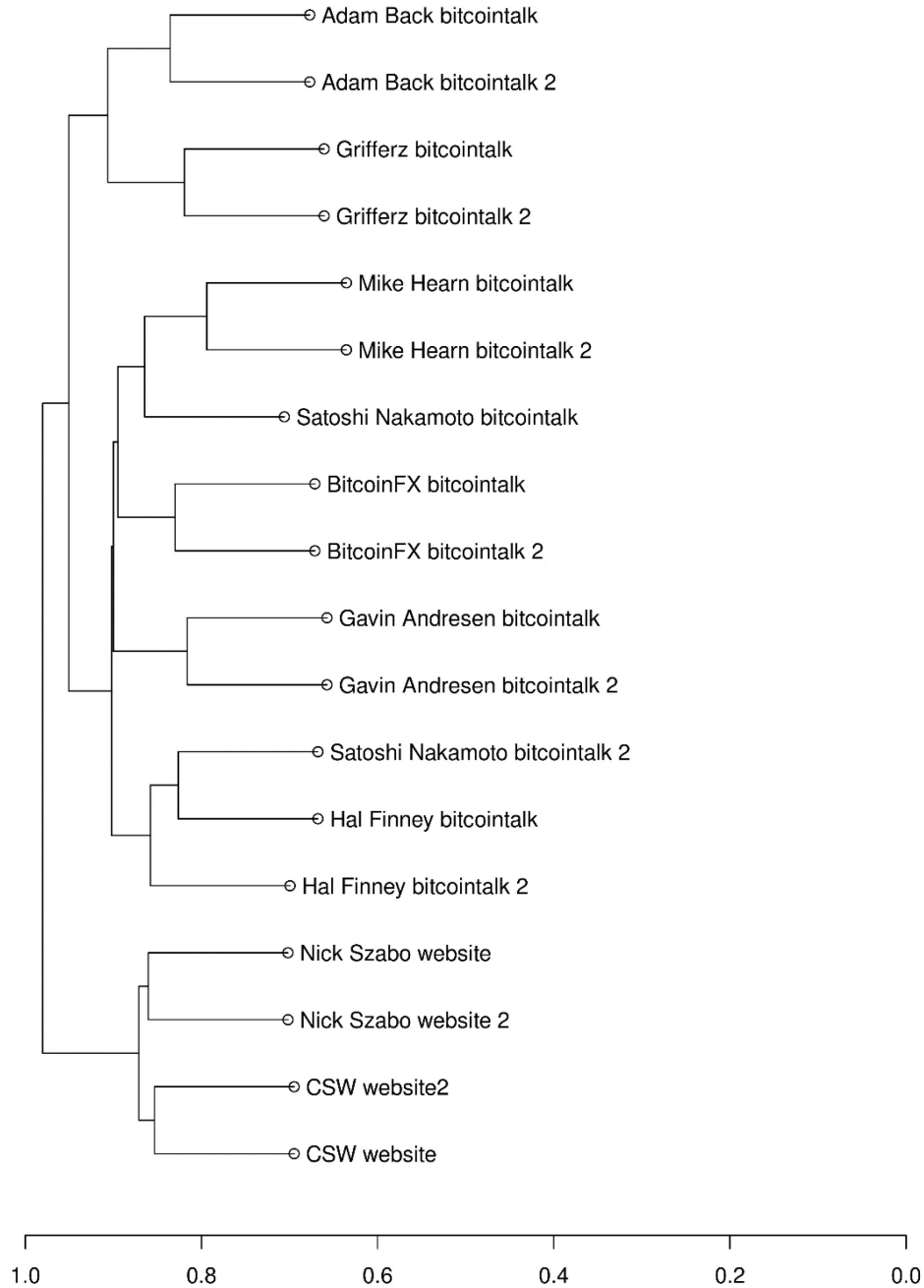
The result of a hapax analysis of all 18 samples from 9 authors, tokenized and unreduced, portrayed by *t*-distributed stochastic neighbor embedding. Cosine dissimilarity was used to calculate the differences between each author. The samples closest to each other on the 2-dimensional map (i.e., that are clustered) are the most similar. Increased dissimilarity is portrayed by greater distance on the map (e.g., CSW and Adam Back).

As we can see, all the authors and texts clustered accurately according to my knowledge. Mike Hearn appears to be the closest to Satoshi Nakamoto, followed by Gavin Andresen and Hal Finney.

To ensure the accuracy of the results and rule out one-time coincidental overlaps, I then repeated this process 10 times on a selection of 5,000 randomly chosen words per text, which were analyzed for hapaxes in the same way. Out of the 10 reduced analyses, 6 times the results looked similar to the example above, with all the authors clustering separately. The remaining 4 times, Hal Finney, Satoshi Nakamoto and Mike Hearn were the authors who seemed to get clustered and in one instance Grifferz and CSW also appeared together. All the results are shown below. I will be focusing on the dendrograms in this section, as they best illustrate the results. The tSNE maps belonging to the shown dendrograms can be found in Chapter 5: **Additional Figures**.

In Figure 1.01, we see one of Nakamoto's samples stand close to Mike Hearn. His other sample got clustered directly with Hal Finney. The accompanying tSNE map can be found in Chapter 5: Additional Figures, Figure 1.11.

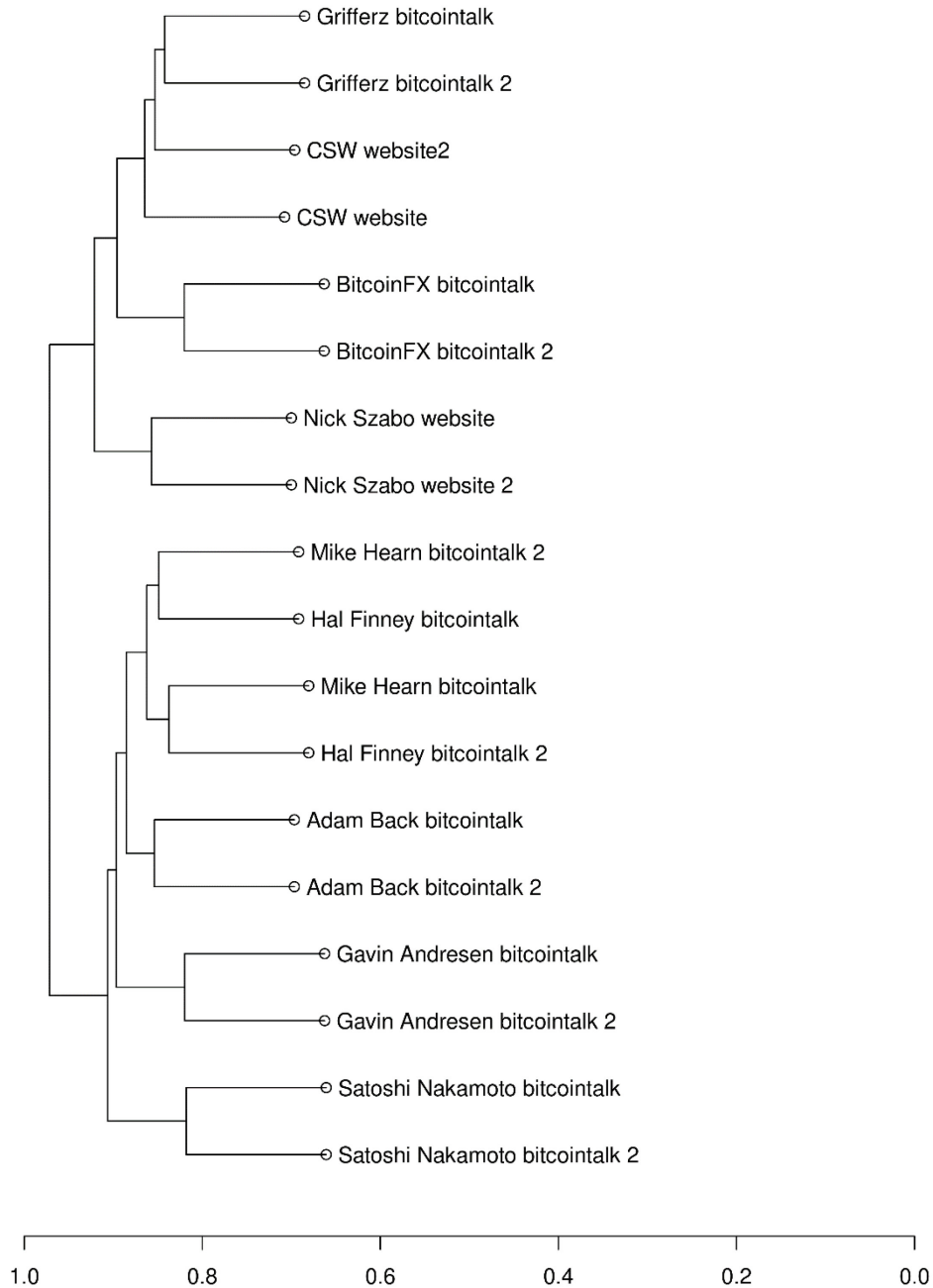
Figure 1.01



The result of a hapax analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed as a hierarchical clustering dendrogram. The same metrics were used as the ones described in Figure 1a.

Figure 1.02 shows Hal Finney getting clustered in between both of Mike Hearn’s samples, while Satoshi Nakamoto remains distant. Additionally, we see Grifferz and CSW grouped together as well. The accompanying tSNE map can be found in Chapter 5: Additional Figures, Figure 1.12.

Figure 1.02

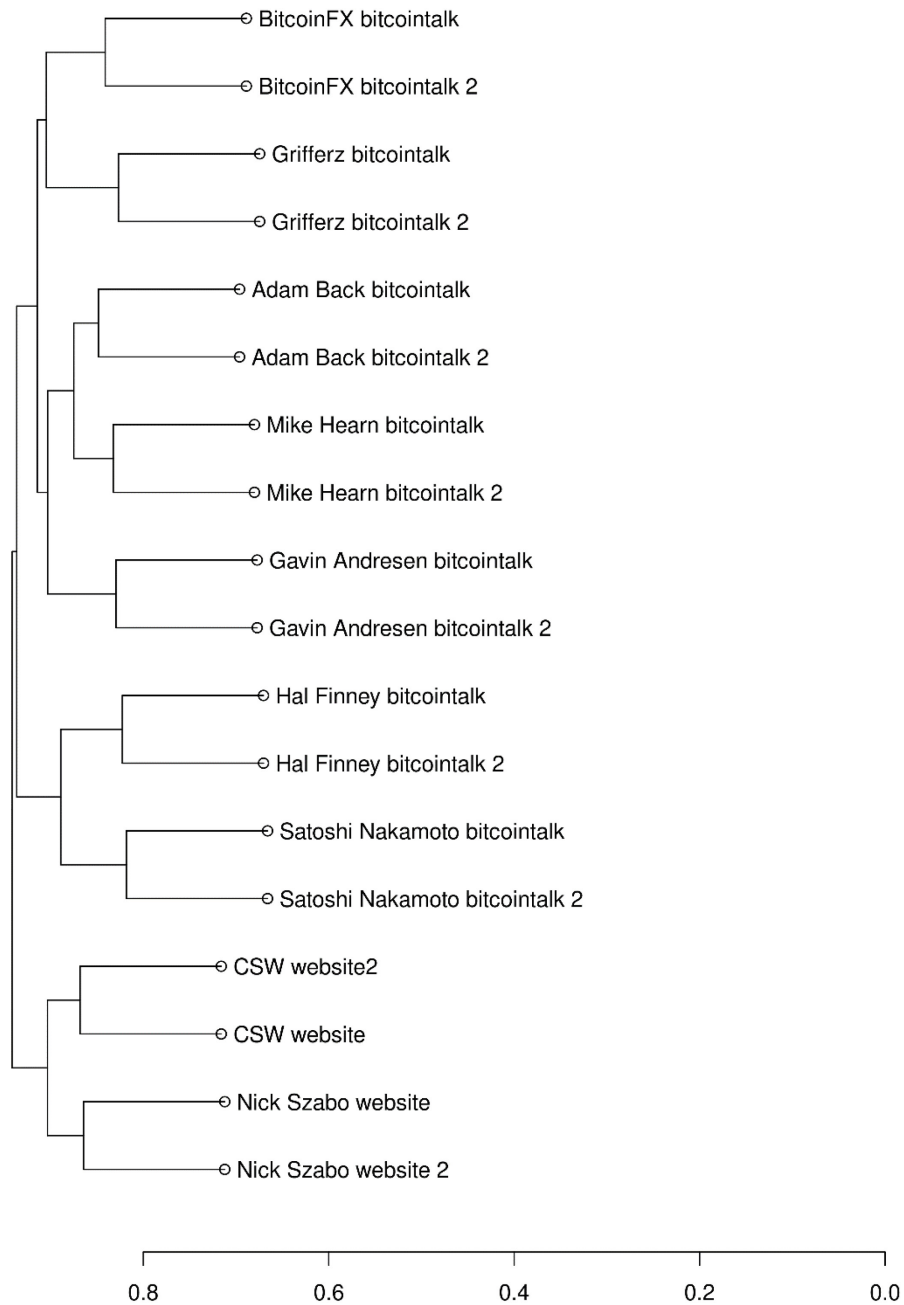


*The result of a hapax analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed as a hierarchical clustering dendrogram. The same metrics were used as the ones described in Figure 1a.*



In Figure 1.03, the closest to Satoshi Nakamoto is Hal Finney but we see no overlaps or irregularities. The accompanying tSNE map can be found in Chapter 5: Additional Figures, Figure 1.13.

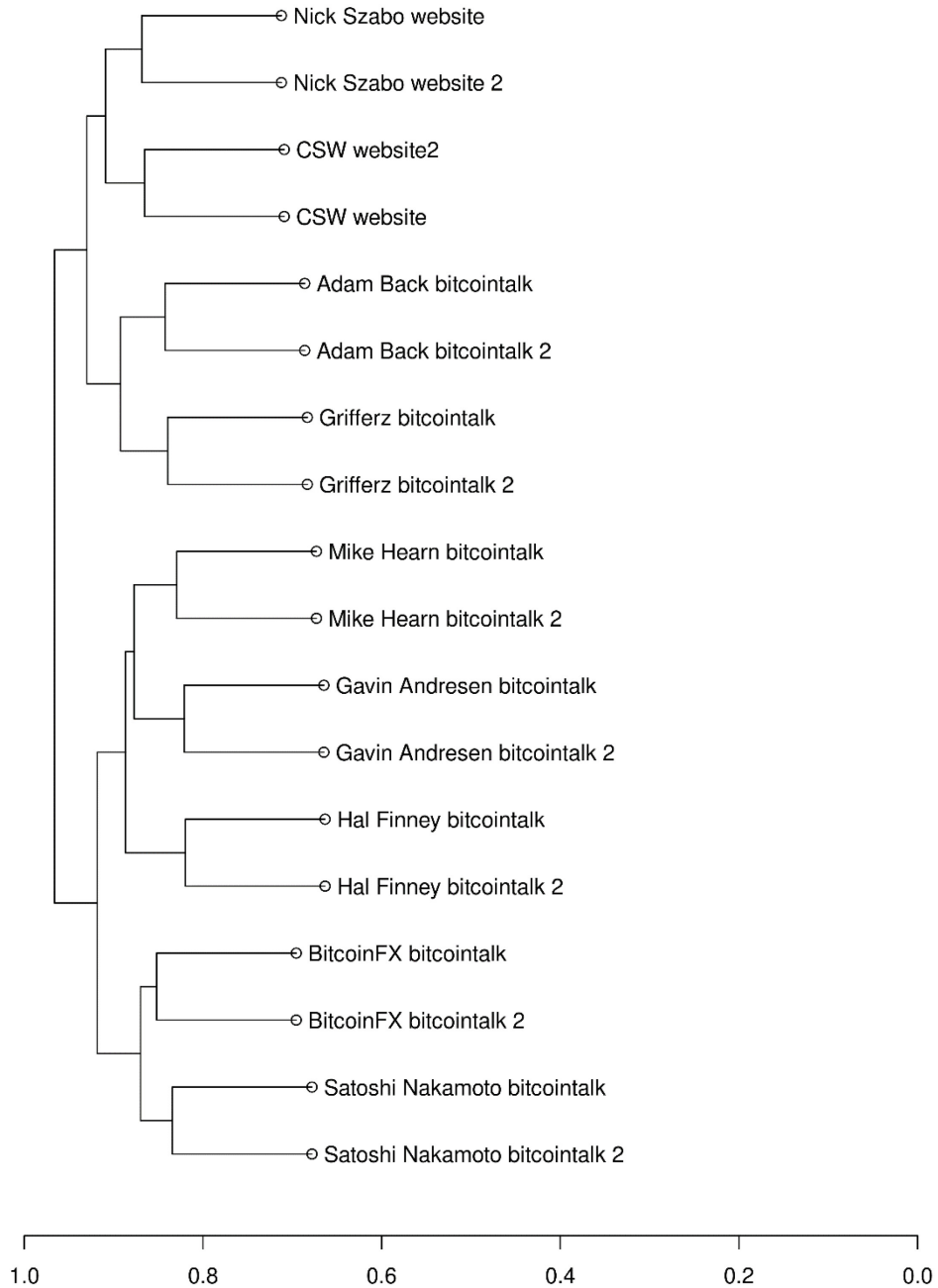
Figure 1.03



The result of a hapax analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed as a hierarchical clustering dendrogram. The same metrics were used as the ones described in Figure 1a.

In Figure 1.04, our control author BitcoinFX clustered the closest to Satoshi Nakamoto. The accompanying tSNE map can be found in Chapter 5: Additional Figures, Figure 1.14.

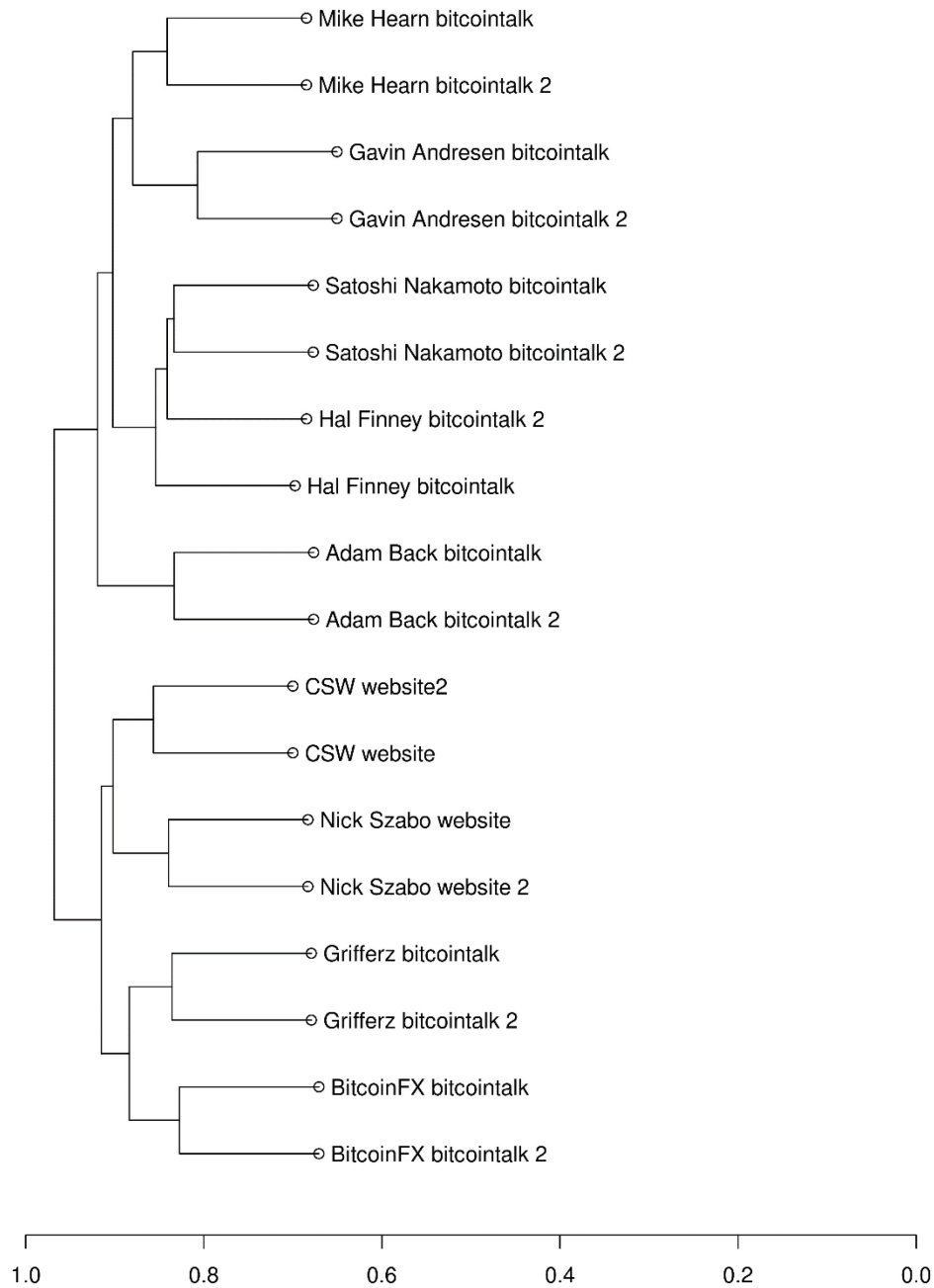
Figure 1.04



*The result of a hapax analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed as a hierarchical clustering dendrogram. The same metrics were used as the ones described in Figure 1a.*

Figure 1.05 shows Satoshi Nakamoto and Hal Finney clustered together. The accompanying tSNE map can be found in Chapter 5: Additional Figures, Figure 1.15.

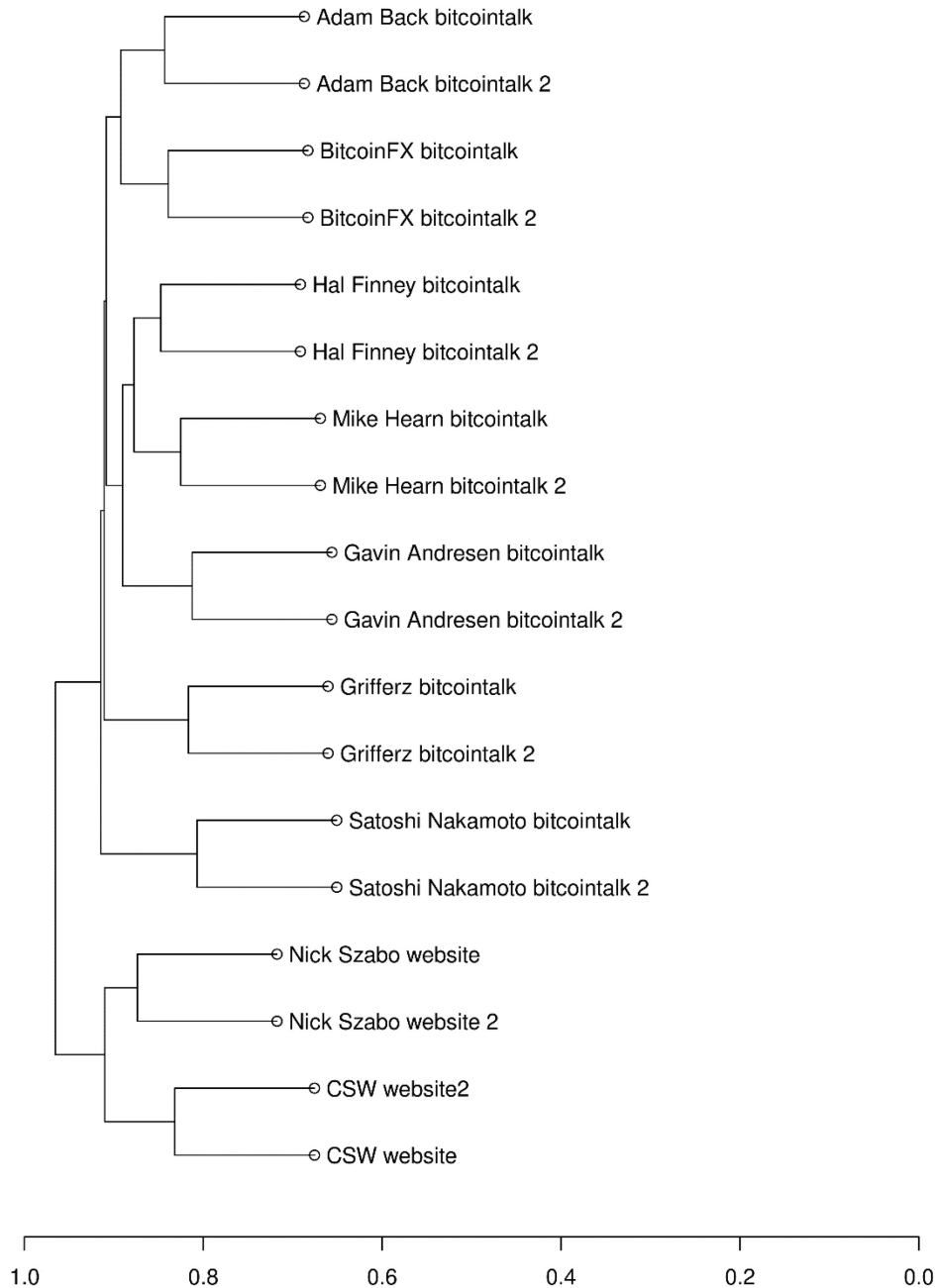
Figure 1.05



The result of a hapax analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed as a hierarchical clustering dendrogram. The same metrics were used as the ones described in Figure 1a.

There are no particular irregularities in Figure 1.06. In this instance, our control author Grifferz appears to be the closest to Satoshi Nakamoto. The accompanying tSNE map can be found in Chapter 5: Additional Figures, Figure 1.16.

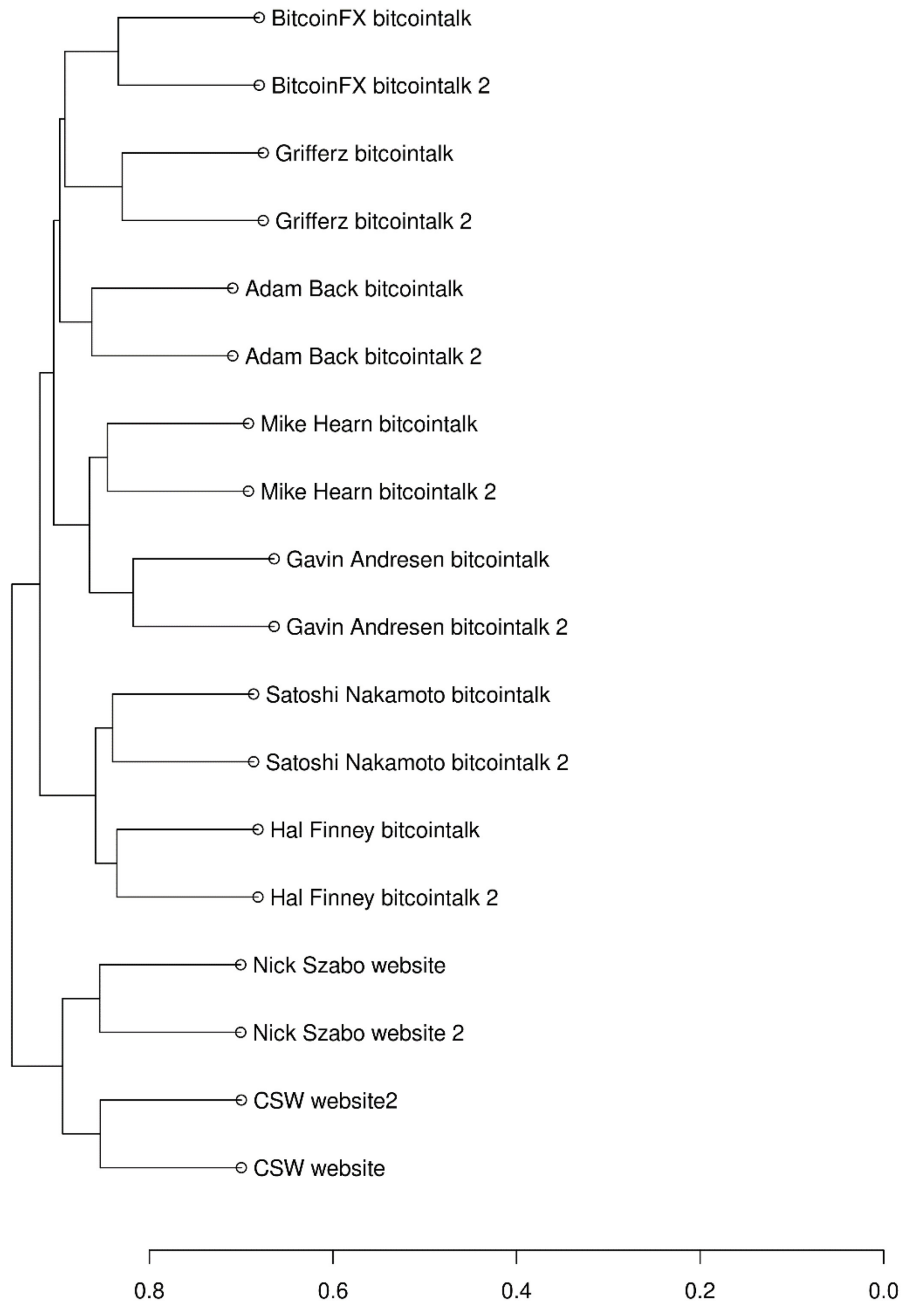
Figure 1.06



The result of a hapax analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed as a hierarchical clustering dendrogram. The same metrics were used as the ones described in Figure 1a.

Figure 1.07 shows Hal Finney cluster close to Satoshi Nakamoto. However, there are no unexpected clusters. The accompanying tSNE map can be found in Chapter 5: Additional Figures, Figure 1.17.

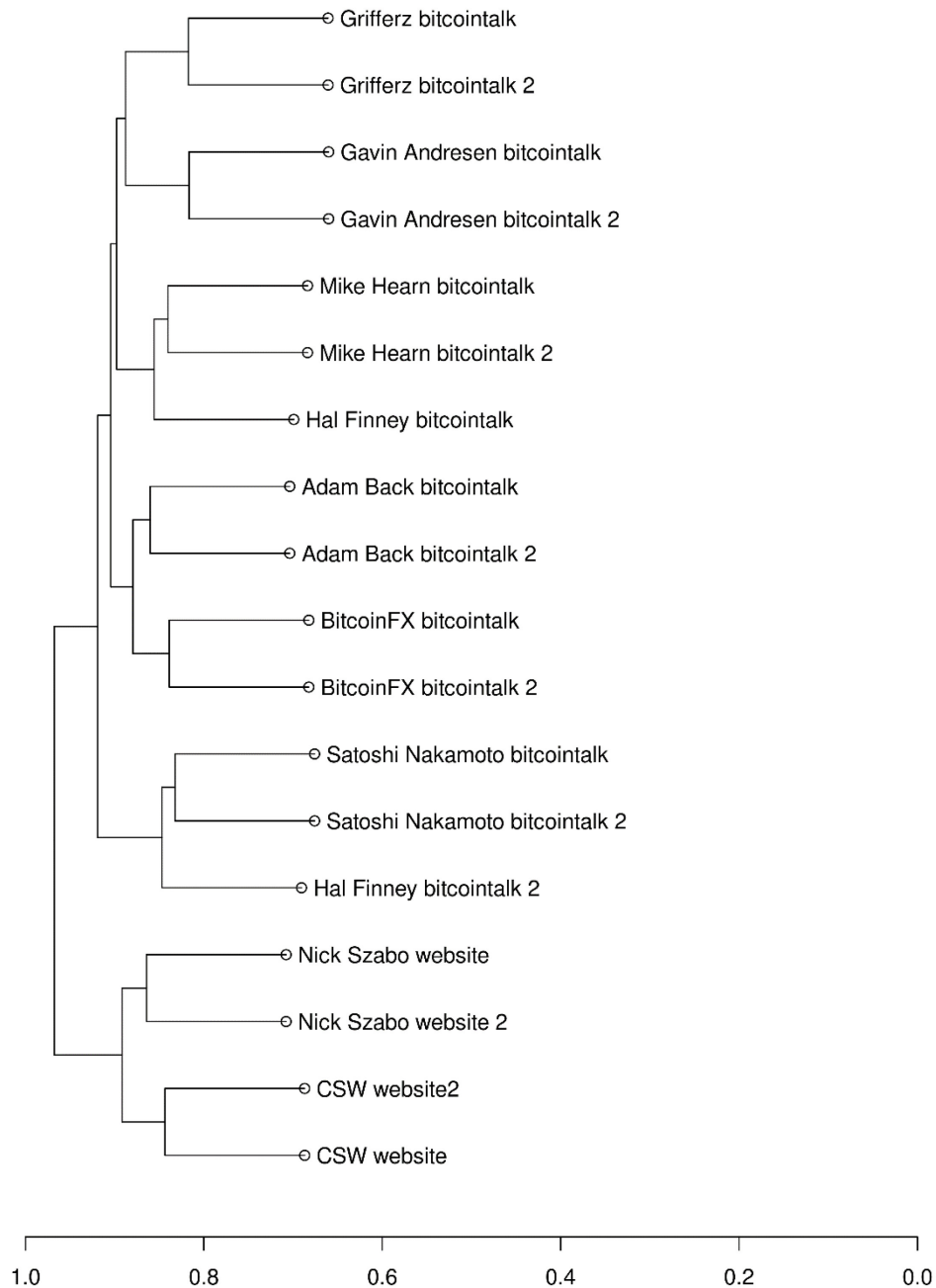
Figure 1.07



The result of a hapax analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed as a hierarchical clustering dendrogram. The same metrics were used as the ones described in Figure 1a.

In Figure 1.08, we can see that one of Hal Finney's samples is clustered with Mike Hearn and the other with Nakamoto. The accompanying tSNE map can be found in Chapter 5: Additional Figures, Figure 1.18.

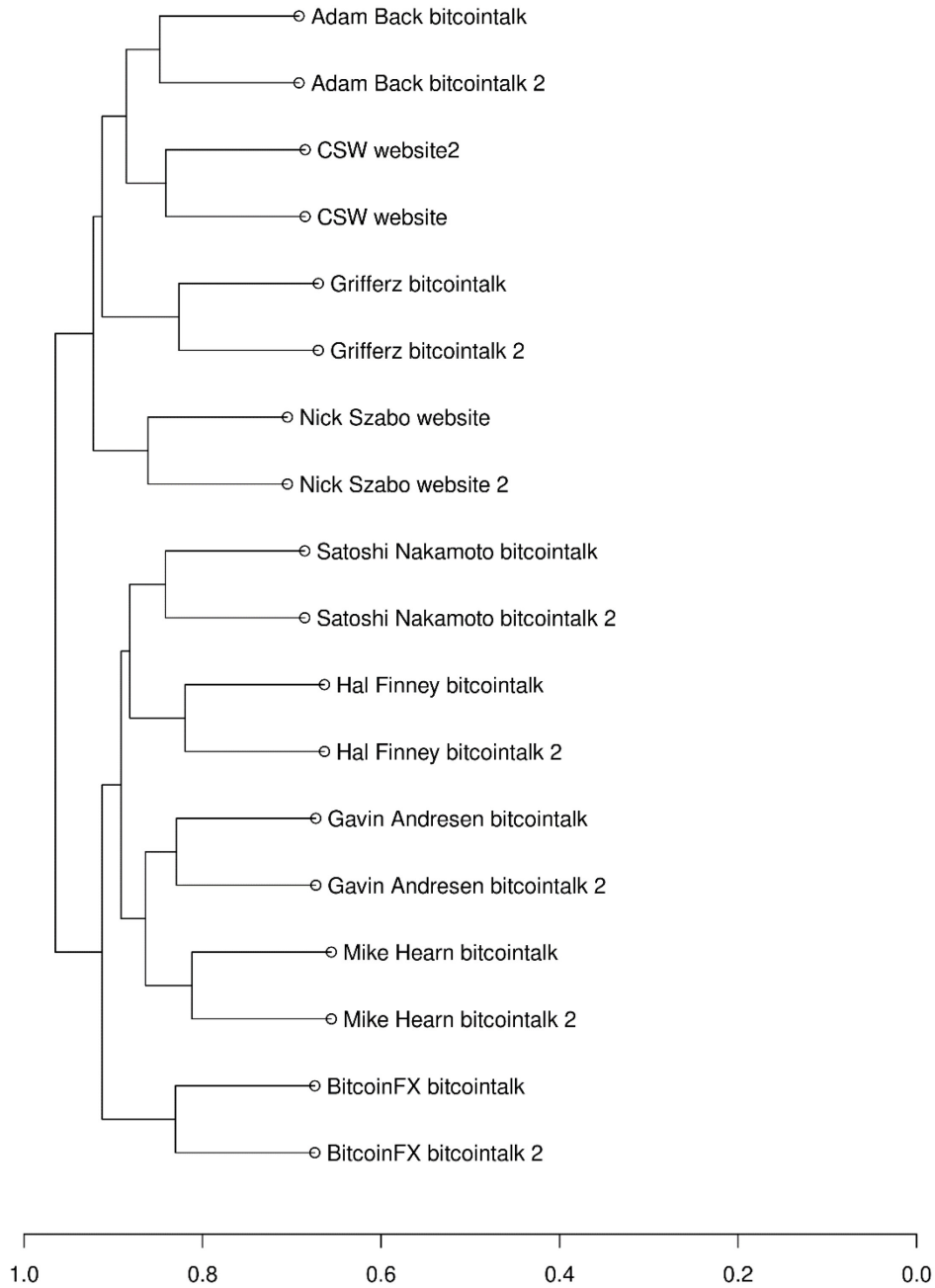
Figure 1.08



The result of a hapax analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed as a hierarchical clustering dendrogram. The same metrics were used as the ones described in Figure 1a.

Figure 1.09 shows Hal Finney continues to cluster closer to Nakamoto than anyone else. However, there are no notable overlaps. The accompanying tSNE map can be found in Chapter 5: Additional Figures, Figure 1.19.

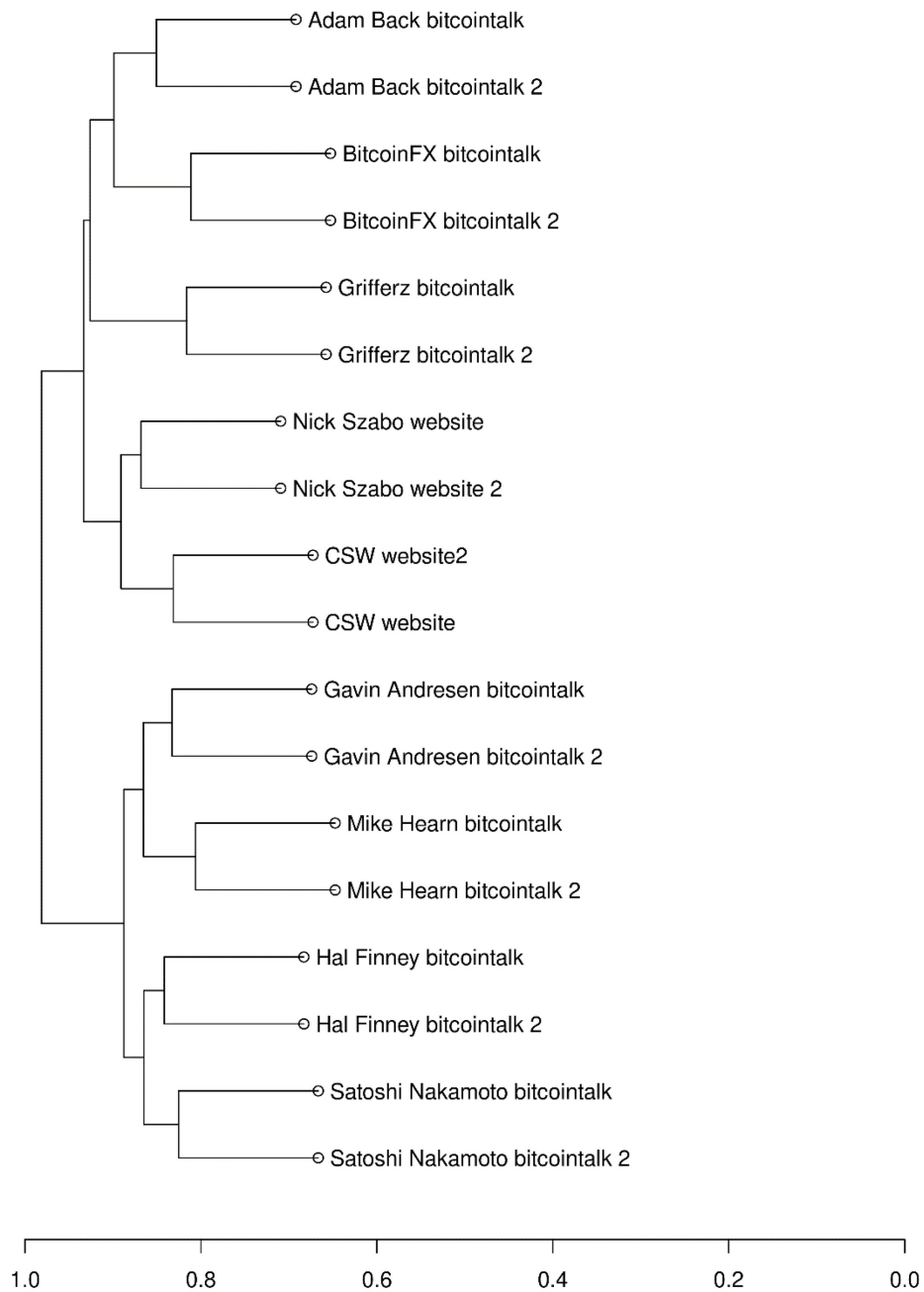
Figure 1.09



*The result of a hapax analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed as a hierarchical clustering dendrogram. The same metrics were used as the ones described in Figure 1a.*

In Figure 1.10, we can see Hal Finney and Satoshi Nakamoto form another relatively close pair, again with no overlaps. The accompanying tSNE map can be found in Chapter 5: Additional Figures, Figure 1.20.

Figure 1.10



*The result of a hapax analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed as a hierarchical clustering dendrogram. The same metrics were used as the ones described in Figure 1a.*



We have no clear-cut answers thus far, as the majority of the times, the authors were clearly distinguished. We could see some unusual clustering in 4 out of the 10 randomized and reduced analyses. In Figure 1.01 we could see Nakamoto cluster once with Finney and once with Hearn. In Figure 1.02 we could see Grifferz with CSW form one cluster and Hearn with Finney form another. Figure 1.05 shows Nakamoto and Finney clustered together. In Figure 1.08 Finney appeared once with Nakamoto and once with Hearn. Aside from these, we can see that 4 out of the 6 remaining times, the closest person to Nakamoto was Hal Finney (1.10, 1.09, 1.07 and 1.03). In Figure 1.06, Adam Back and Hal Finney are roughly equally distant from Nakamoto (better illustrated in the tSNE map in Chapter 5, Figure 1.16.) Lastly, the closest to Nakamoto in Figure 1.04 is BitcoinFX. We will take note of these results as we move on to the next wave of analyses.

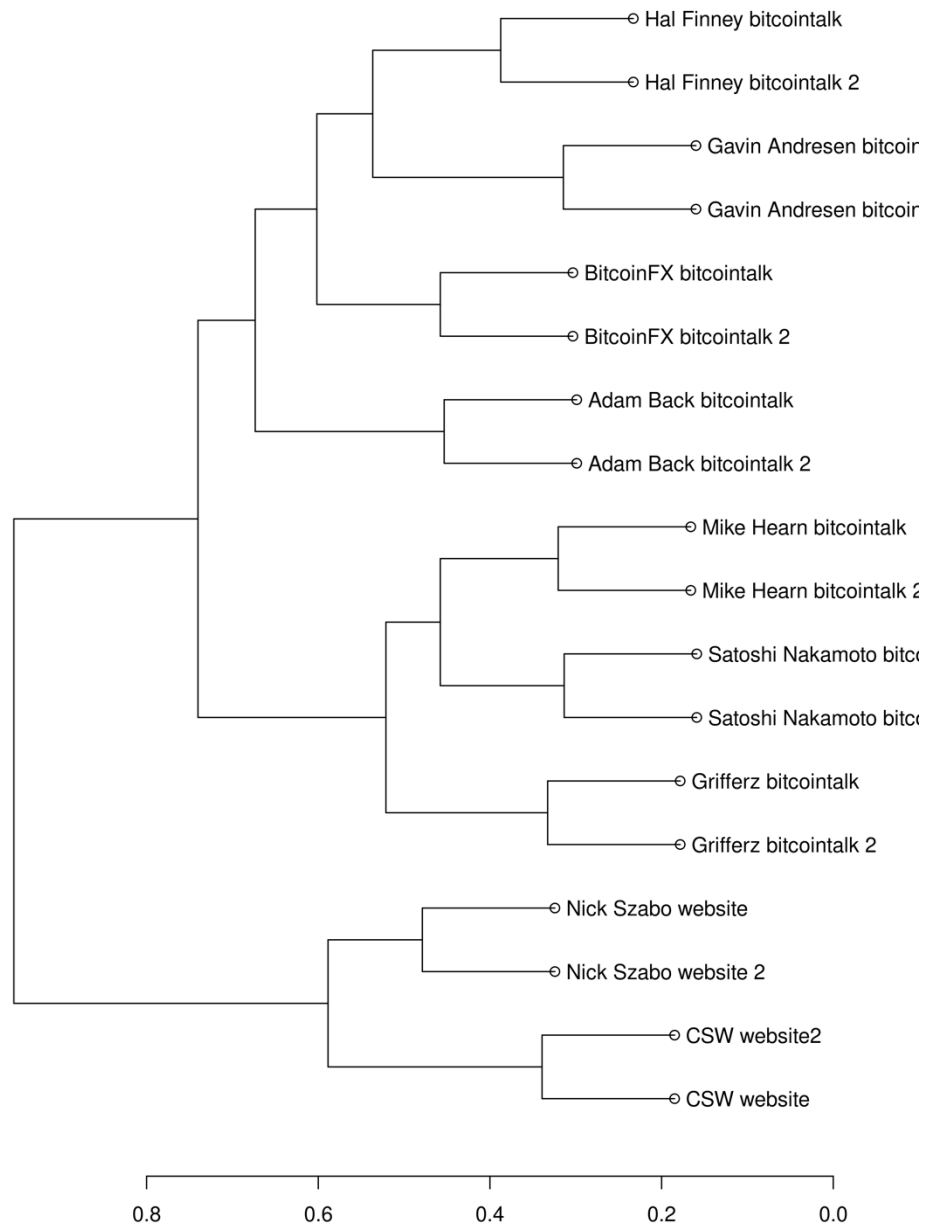
## 2.4 N-grams

N-gram is a sequence of consecutive specified items, where the  $n$  is defined as the number of items in the sequence: 2-grams (bigrams), 3-grams (trigrams), 4-grams (tetragrams), 5-grams (pentagrams), etc. In terms of linguistics, n-grams are usually defined as a sequence of characters or words. For word n-grams, the most common word combinations are known as collocations; generally used phrases or words that are likely to appear together, such as “heavy drinker”. If we take the collection of texts used in my analyses as its own isolated corpus, the words “bitcoin wallet” might appear together a lot more often than if we used a larger, less specified corpus of English. Character n-grams apply the same principle of item sequences but with focus on characters. Research comparing different authorship attribution methods indicates that character n-gram analysis ranks among the most accurate we have so far (Koppel & Schler, 2006). Because the corpus itself matters, this means that we can take each author and explore the n-grams that appear in their individual writing and then compare them with each other. Today, I will explore two types of n-grams: word 2-grams and character 3-grams.

### 2.4.1 Word 2-grams

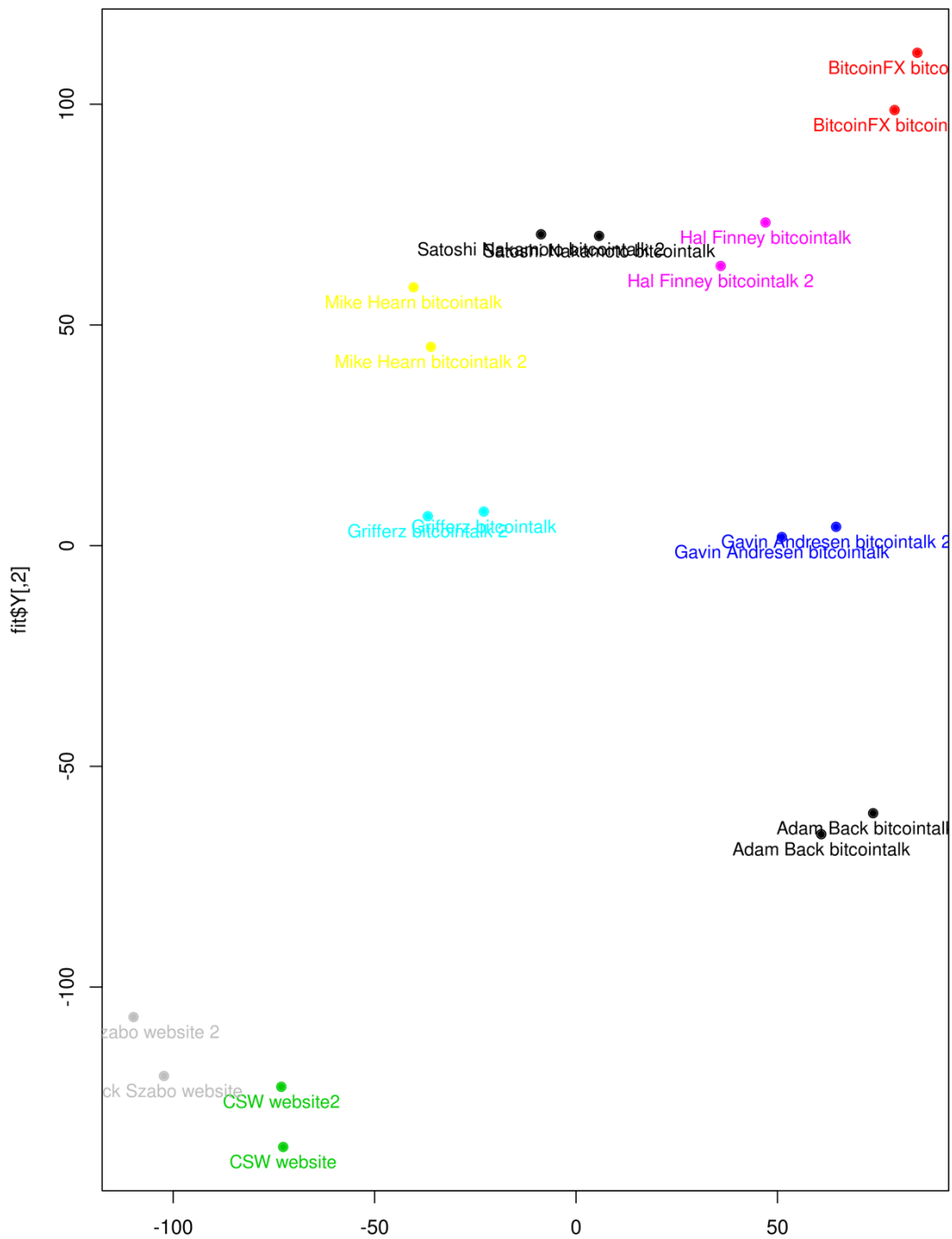
Let us start our analyses with word 2-grams. I will continue to use the online tool QUITA used for the hapax method and, once again, present the results in form of hierarchical clustering dendrograms and tSNE maps. Cosine dissimilarity will be used to compare all 18 plain text files, first without any reduction (Figures 2a & 2b).

Figure 2a



*The result of a word 2-gram analysis of all 18 samples from 9 authors, tokenized and unreduced, portrayed as a hierarchical clustering dendrogram. Cosine dissimilarity was used to calculate the differences between each author. The samples on one branch are the closest to each other, increased dissimilarity is portrayed by higher amounts of branch divisions between samples (e.g., CSW and Hal Finney).*

Figure 2b



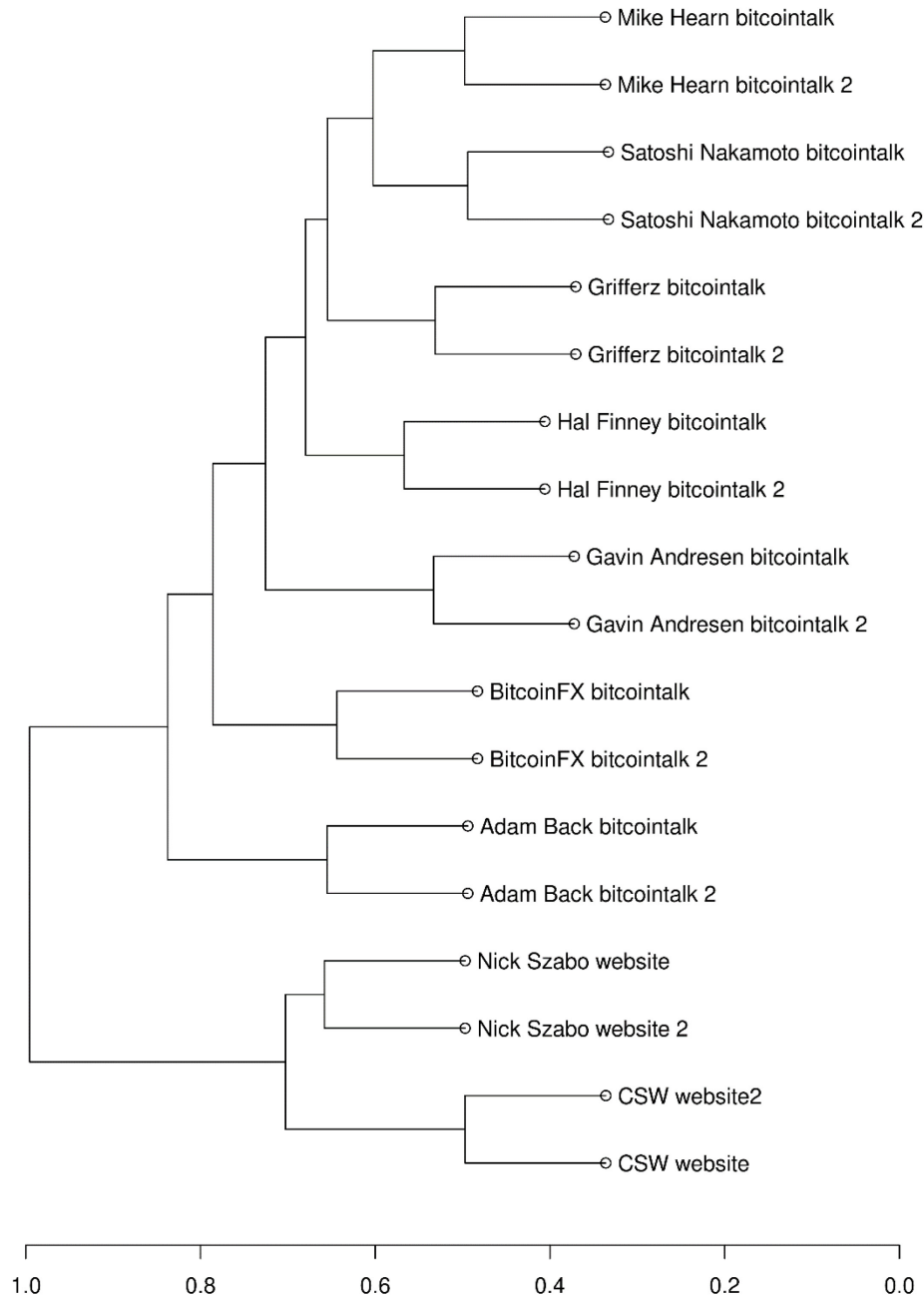
The result of a word 2-gram analysis of all 18 samples from 9 authors, tokenized and unreduced, portrayed by *t*-distributed stochastic neighbor embedding. Cosine dissimilarity was used to calculate the differences between each author. The samples closest to each other on the 2-dimensional map (i.e., that are clustered) are the most similar. Increased dissimilarity is portrayed by greater distance on the map (e.g., BitcoinFX and Adam Back).

Just as with my analyses of hapax legomena, all the authors and texts clustered accurately. The closest to Nakamoto appears to be Mike Hearn with Hal Finney being the close second (this is more visible in the tSNE map, Figure 2b). The two authors from whom website posts were used clustered considerably far away from the others.

I repeated the word 2-gram analysis 10 times with 5,000 randomly selected tokens in order to see if this trend of CSW and Szabo clustering away from the others continues, as well as to check for any other irregularities. This time, no apparent clusters of different authors were observed. 6 out of the 10 analyses had similar results to the ones shown above, with CSW and Nick Szabo sharing a branch away from the other authors. The 4 remaining times, this distance is less pronounced as they end up on the same branches as other authors. Furthermore, 8 times out of 10, Mike Hearn appeared the closest to Satoshi Nakamoto and the two remaining times, Hal Finney was the closest. All the results are shown below. I will continue to focus on the dendrograms, as they best illustrate the results. The tSNE maps belonging to the shown dendrograms can be found in Chapter 5: Additional Figures.

In Figure 2.01, Mike Hearn can be seen clustering the closest to Nakamoto out of all the authors while Nick Szabo and CSW continue to occupy a separate branch. The accompanying tSNE map can be found in Chapter 5: Additional Figures, Figure 2.11.

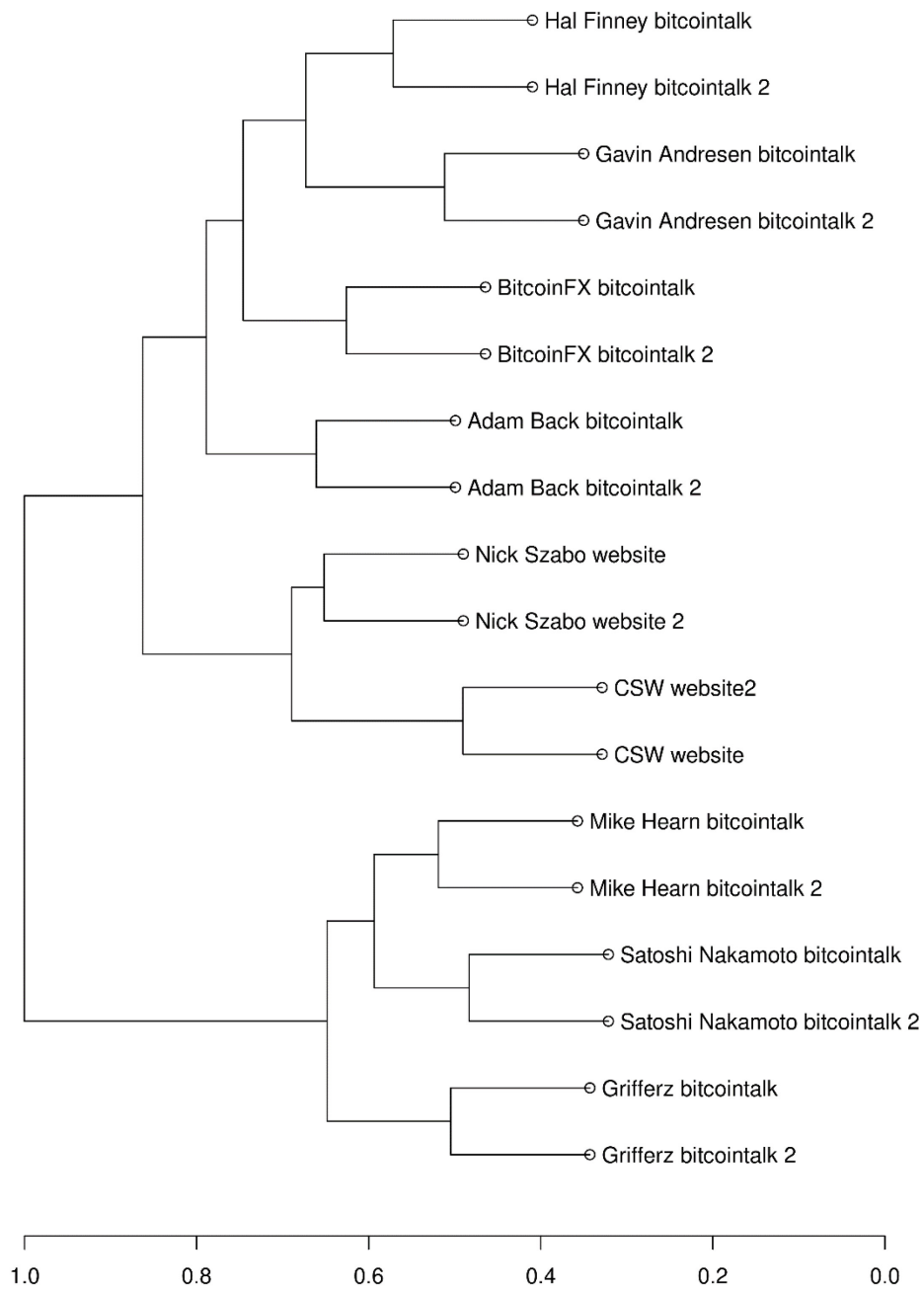
Figure 2.01



*The result of a word 2-gram analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed as a hierarchical clustering dendrogram. The same metrics were used as the ones described in Figure 2a.*

In Figure 2.02, we can see that the two website texts are in the majority branch with Finney, Andresen, BitcoinFX and Back. Mike Hearn and Grifferz share a separate branch with Nakamoto, with Hearn being closer to Nakamoto than Grifferz. The accompanying tSNE map can be found in Chapter 5: Additional Figures, Figure 2.12.

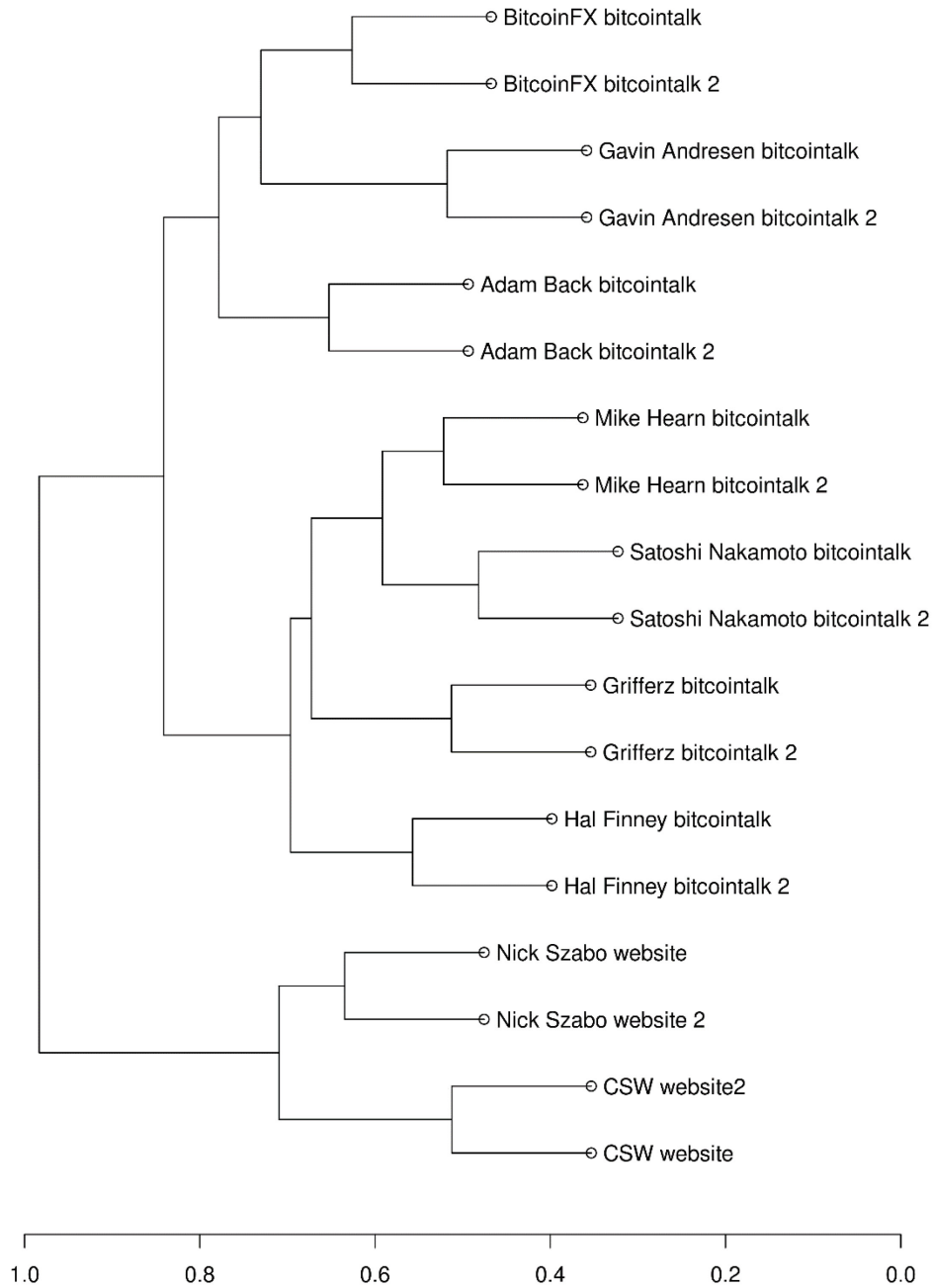
Figure 2.02



The result of a word 2-gram analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed as a hierarchical clustering dendrogram. The same metrics were used as the ones described in Figure 2a.

In Figure 2.03 the closest author to Satoshi Nakamoto is once again Mike Hearn while Szabo and CSW occupy a separate branch. The accompanying tSNE map can be found in Chapter 5: Additional Figures, Figure 2.13.

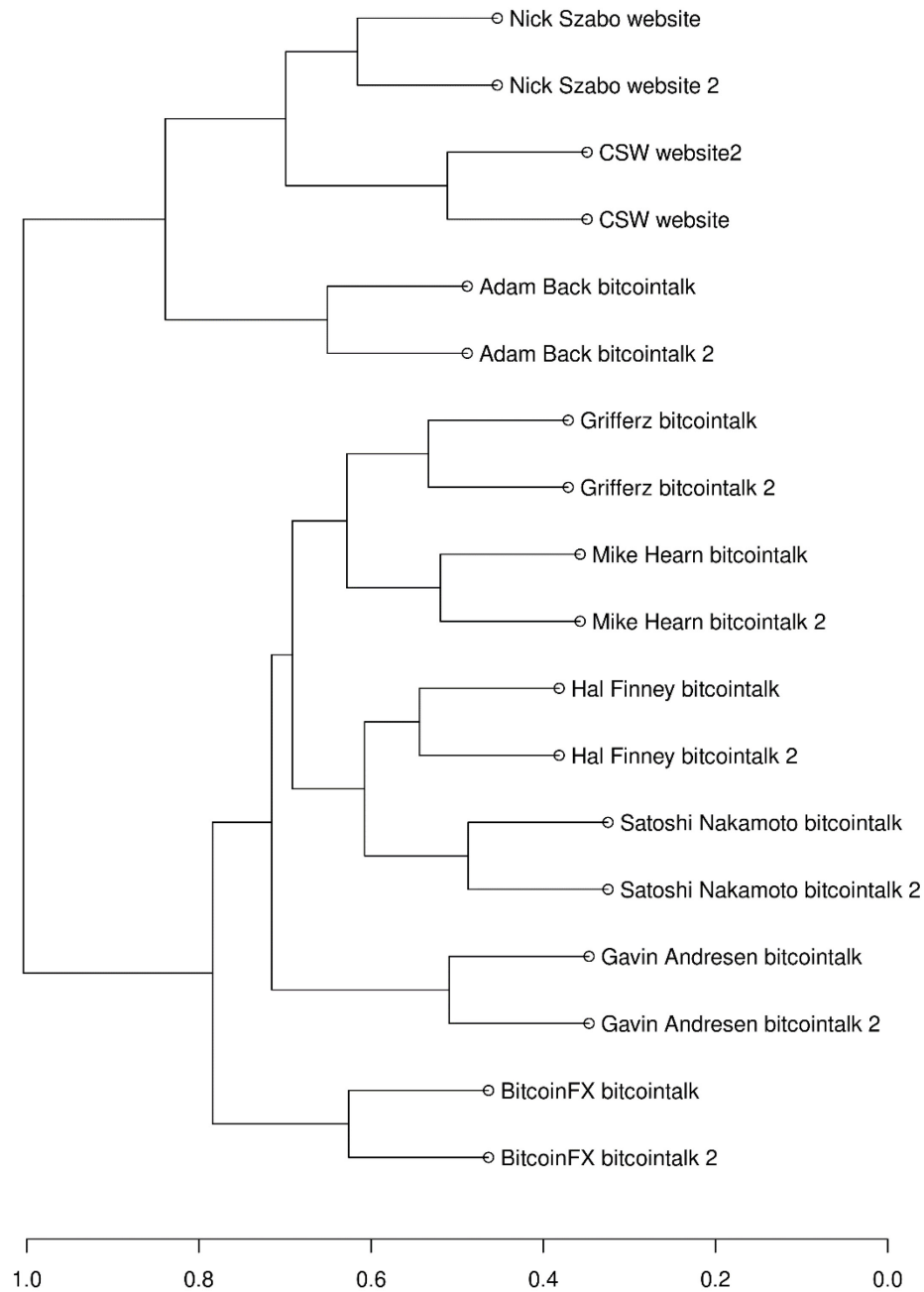
Figure 2.03



*The result of a word 2-gram analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed as a hierarchical clustering dendrogram. The same metrics were used as the ones described in Figure 2a.*

Figure 2.04 shows Szabo and CSW sharing a branch with Back. In the other branch, the closest author to Satoshi Nakamoto is Hal Finney. The accompanying tSNE map can be found in Chapter 5: Additional Figures, Figure 2.14.

Figure 2.04

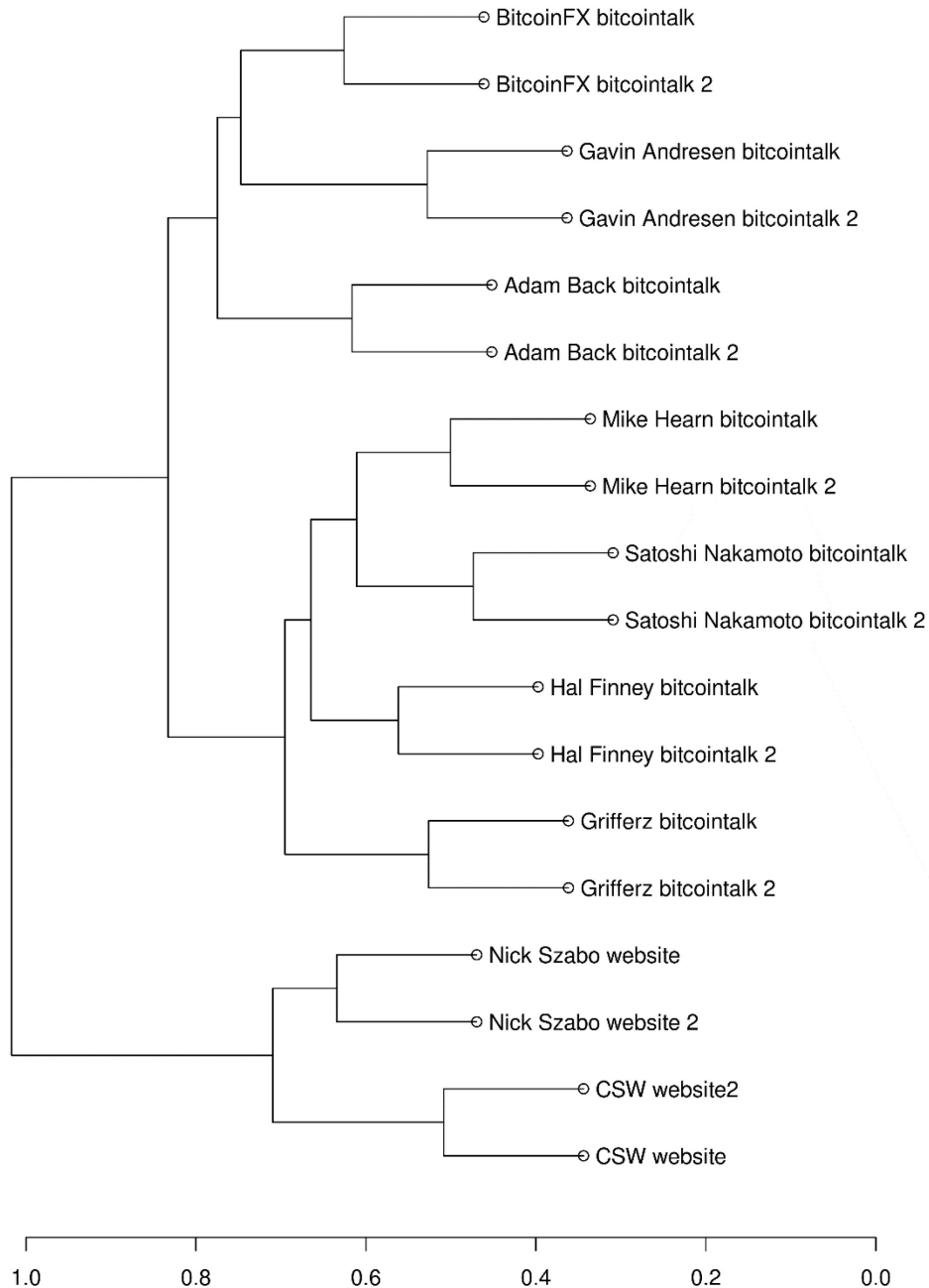


*The result of a word 2-gram analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed as a hierarchical clustering dendrogram. The same metrics were used as the ones described in Figure 2a.*



In Figure 2.05, we can see that the closest to Satoshi Nakamoto is Mike Hearn with Hal Finney following closely behind. Szabo and CSW are relatively distant from the other authors. The accompanying tSNE map can be found in Chapter 5: Additional Figures, Figure 2.15.

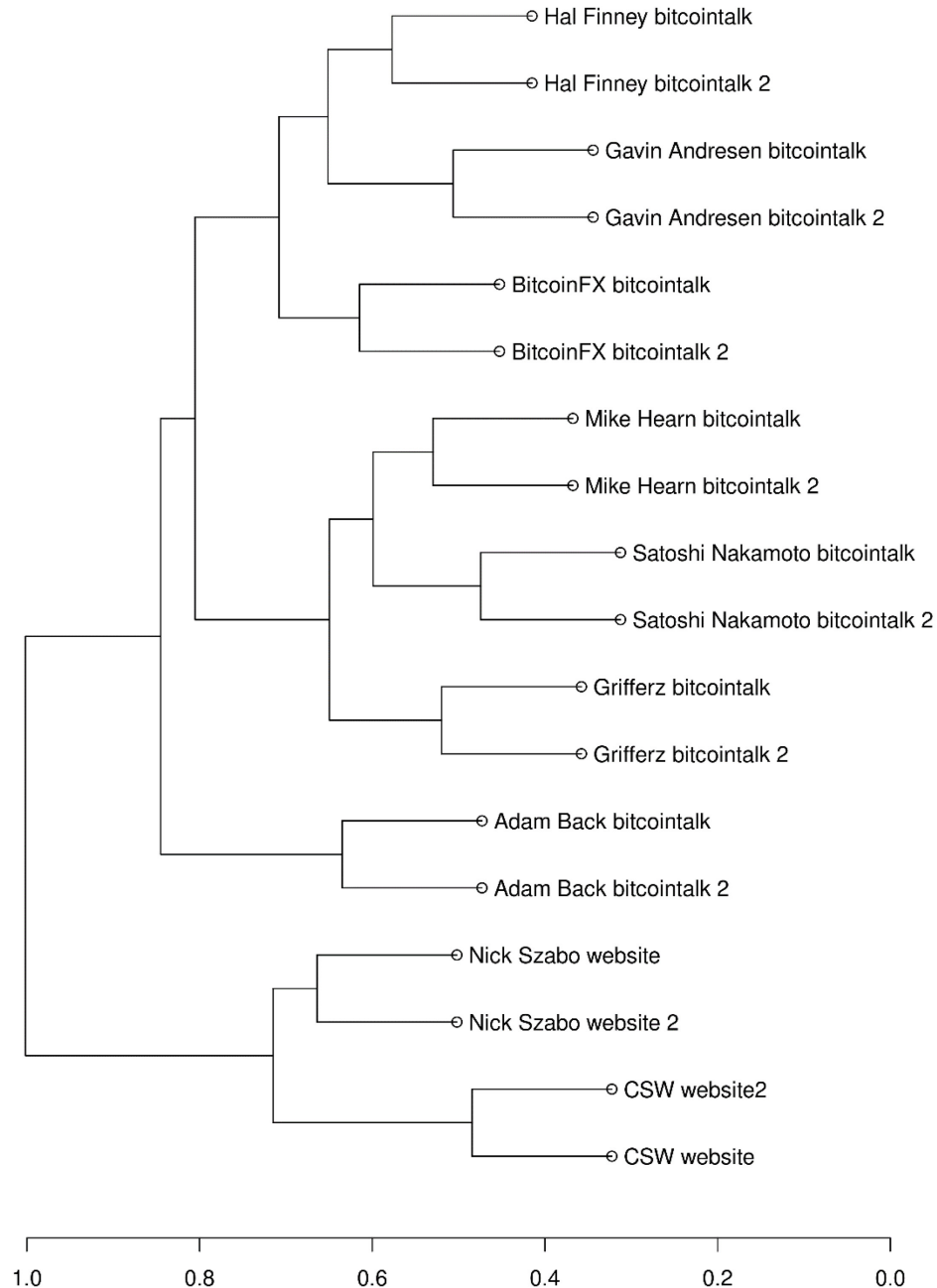
Figure 2.05



*The result of a word 2-gram analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed as a hierarchical clustering dendrogram. The same metrics were used as the ones described in Figure 2a.*

In Figure 2.06, Nakamoto clusters close to Mike Hearn, followed by our control author Grifferz. Szabo and CSW are, once again, clustered on a separate branch. The accompanying tSNE map can be found in Chapter 5: Additional Figures, Figure 2.16.

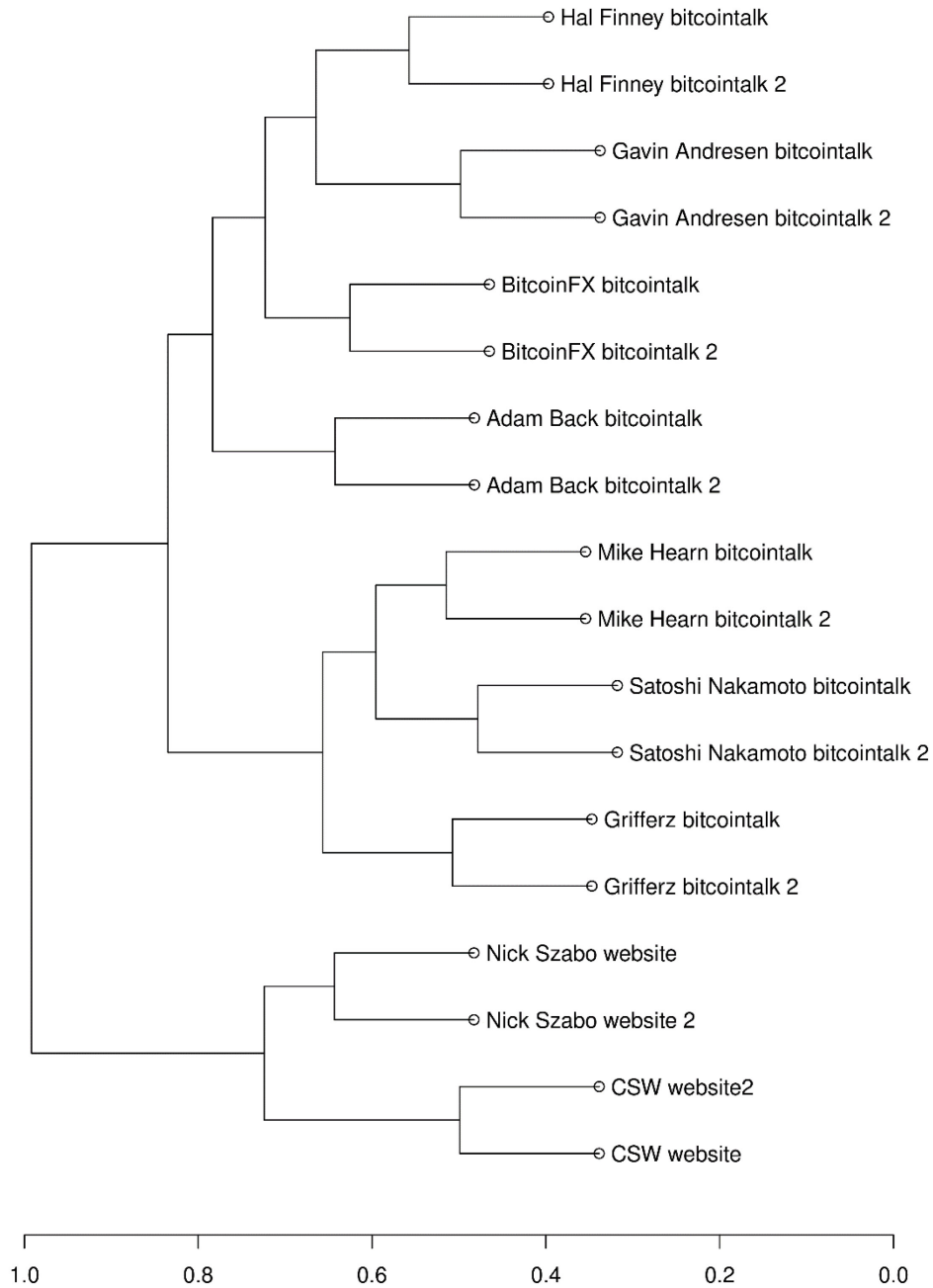
Figure 2.06



*The result of a word 2-gram analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed as a hierarchical clustering dendrogram. The same metrics were used as the ones described in Figure 2a.*

Figure 2.07 shows very similar results to Figure 2.06, the only notable difference being that Back clusters closer to the majority branch. The accompanying tSNE map can be found in Chapter 5: Additional Figures, Figure 2.17.

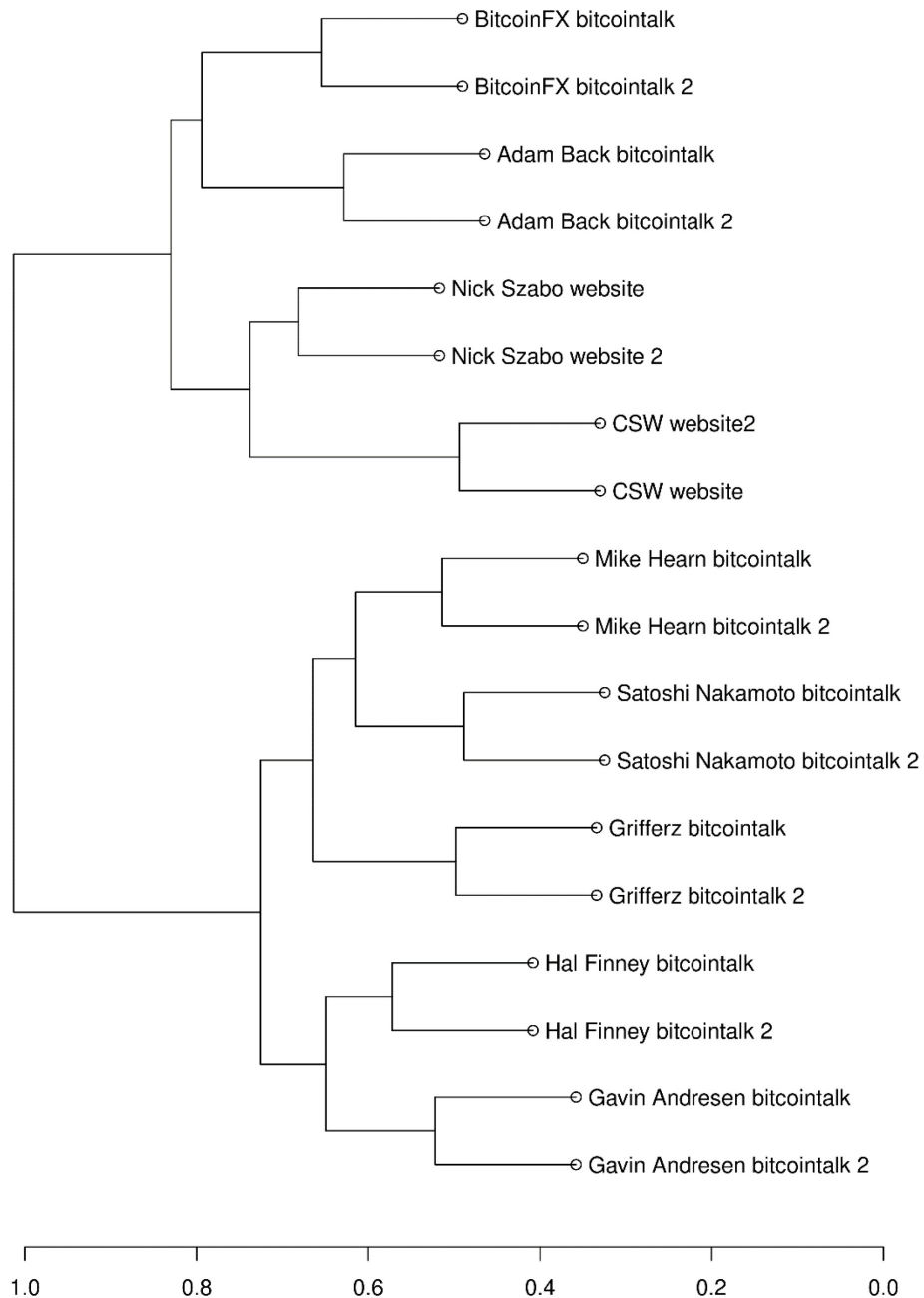
Figure 2.07



*The result of a word 2-gram analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed as a hierarchical clustering dendrogram. The same metrics were used as the ones described in Figure 2a.*

In Figure 2.08, we can see the texts originating from a website once again clustered, and close to them are Adam Back and BitcoinFX. The closest to Satoshi Nakamoto is Mike Hearn. The accompanying tSNE map can be found in Chapter 5: Additional Figures, Figure 2.18.

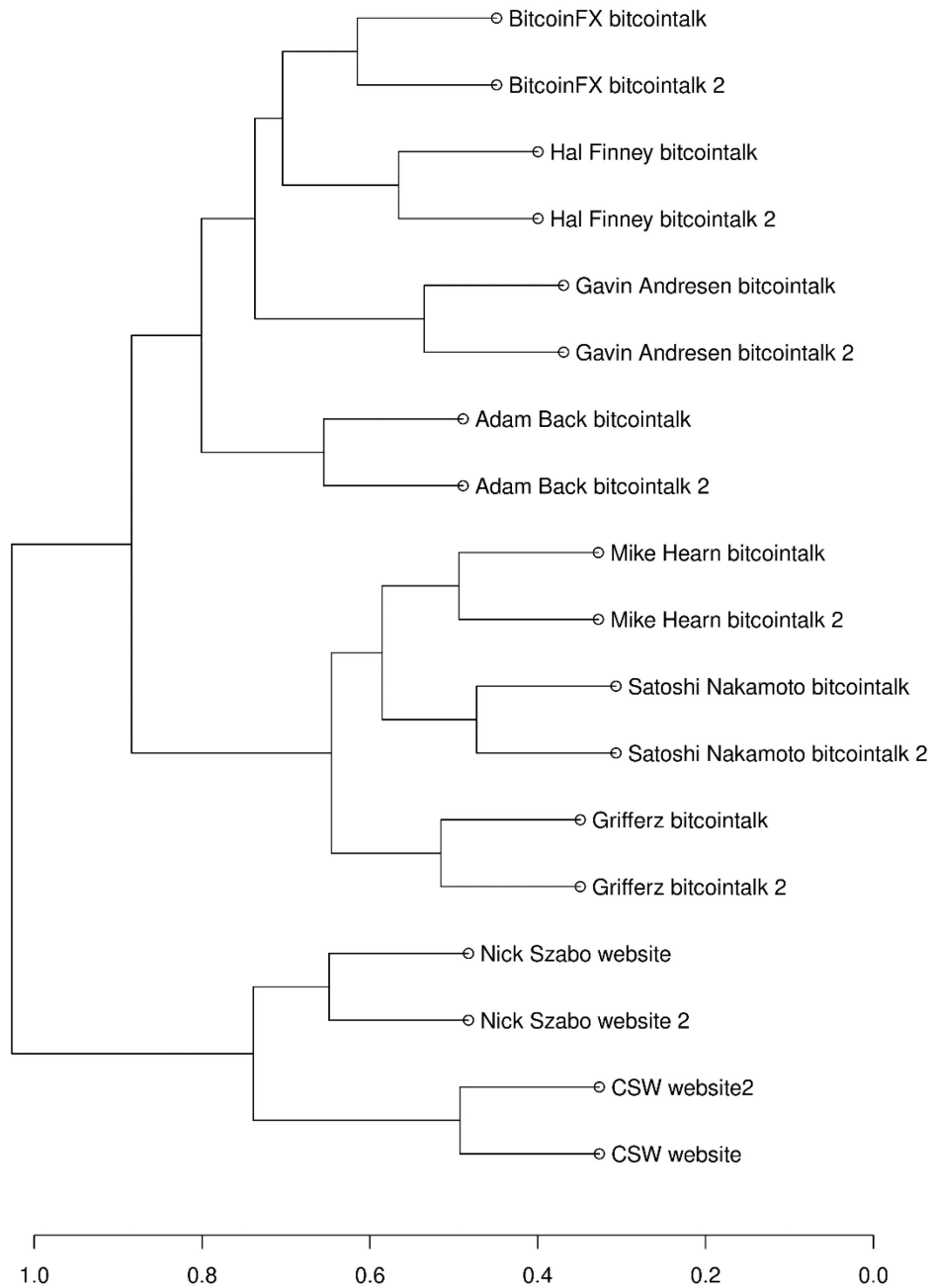
Figure 2.08



*The result of a word 2-gram analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed as a hierarchical clustering dendrogram. The same metrics were used as the ones described in Figure 2a.*

Figure 2.09 portrays Mike Hearn appearing very close to Satoshi Nakamoto. Despite Finney’s proximity not being immediately visible, the accompanying tSNE map (Figure 2.19), shows that he follows closely after.

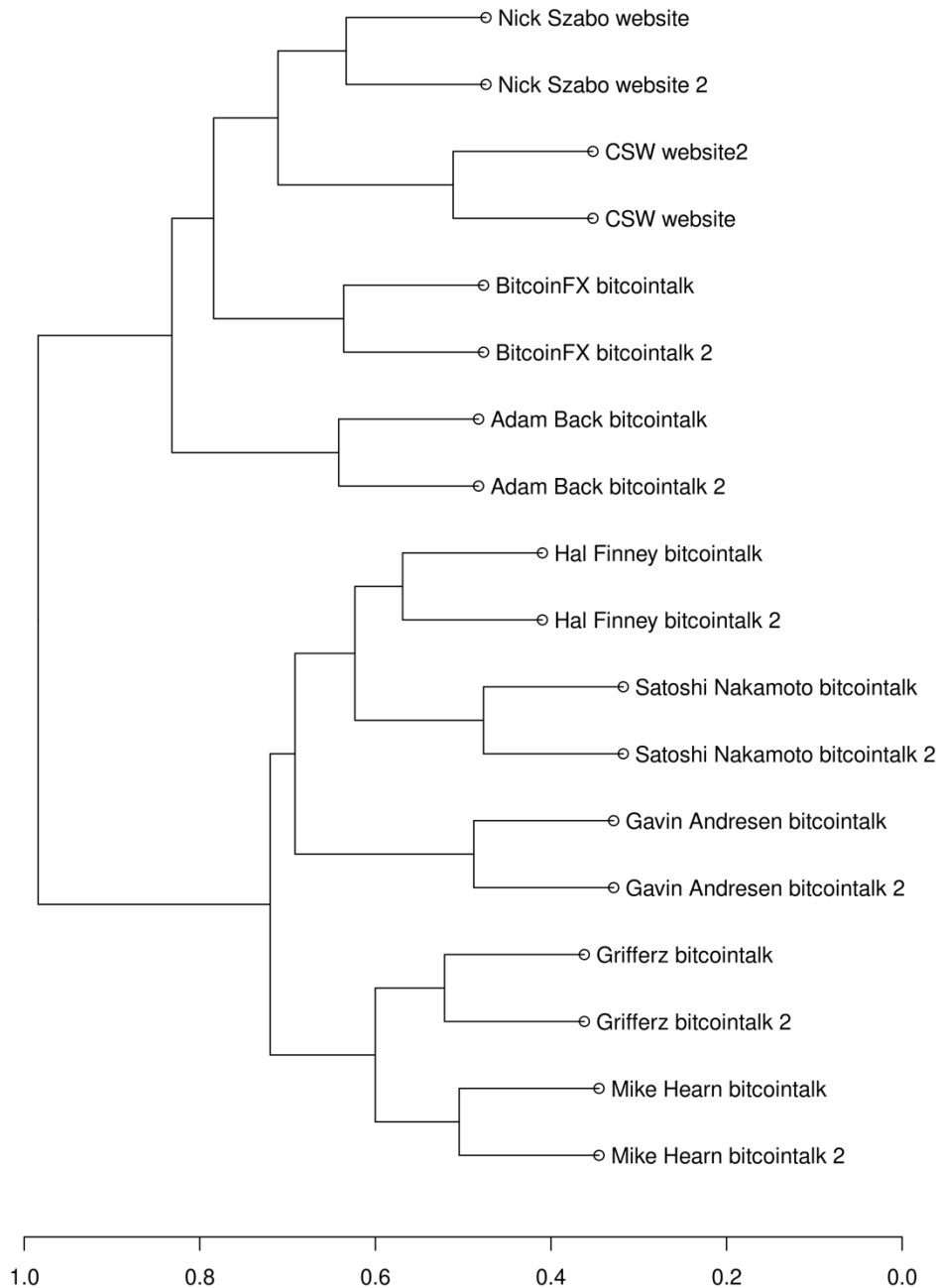
Figure 2.09



*The result of a word 2-gram analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed as a hierarchical clustering dendrogram. The same metrics were used as the ones described in Figure 2a.*

In Figure 2.10 Nick Szabo and CSW are again on the same branch as BitcoinFX and Adam Back. Satoshi Nakamoto appears to be the closest to Hal Finney. The accompanying tSNE map can be found in Chapter 5: Additional Figures, Figure 2.20.

Figure 2.10



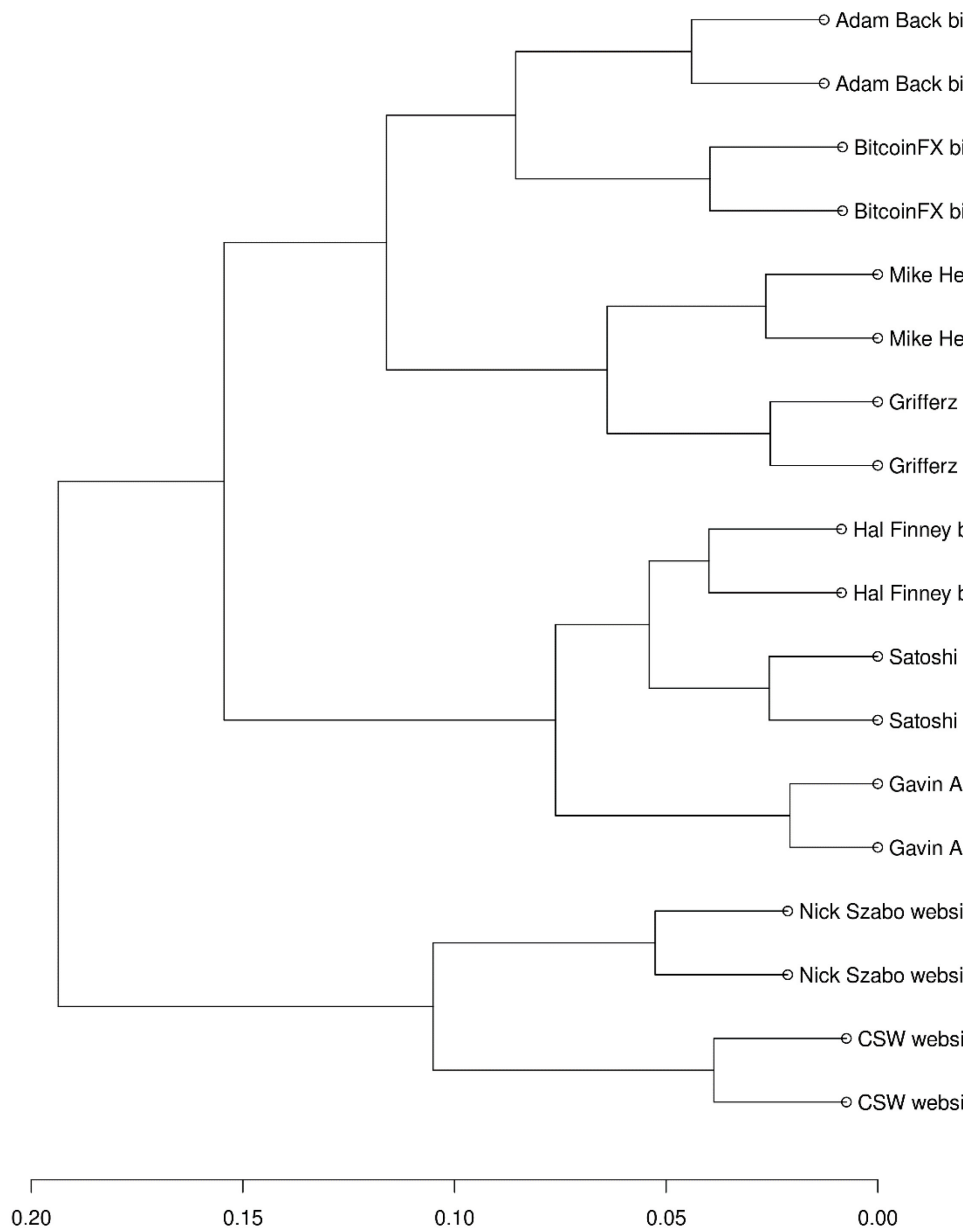
*The result of a word 2-gram analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed as a hierarchical clustering dendrogram. The same metrics were used as the ones described in Figure 2a.*

Due to the apparent distance between website and forum clusters, we can assume that the n-gram word analysis is more dependent on style than the hapax method, as that is the most apparent difference between the texts that clustered separately. The website articles by Nick Szabo and Craig Steven Wright are composed of longer sentences and the register is arguably more formal. The articles' style is more akin to academic writing than to the rather spontaneous and casual content of the forums. Despite this, we were able to see the continuous trend of Finney's and Hearn's similarity to Nakamoto, with 8 out of 10 results indicating Mike Hearn's proximity to Nakamoto, with the only exceptions being Figures 2.04 and 2.10, where Hal Finney is the one who appears the closest to Nakamoto. In these two cases, Mike Hearn still remains nearby. It is also notable that several times, BitcoinFX clustered very close to Nakamoto, Hearn and Finney – this is especially visible in the tSNE maps in Figures 2.01, 2.04, 2.05 and 2.07. Despite the undeniable proximity of Finney and Hearn to Nakamoto, we have seen no real overlaps when applying word 2-gram analysis. According to our current knowledge, the texts continue to cluster accurately.

#### **2.4.2 Character 3-grams**

I will continue my n-gram analysis with character 3-grams. Just like previously, I will be using QUITA and present the results in form of hierarchical clustering dendrograms and tSNE maps. Cosine dissimilarity will be used to compare all 18 plain text files, first without any reduction (Figures 3a & 3b).

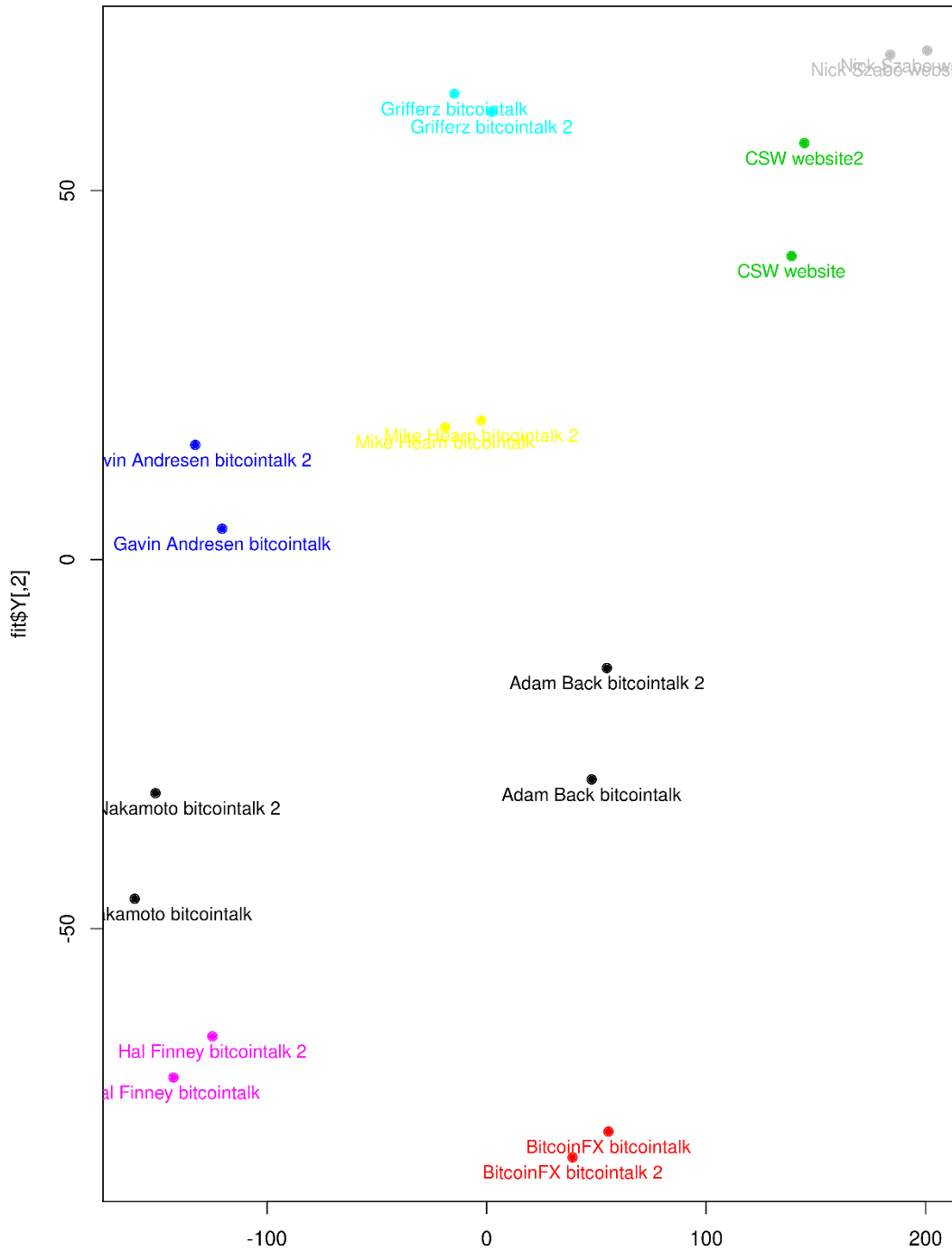
Figure 3a



*The result of a character 3-gram analysis of all 18 samples from 9 authors, tokenized and unreduced, portrayed as a hierarchical clustering dendrogram. Cosine dissimilarity was used to calculate the differences between each author. The samples on one branch are the closest to each other, increased dissimilarity is portrayed by higher amounts of branch divisions between samples (e.g., Adam Back and CSW).*



Figure 3b



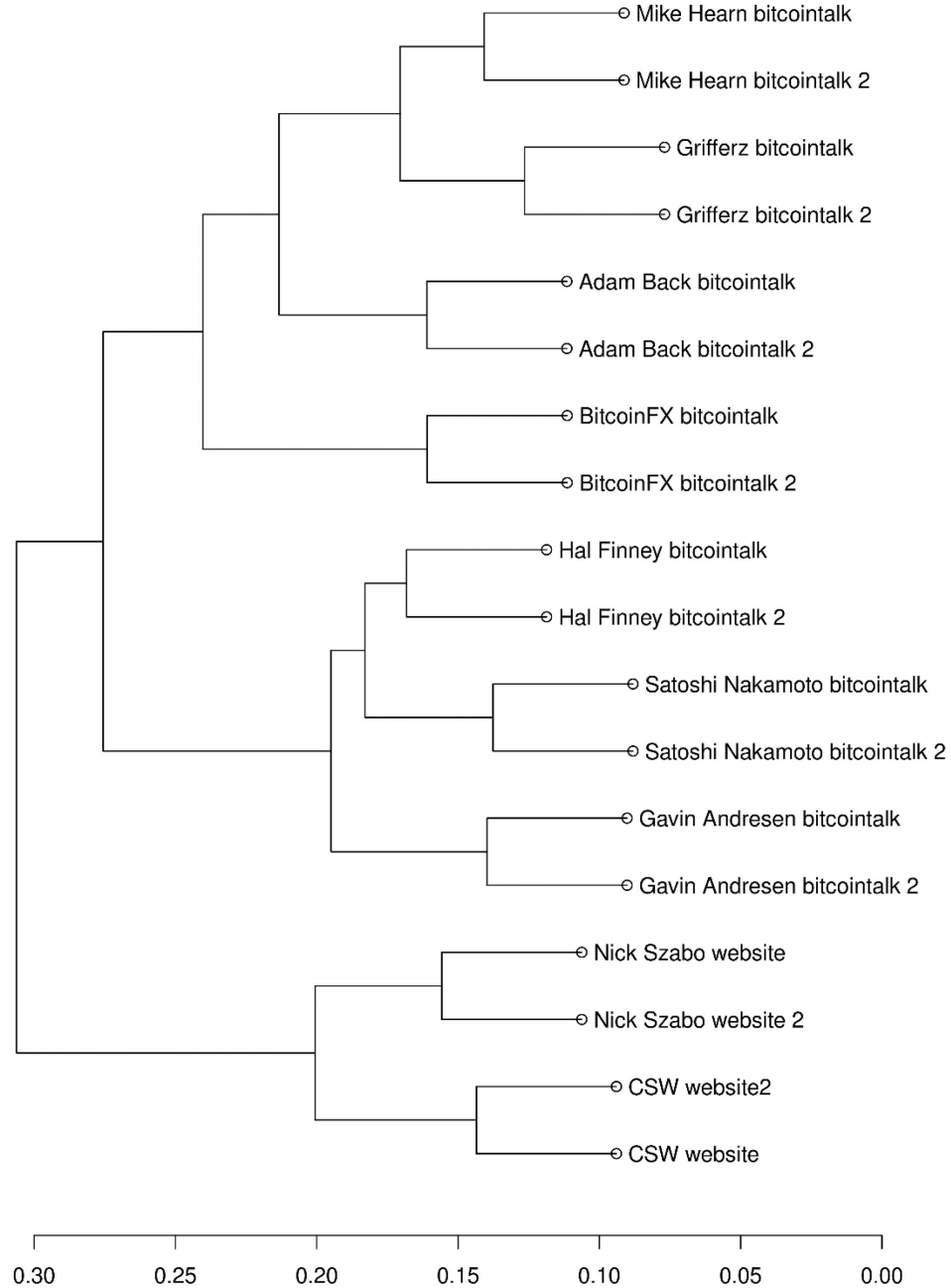
The result of a character 3-gram analysis of all 18 samples from 9 authors, tokenized and unreduced, portrayed by *t*-distributed stochastic neighbor embedding. Cosine dissimilarity was used to calculate the differences between each author. The samples closest to each other on the 2-dimensional map (i.e., that are clustered) are the most similar. Increased dissimilarity is portrayed by greater distance on the map (e.g., Grifferz and Hal Finney).

Just like in our earlier analyses, we can see that the websites' content seems to be noticeably far away from the rest of the authors, but the tSNE map shows that the distance is not quite as great as it was with word 2-grams (Figure 2b). Grifferz appears to cluster relatively close to CSW and Szabo. All the authors continue to cluster correctly with no two authors directly overlapping. The closest to Satoshi Nakamoto is Hal Finney.

I repeated the character 3-gram analysis 10 times with 5,000 randomly selected tokens. This time, no apparent overlaps of different authors were observed. 10 out of 10 of our analyses showed Hal Finney appearing very close to Nakamoto, with one showing Satoshi Nakamoto's texts clustering together with Finney (Figure 3.06) and one where Gavin Andresen clusters slightly closer to Nakamoto than Finney does (3.09). All the results are below. I will continue to focus on the dendrograms, with tSNE maps belonging to them show in Chapter 5: **Additional Figures**.

In Figure 3.01, we can see no irregularities or overlaps. Hal Finney appears the closest to Satoshi Nakamoto, with Gavin Andresen following closely behind. Nick Szabo and CSW form a separate branch. The accompanying tSNE map can be found in Chapter 5: Additional Figures, Figure 3.11.

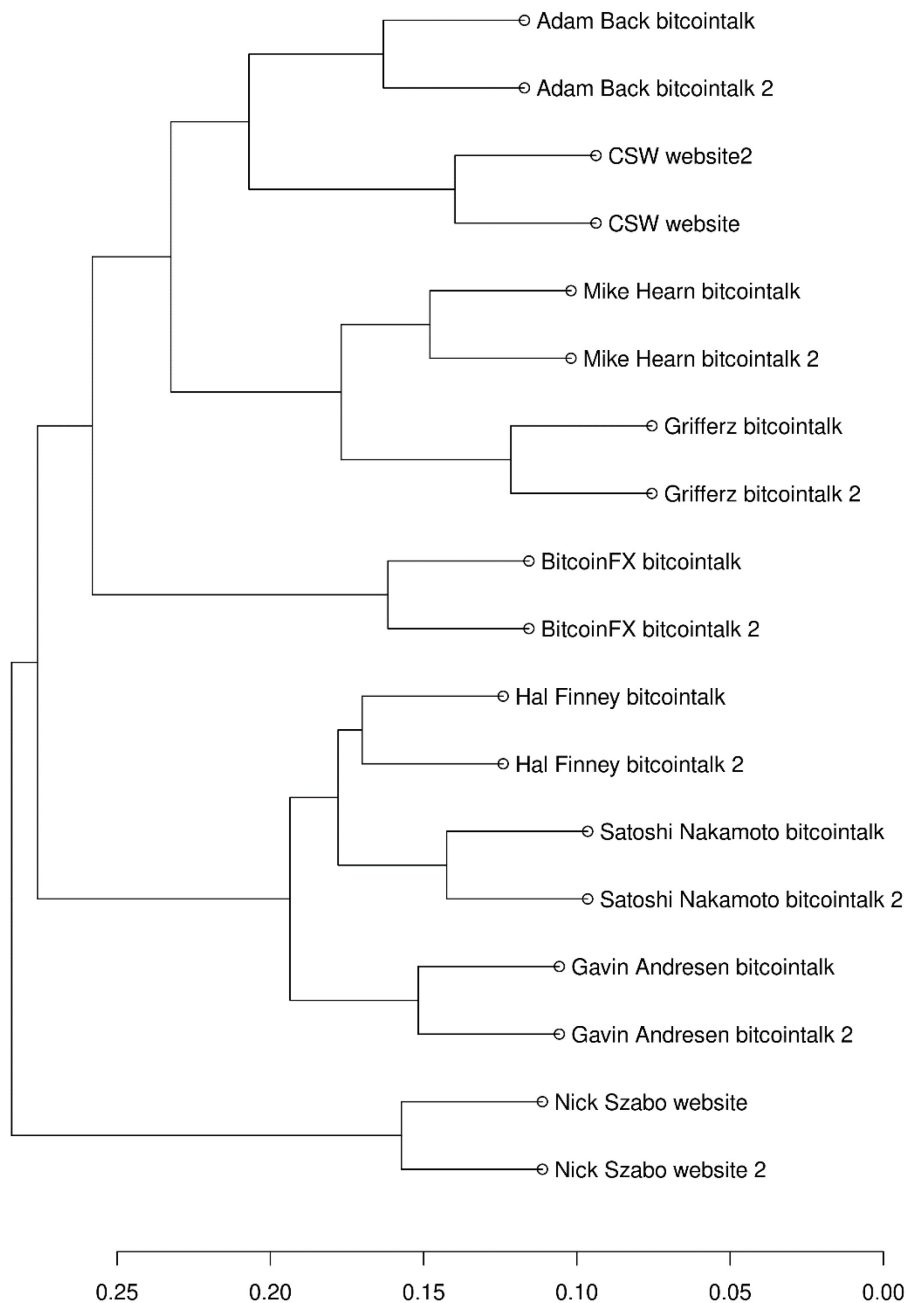
Figure 3.01



*The result of a character 3-gram analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed as a hierarchical clustering dendrogram. The same metrics were used as the ones described in Figure 3a.*

Figure 3.02, similarly to the previous one, shows Finney clustering the closest to Nakamoto, with Andresen following closely behind. Szabo and CSW do not appear significantly distant from the other authors and there are no overlaps of multiple authors. The accompanying tSNE map can be found in Chapter 5: Additional Figures, Figure 3.12.

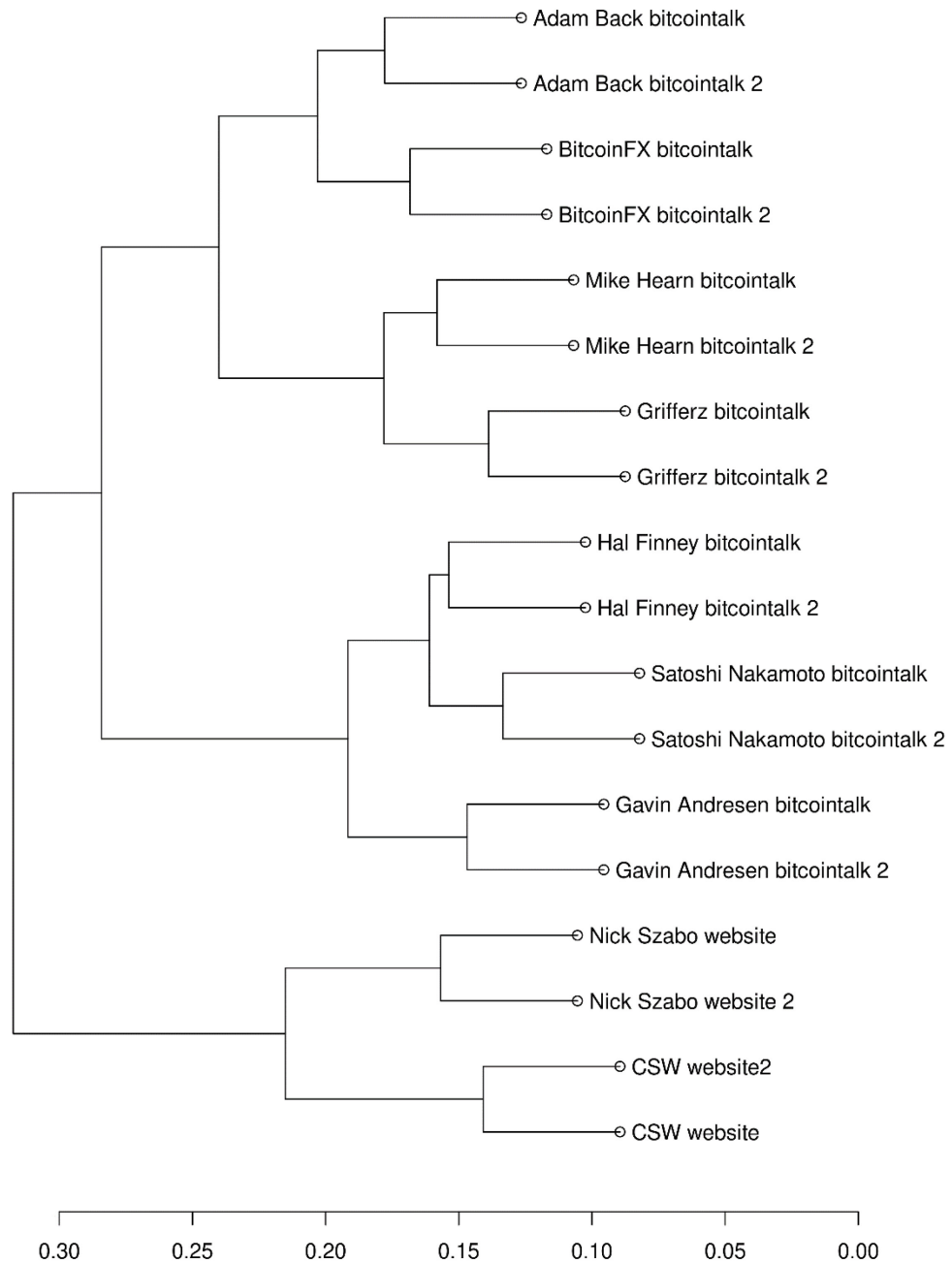
Figure 3.02



*The result of a character 3-gram analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed as a hierarchical clustering dendrogram. The same metrics were used as the ones described in Figure 3a.*

In Figure 3.03, Finney, once again, clusters very close to Nakamoto, sharing a branch with Andresen. Szabo and CSW form a separate branch. There are no overlaps or irregularities. The accompanying tSNE map can be found in Chapter 5: Additional Figures, Figure 3.13.

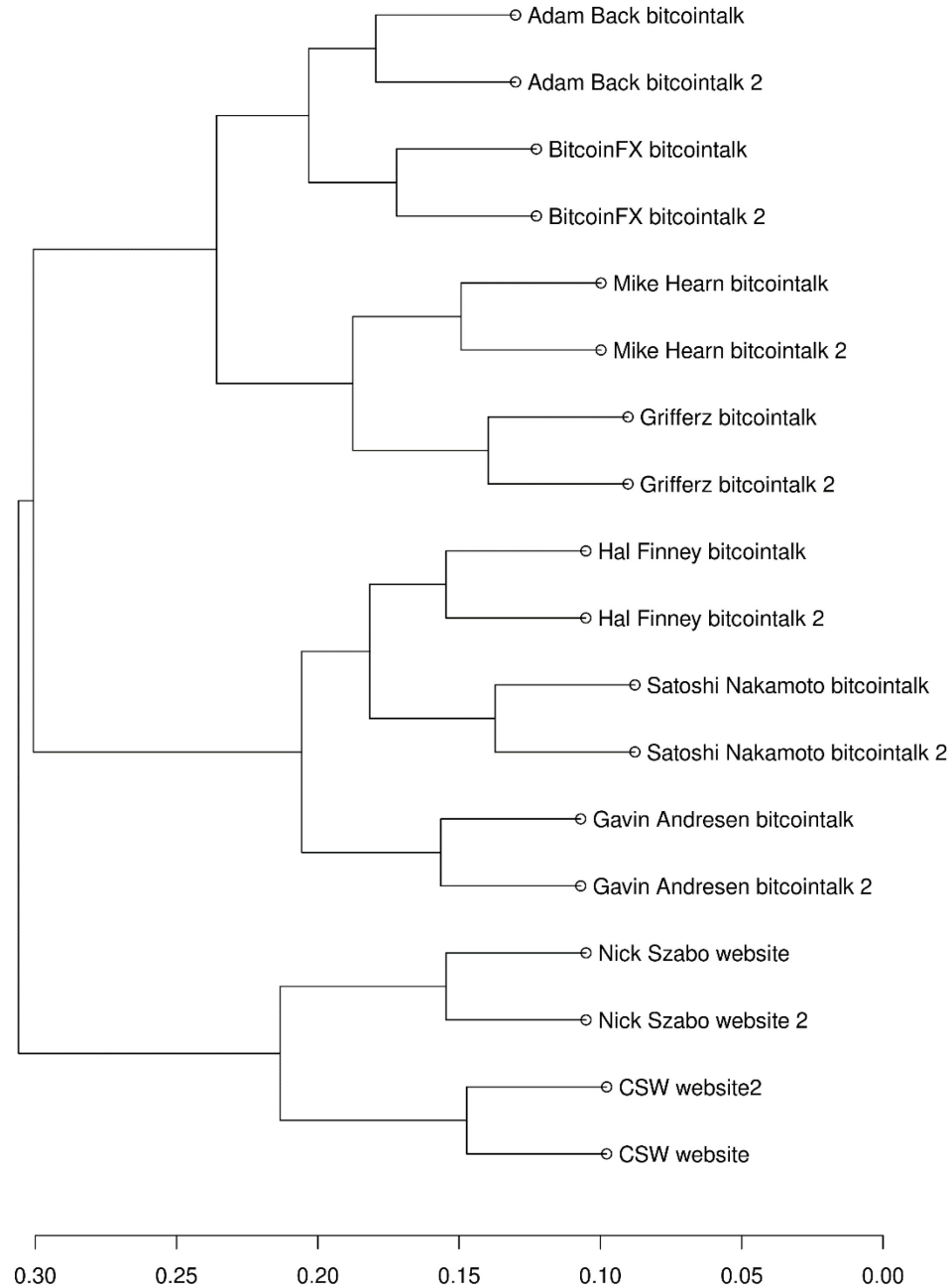
Figure 3.03



The result of a character 3-gram analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed as a hierarchical clustering dendrogram. The same metrics were used as the ones described in Figure 3a.

In Figure 3.04, Finney clusters very close to Nakamoto as Andresen follows closely behind. Szabo and CSW form a separate branch. We can see no overlaps of multiple authors. The accompanying tSNE map can be found in Chapter 5: Additional Figures, Figure 3.14.

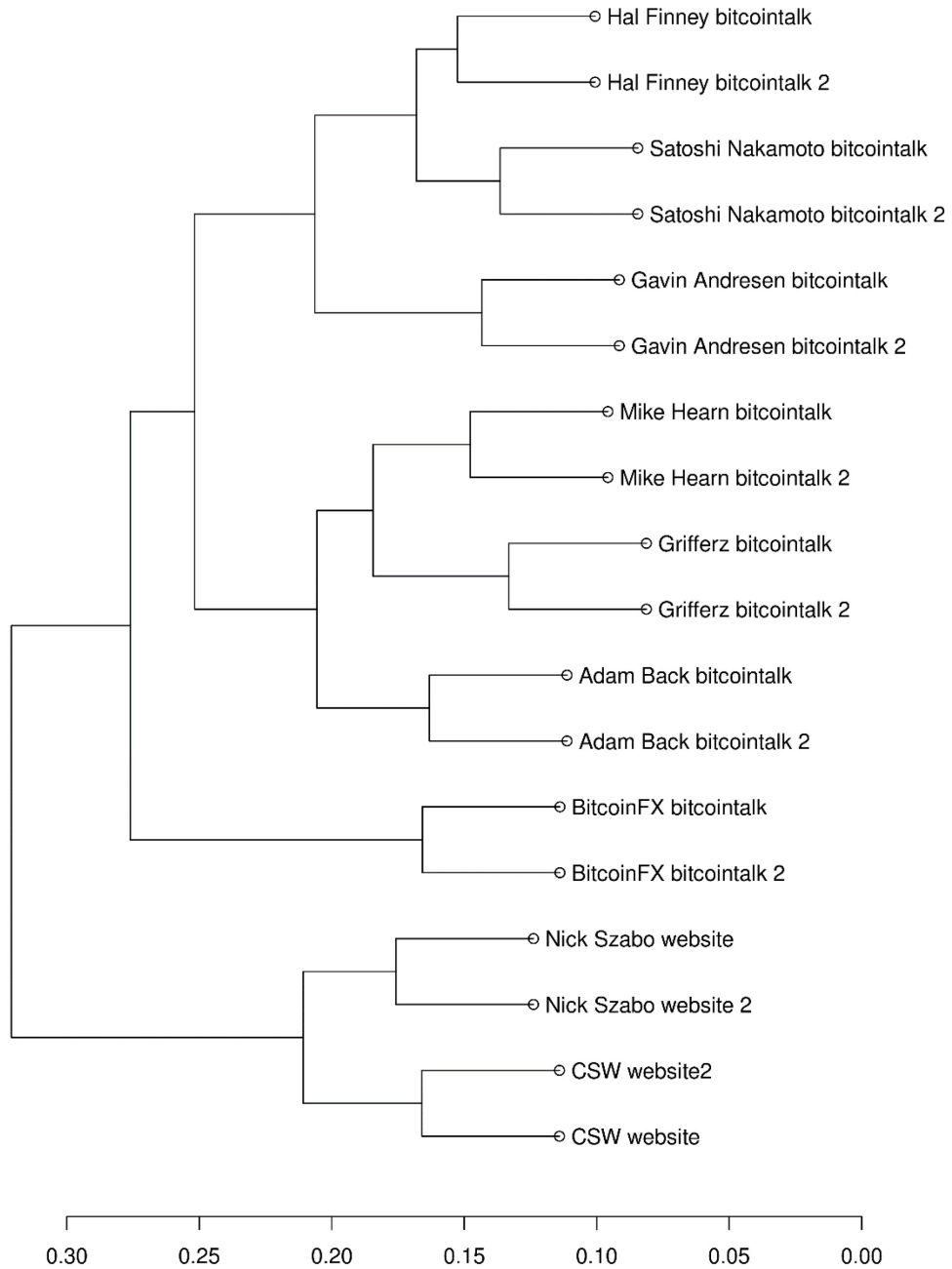
Figure 3.04



*The result of a character 3-gram analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed as a hierarchical clustering dendrogram. The same metrics were used as the ones described in Figure 3a.*

In Figure 3.05, Finney and Nakamoto continue to appear close together, followed by Andresen. Szabo and CSW form a separate branch. We can see no overlaps of multiple authors. The accompanying tSNE map can be found in Chapter 5: Additional Figures, Figure 3.15.

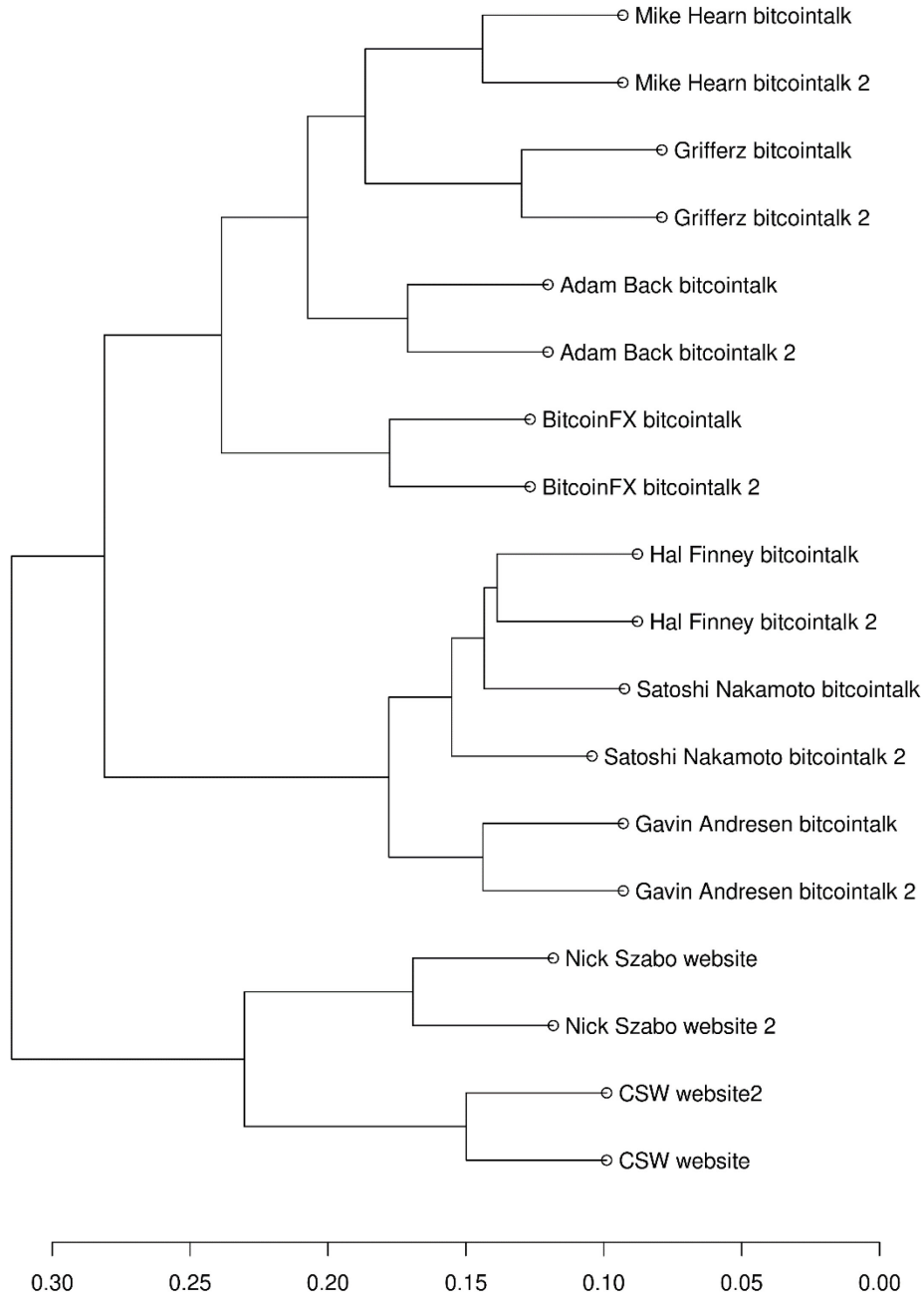
Figure 3.05



*The result of a character 3-gram analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed as a hierarchical clustering dendrogram. The same metrics were used as the ones described in Figure 3a.*

Figure 3.06 shows Nakamoto, Finney and Andresen form a distinctive branch. While Andresen remains distinct from the other two, one of Nakamoto's samples appears closer to Finney than to its counterpart. Once again, Szabo and CSW form a separate branch. The accompanying tSNE map can be found in Chapter 5: Additional Figures, Figure 3.16.

Figure 3.06

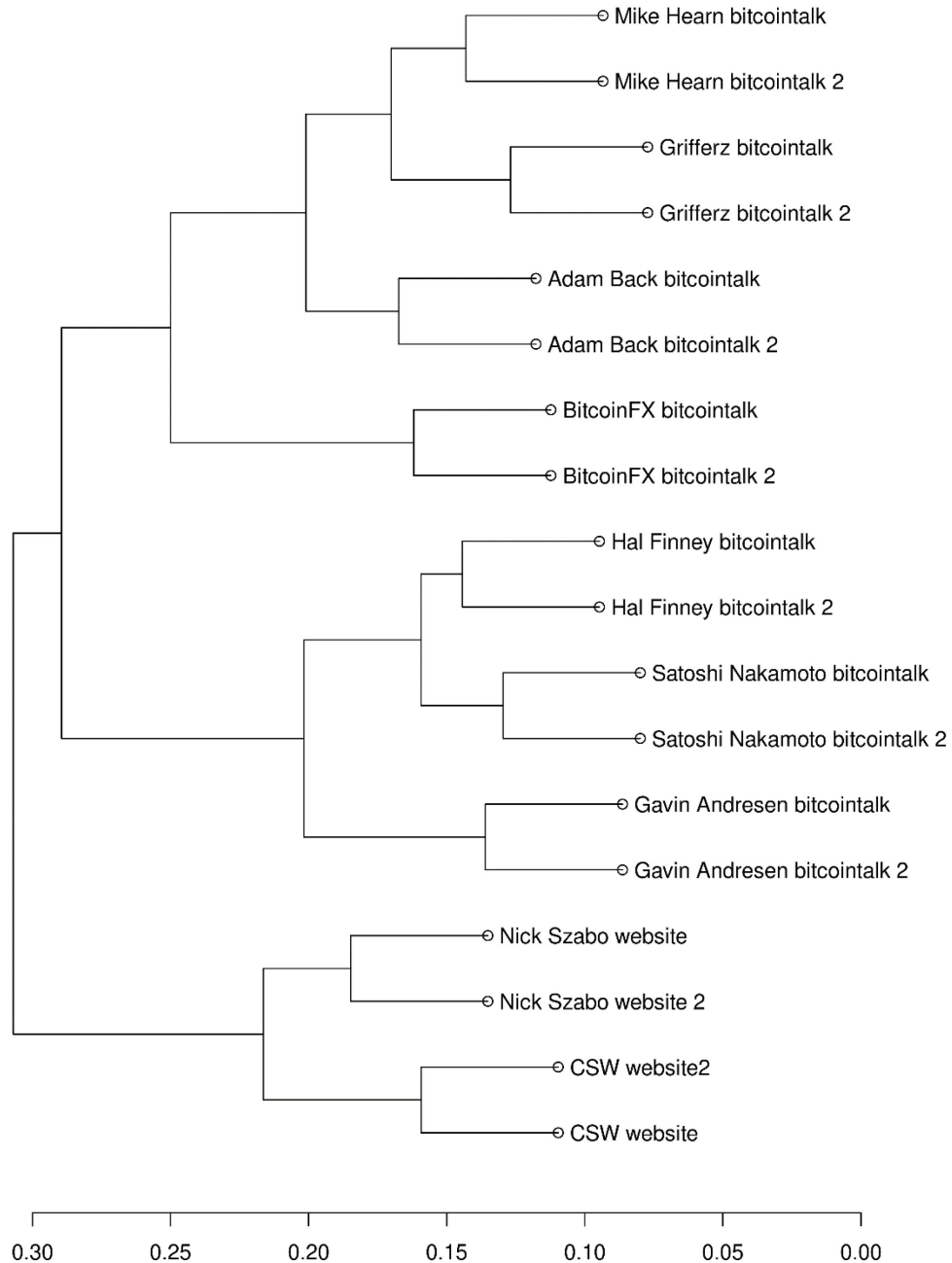


The result of a character 3-gram analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed as a hierarchical clustering dendrogram. The same metrics were used as the ones described in Figure 3a.



In Figure 3.07, we can see no irregularities or overlaps. Hal Finney appears the closest to Satoshi Nakamoto, with Gavin Andresen, much like in previous instances, following closely behind. Nick Szabo and CSW form a separate branch. The accompanying tSNE map can be found in Chapter 5: Additional Figures, Figure 3.17.

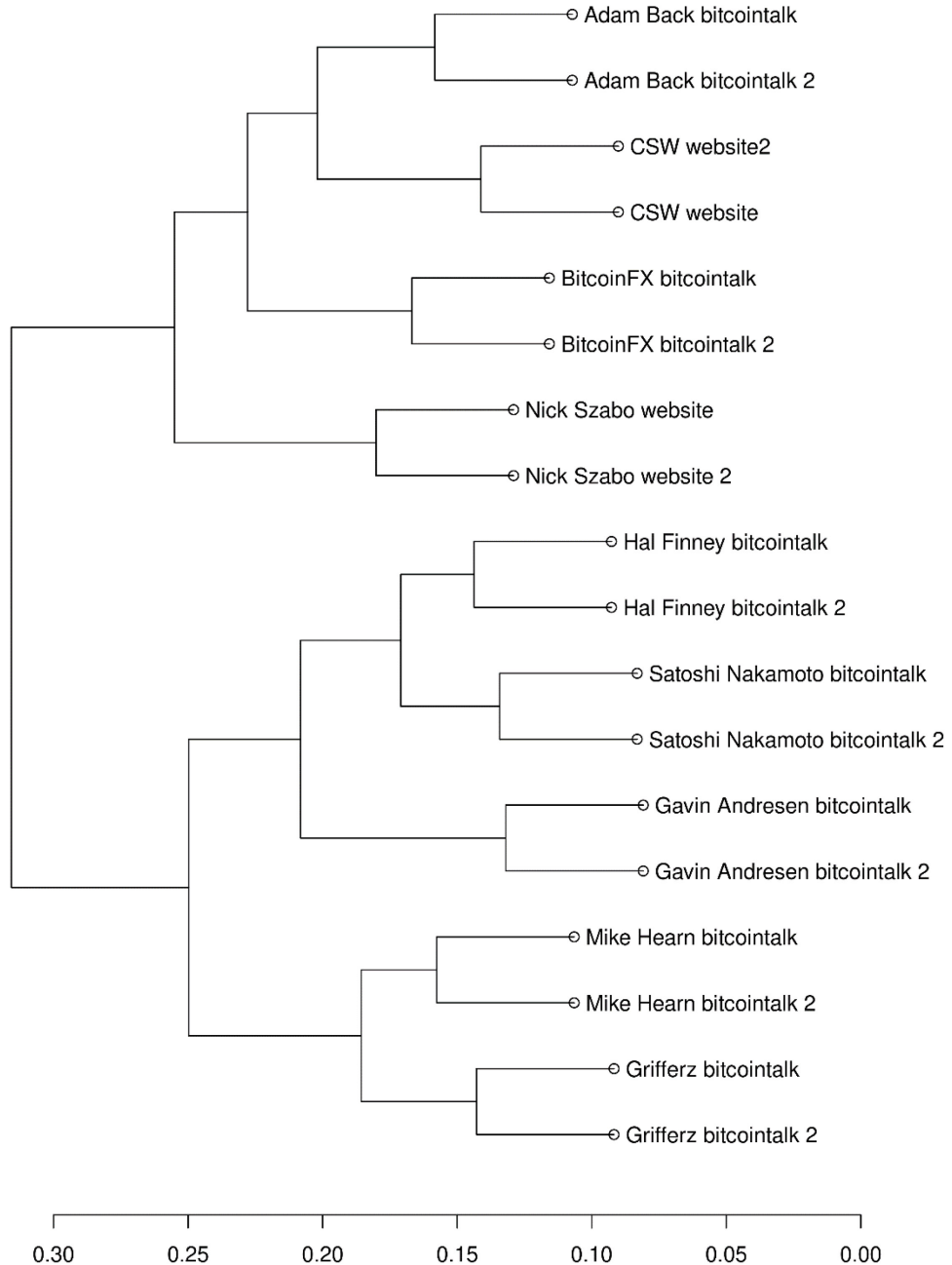
Figure 3.07



The result of a character 3-gram analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed as a hierarchical clustering dendrogram. The same metrics were used as the ones described in Figure 3a.

Figure 3.08, shows Hal Finney clustering the closest to Nakamoto, followed by Gavin Andresen. Nick Szabo and CSW do not appear significantly distant from the other authors and there are no apparent overlaps. The accompanying tSNE map can be found in Chapter 5: Additional Figures, Figure 3.18.

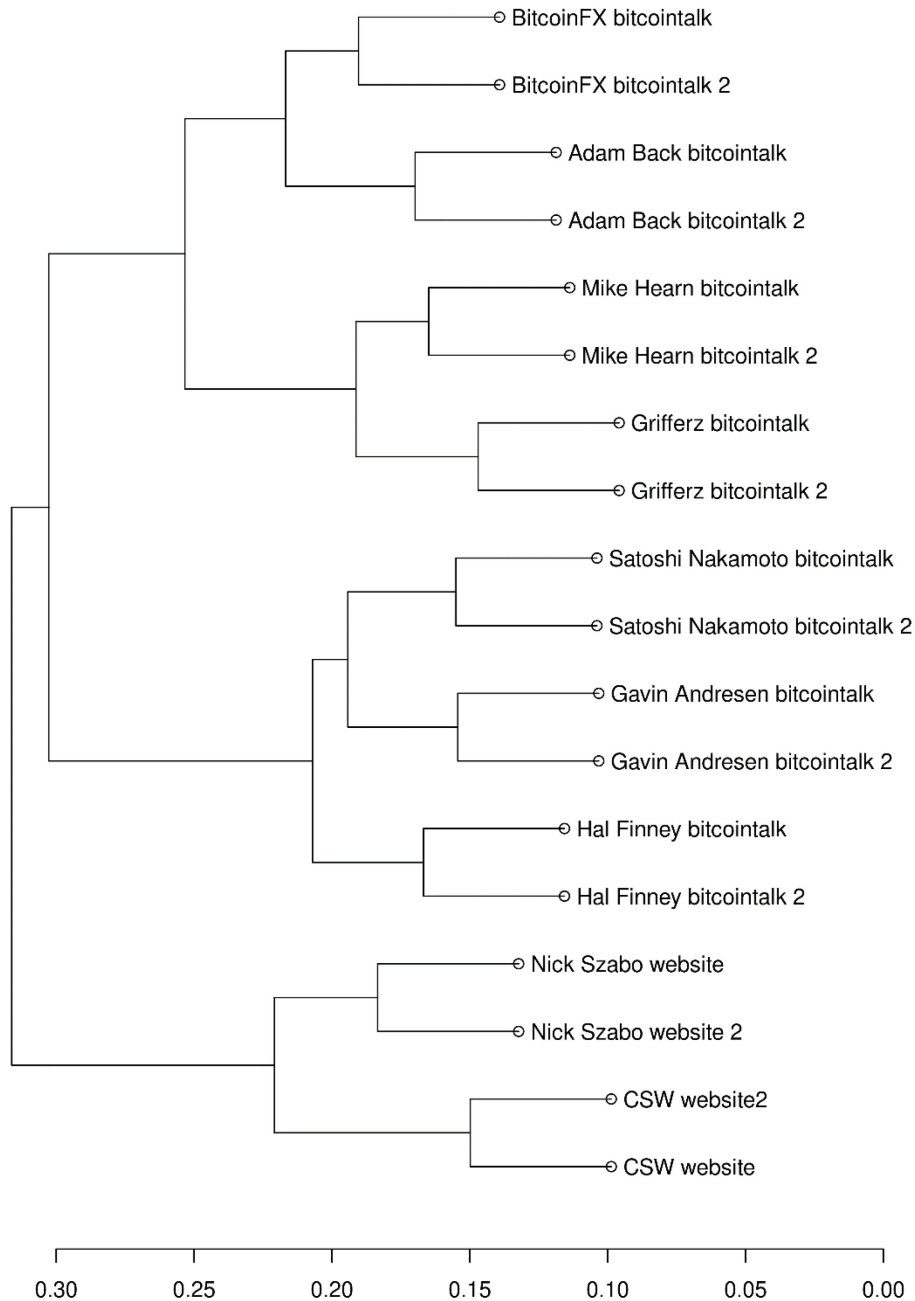
Figure 3.08



*The result of a character 3-gram analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed as a hierarchical clustering dendrogram. The same metrics were used as the ones described in Figure 3a.*

In Figure 3.09, for the first time we see Gavin Andresen cluster closer to Nakamoto, with Hal Finney being the second closest. Nick Szabo and CSW form a separate branch. The accompanying tSNE map can be found in Chapter 5: Additional Figures, Figure 3.19.

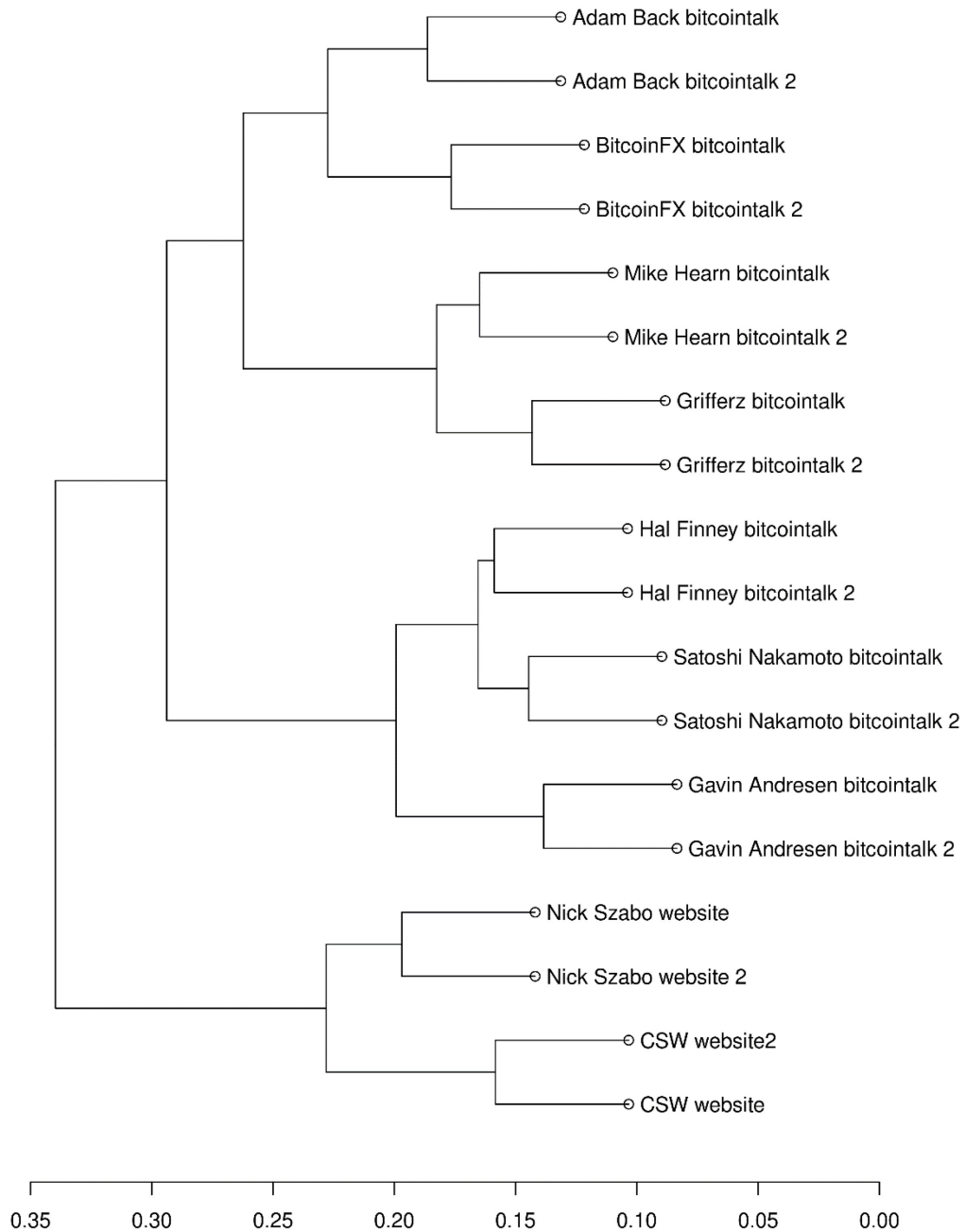
Figure 3.09



The result of a character 3-gram analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed as a hierarchical clustering dendrogram. The same metrics were used as the ones described in Figure 3a.

In Figure 3.10, we can see Hal Finney once again considerably closer to Nakamoto than Gavin Andresen. There are no overlaps or irregularities. Nick Szabo and CSW form a separate branch. The accompanying tSNE map can be found in Chapter 5: Additional Figures, Figure 3.20

Figure 3.10



The result of a character 3-gram analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed as a hierarchical clustering dendrogram. The same metrics were used as the ones described in Figure 3a.

This wave of analyses has brought us some interesting results. 8 out of 10 times, CSW and Szabo appeared by themselves on a different branch from everyone else, showcasing, once again, that the writing style seems to affect the n-gram method of authorship attribution. Hal Finney continues to appear very close to Satoshi Nakamoto, but we have also seen Gavin Andresen start appearing much closer while Mike Hearn recedes further. 9 out of 10 times, Finney clustered the closest to Nakamoto out of all the other authors, getting so close as to overlap, as portrayed in Figure 3.06. Gavin Andresen followed very close behind Finney in every instance, and in Figure 3.09, he appears the closest to Nakamoto while Finney takes the second place.

Much like the 2-gram word analyses, the character 3-grams seem to be dependent on stylistic factors. While this means that we cannot take the dissimilarity of CSW and Nick Szabo at face value, the correct clustering of all the authors without any unexpected overlaps lend credence to the results thus far.

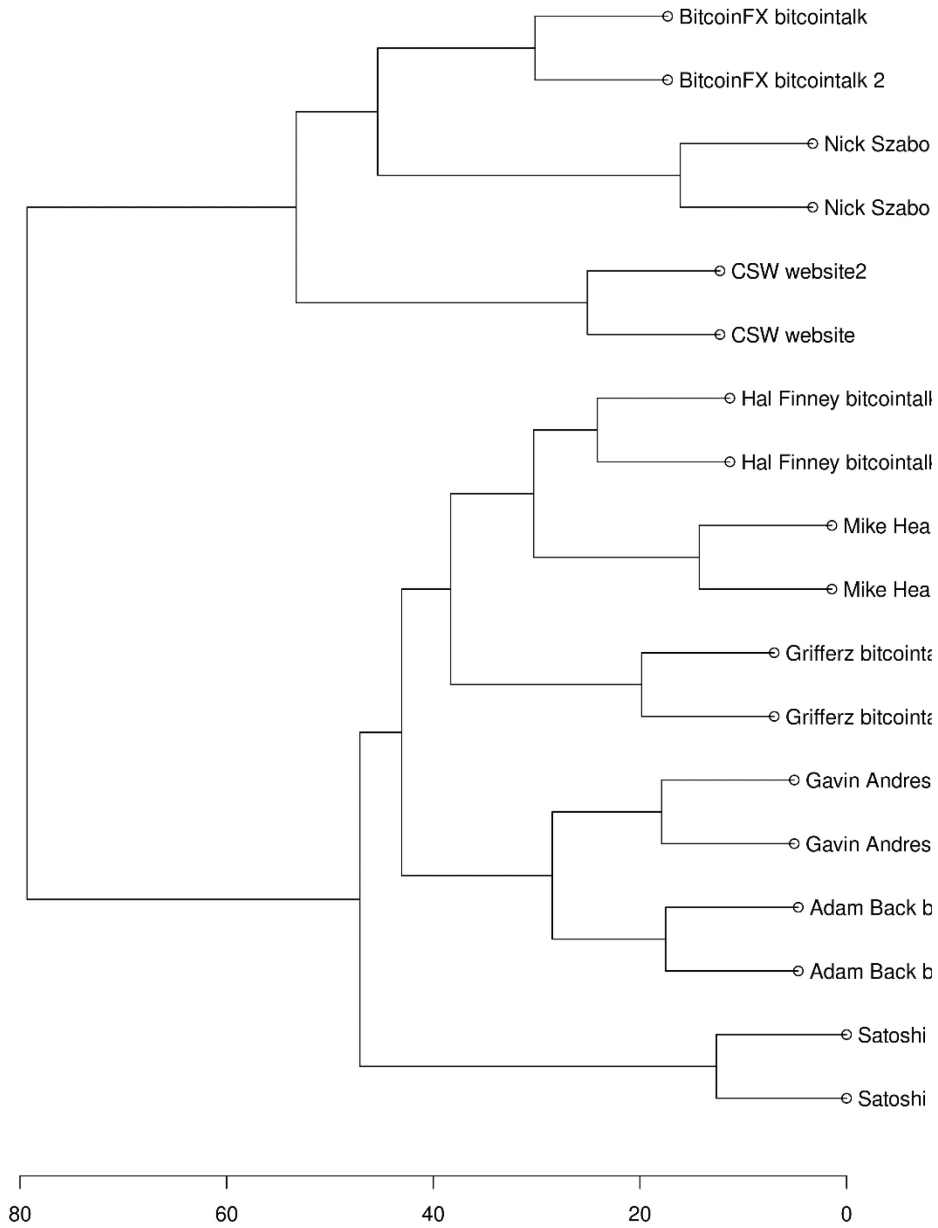
## 2.5 Function words

Function words are a category of words that carry very little meaning by themselves but instead serve as syntactic or semantic connectors. These are by default the most commonly used words in the English language, and they can be prepositions, pronouns, conjunctions, particles, or auxiliary verbs. Their potential use in authorship attribution was successfully demonstrated by Mosteller and Wallace (1964) when they tested the method on the Federalist Papers. Because they carry no meaning by themselves, they are not dependent on the topic of the text, but they might depend on the register (for example 'whereas' is not a commonly used word in everyday conversations). For the purposes of this research, I have created my own set of 30 most used function words across my collection of samples. The function words I will be working with in next set of analyses are the following:

the, to, a, of, and, that, is, it, I, in, you, for, be, as, with, not, are, if, on, or,  
have, this, they, can, but, would, we, will, an, so, by

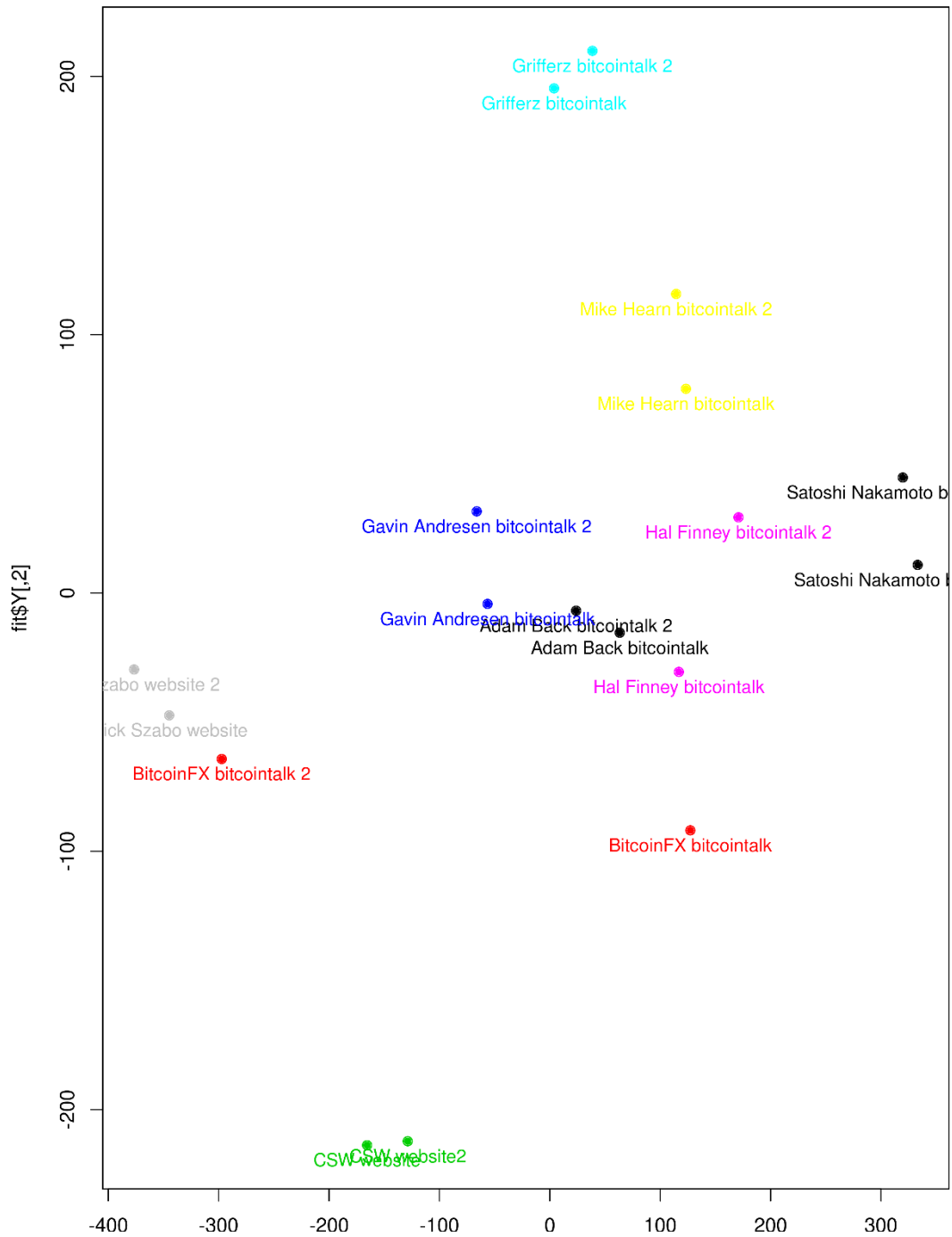
I will begin by comparing all 18 text files unreduced. I will be using QUITA and present the results in form of hierarchical clustering dendrograms and tSNE maps. This time, I opted for Manhattan dissimilarity and applied the standard score (z-score) to scale the results (4a & 4b).

Figure 4a



*The result of a function word analysis of all 18 samples from 9 authors, tokenized and unreduced, portrayed as a hierarchical clustering dendrogram. Manhattan dissimilarity was used to calculate the differences between each author. The samples on one branch are the closest to each other, increased dissimilarity is portrayed by higher amounts of branch divisions between samples (e.g., Satoshi Nakamoto and CSW).*

Figure 4b



The result of a function word analysis of all 18 samples from 9 authors, tokenized and unreduced, portrayed by *t*-distributed stochastic neighbor embedding. Manhattan dissimilarity was used to calculate the differences between each author. The samples closest to each other on the 2-dimensional map (i.e., that are clustered) are the most similar. Increased dissimilarity is portrayed by greater distance on the map (e.g., Grifferz and Nick Szabo).

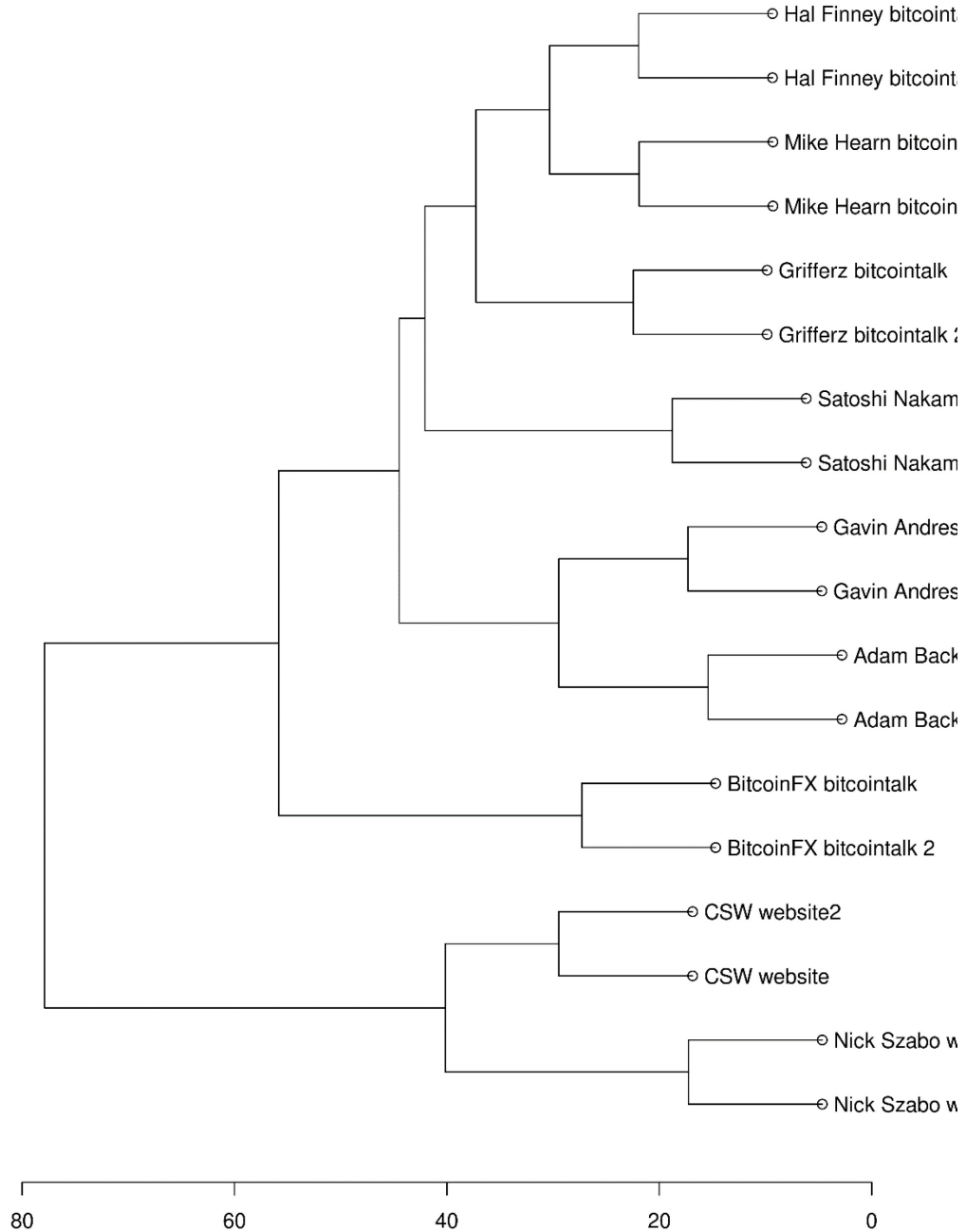
Interestingly, we can see that with the function words analyses the results once again reflect the difference between website posts and forum messages. However, BitcoinFX is also a part of this cluster. Satoshi Nakamoto does not seem to be particularly close to anyone in Figure 4a, but Figure 4b reveals relative proximity to Hal Finney and Mike Hearn with Adam Back and Gaving Andresen also clustering nearby. There are no direct overlaps apparent.

I repeated the function word analysis 10 times with 5,000 randomly selected tokens. In all of our analyses, CSW and Nick Szabo appeared on a separate branch and were joined by BitcoinFX 3 times. We have seen some unexpected overlaps in 4 of the results, all of them involving Hal Finney and 2 of them involving Hal Finney, Mike Hearn and Satoshi Nakamoto. 4 out of 10 times, Finney was the closest to Nakamoto. The remaining 6 times, Nakamoto did not cluster particularly close to anyone. All the results are shown below. I will continue to focus on the dendrograms, with tSNE maps belonging to them show in Chapter 5: **Additional Figures**.



Figure 4.01 shows all the authors clustering separately with no overlaps or irregularities. Nobody seems particularly close to Satoshi Nakamoto. CSW and Nick Szabo form a separate branch. The accompanying tSNE map can be found in Chapter 5: Additional Figures, Figure 4.11.

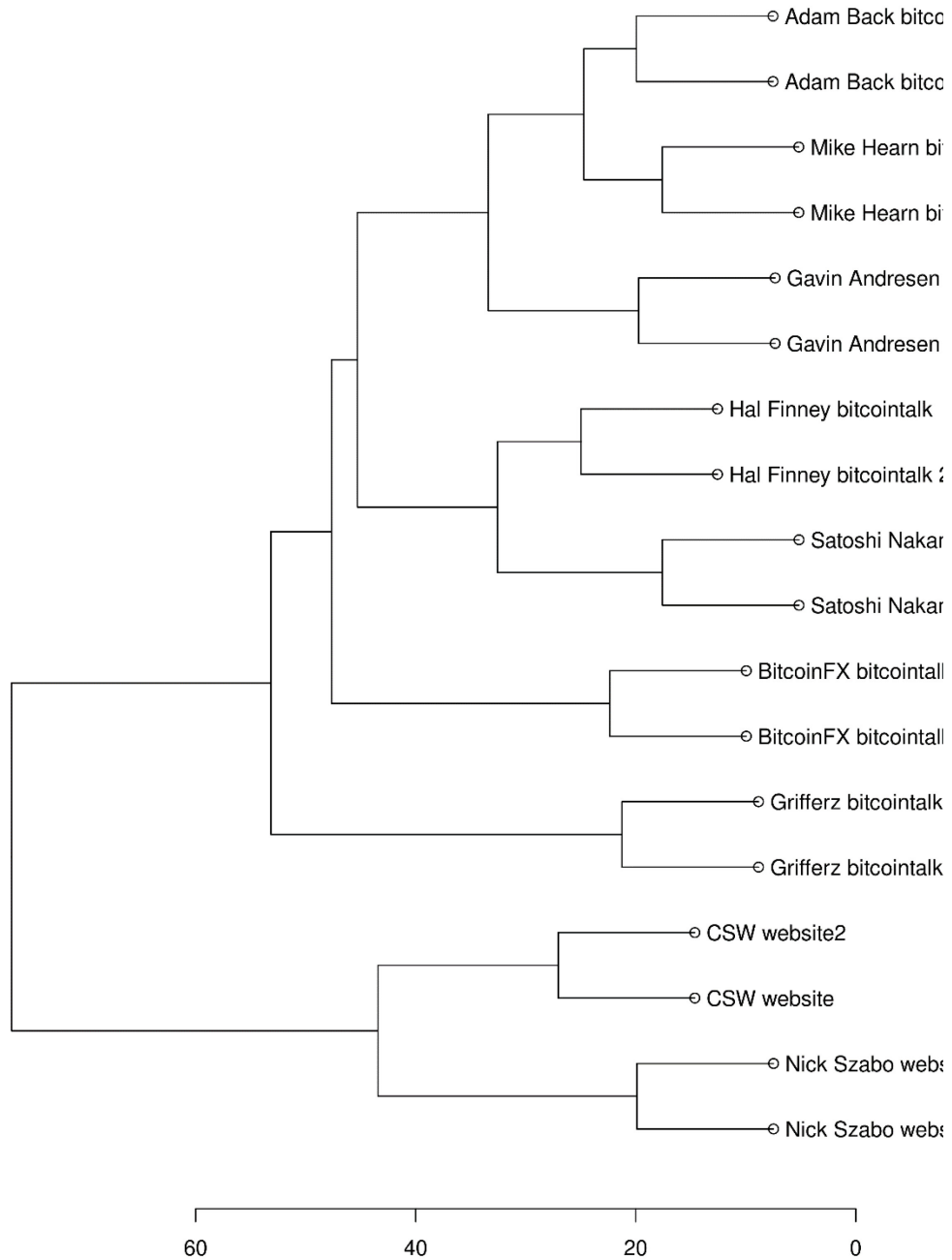
Figure 4.01



*The result of function word analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed as a hierarchical clustering dendrogram. The same metrics were used as the ones described in Figure 4a.*

In Figure 4.02, we can see no irregularities or overlaps. Hal Finney appears the closest to Satoshi Nakamoto. Nick Szabo and CSW form a separate branch. The accompanying tSNE map can be found in Chapter 5: Additional Figures, Figure 4.12.

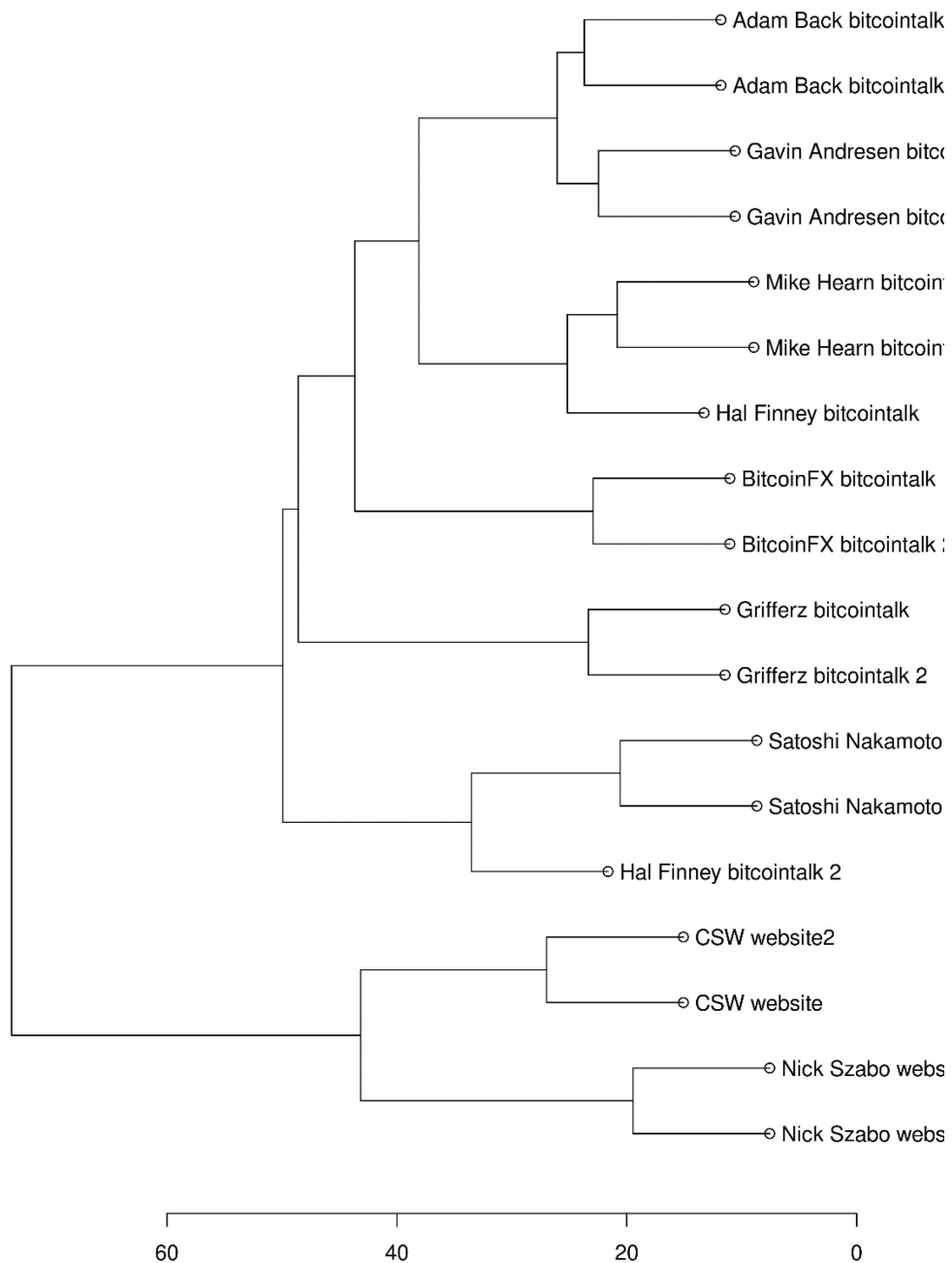
Figure 4.02



The result of function word analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed as a hierarchical clustering dendrogram. The same metrics were used as the ones described in Figure 4a.

In Figure 4.03, we can see Hal Finney's samples divided, appearing quite far away from each other. One of the samples clustered close to Mike Hearn, while the other one appears with Satoshi Nakamoto. CSW and Nick Szabo form a separate branch. The accompanying tSNE map can be found in Chapter 5: Additional Figures, Figure 4.13.

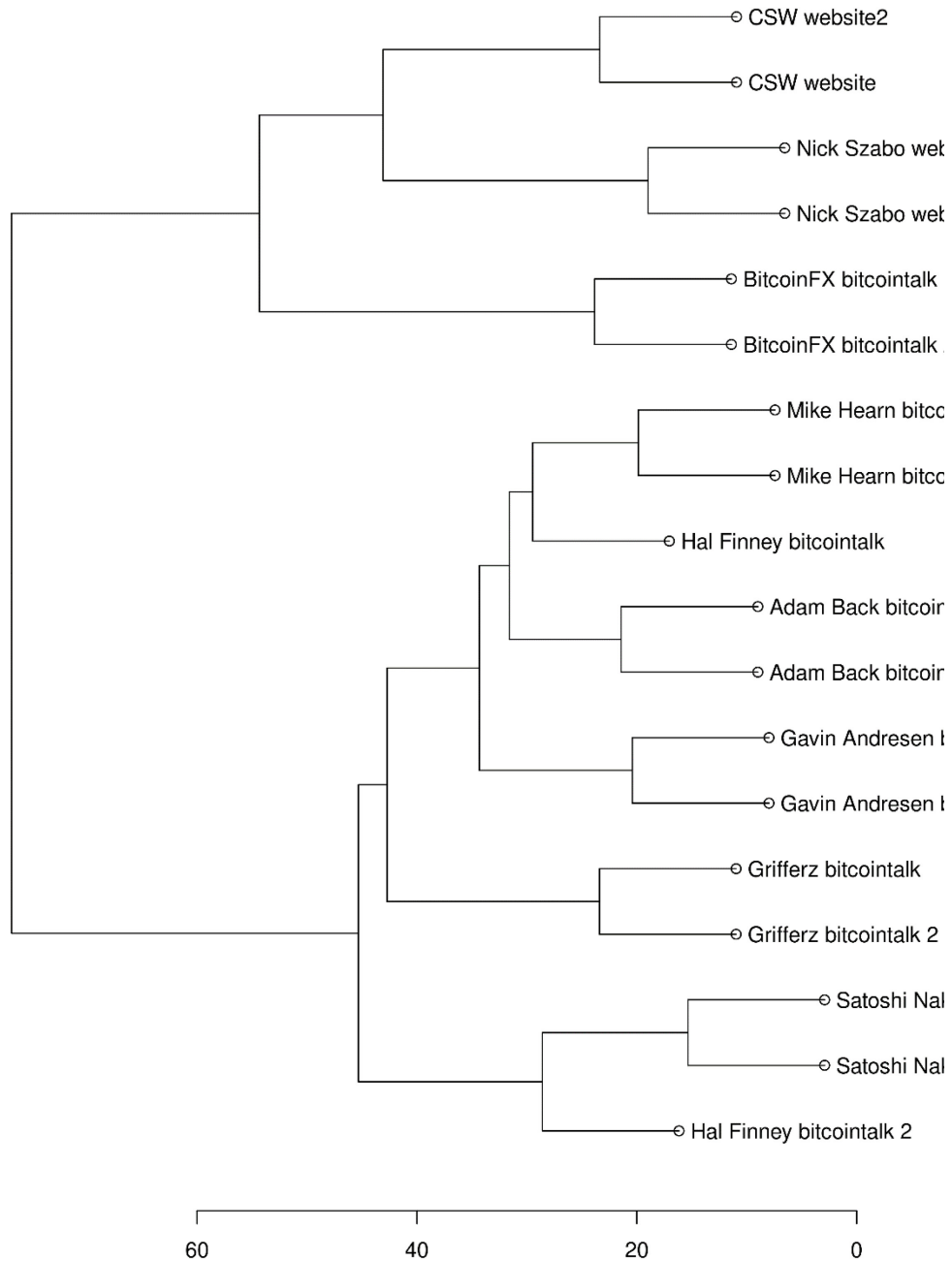
Figure 4.03



The result of function word analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed as a hierarchical clustering dendrogram. The same metrics were used as the ones described in Figure 4a.

Once again, in Figure 4.04 we can see Hal Finney’s samples are divided and clustered once with Nakamoto and once with Hearn. CSW and Nick Szabo’s cluster are joined by BitcoinFX. The accompanying tSNE map can be found in Chapter 5: Additional Figures, Figure 4.14.

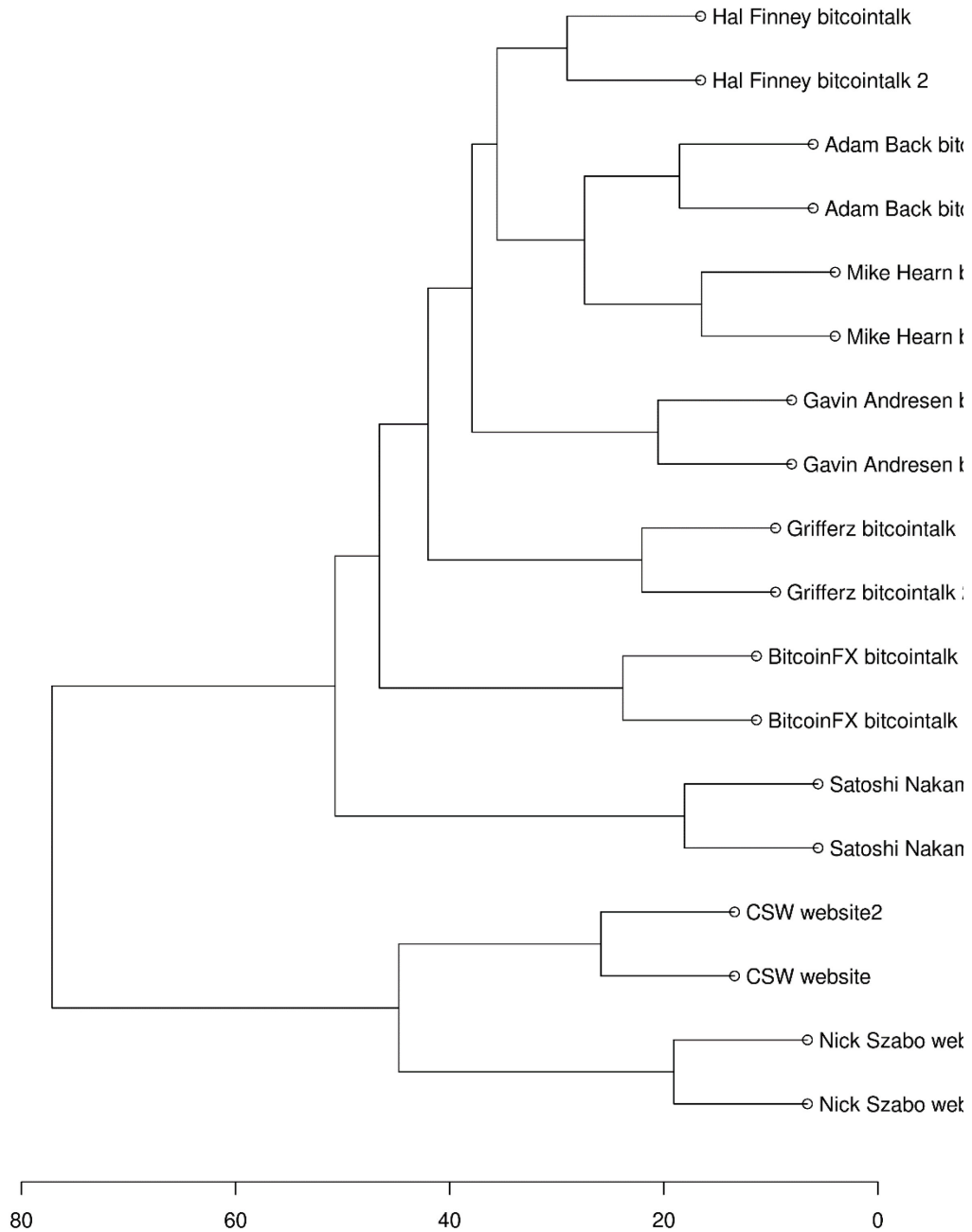
Figure 4.04



*The result of function word analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed as a hierarchical clustering dendrogram. The same metrics were used as the ones described in Figure 4a.*

In Figure 4.05, we can see all the authors cluster with nobody being close to Satoshi Nakamoto. There are no overlaps. CSW and Nick Szabo form a separate branch. The accompanying tSNE map can be found in Chapter 5: Additional Figures, Figure 4.15.

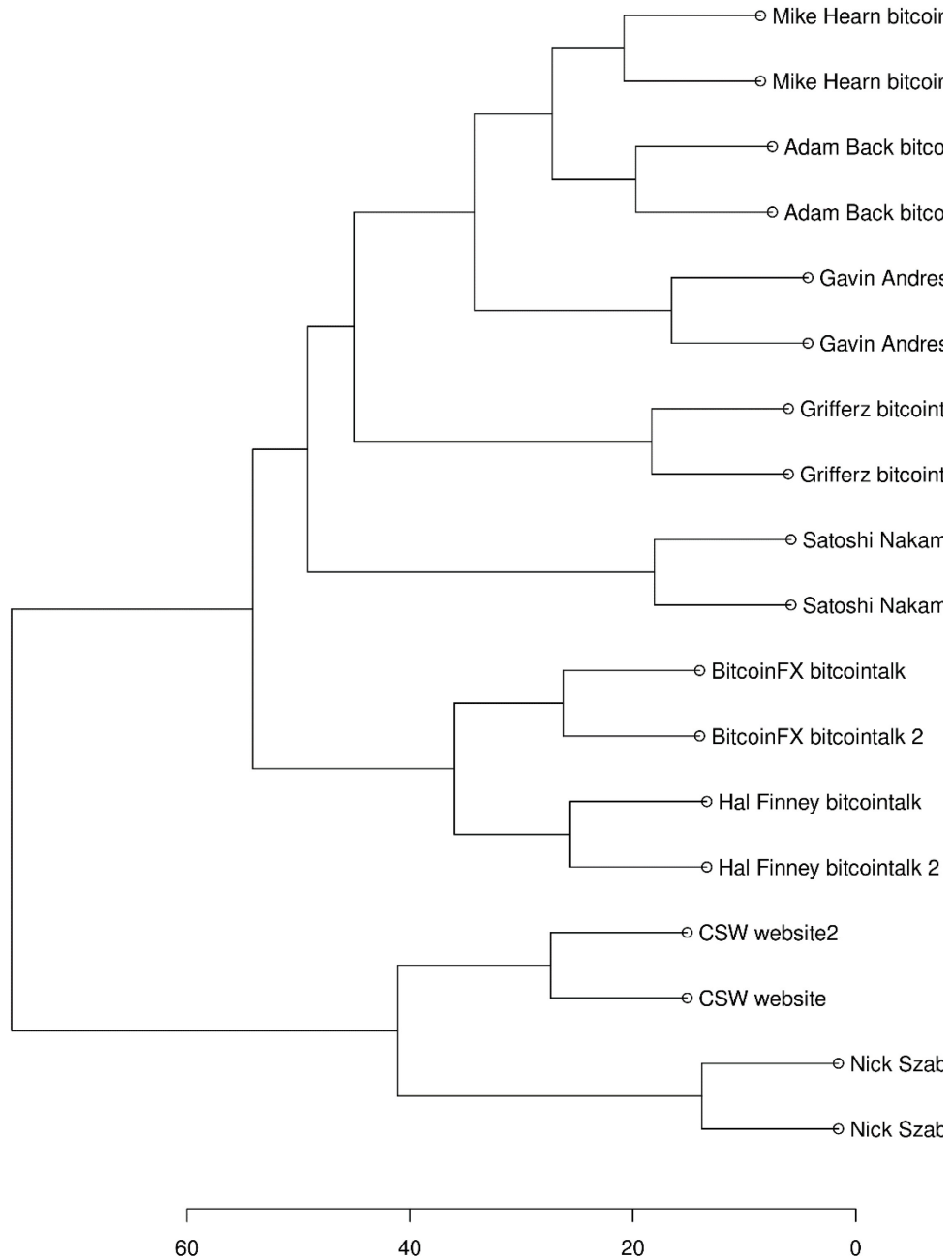
Figure 4.05



*The result of function word analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed as a hierarchical clustering dendrogram. The same metrics were used as the ones described in Figure 4a.*

Figure 4.06 shows no irregularities or overlaps. CSW and Nick Szabo continue to form a separate branch and nobody clusters particularly close to Satoshi Nakamoto. The accompanying tSNE map can be found in Chapter 5: Additional Figures, Figure 4.16.

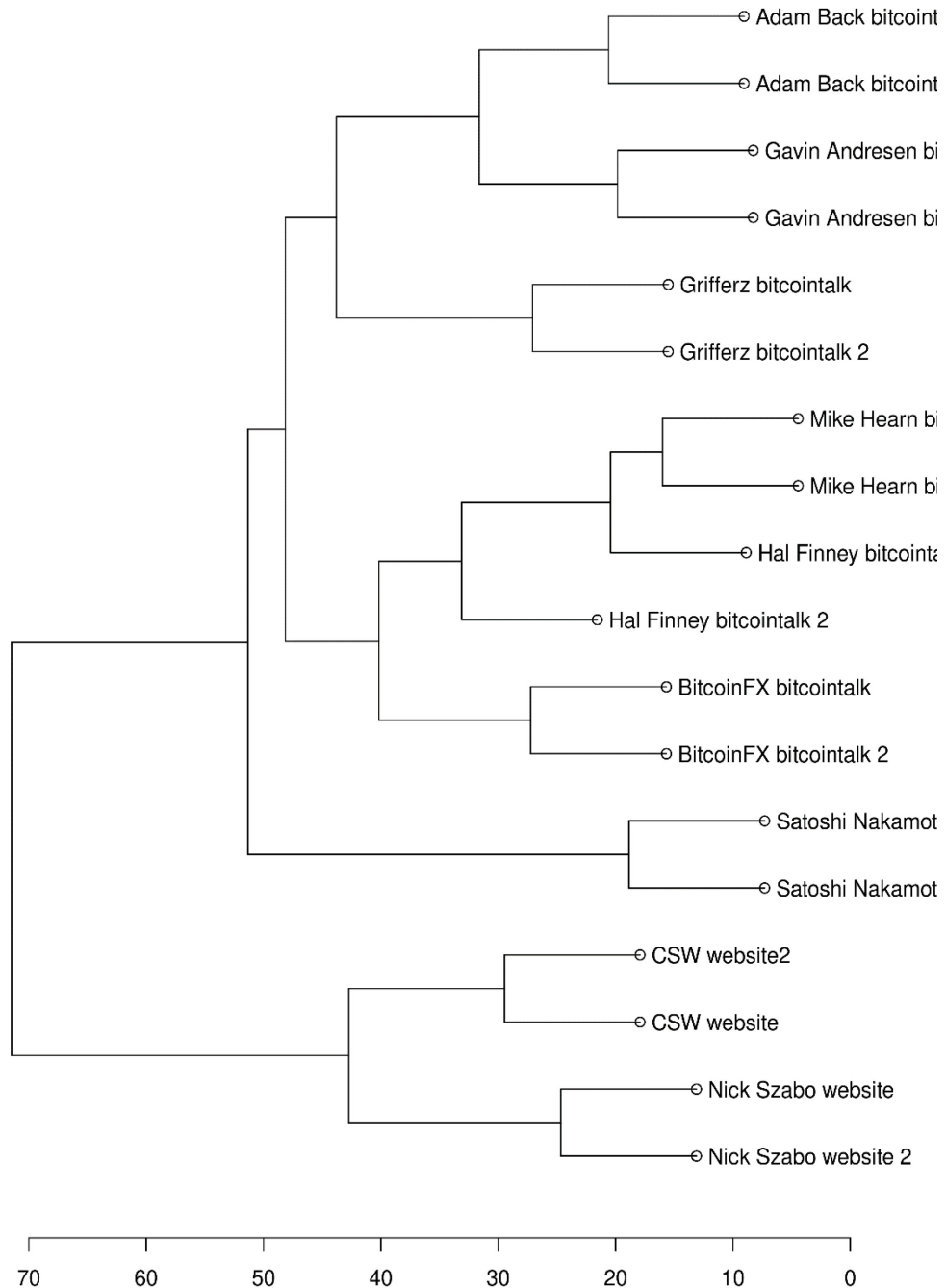
Figure 4.06



*The result of function word analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed as a hierarchical clustering dendrogram. The same metrics were used as the ones described in Figure 4a.*

In Figure 4.07, Hal Finney’s texts are slightly divided, with one of them appearing closer to Mike Hearn than to its counterpart. Nakamoto seems to cluster away from most other authors while CSW and Nick Szabo continue to form a separate branch. The accompanying tSNE map can be found in Chapter 5: Additional Figures, Figure 4.17.

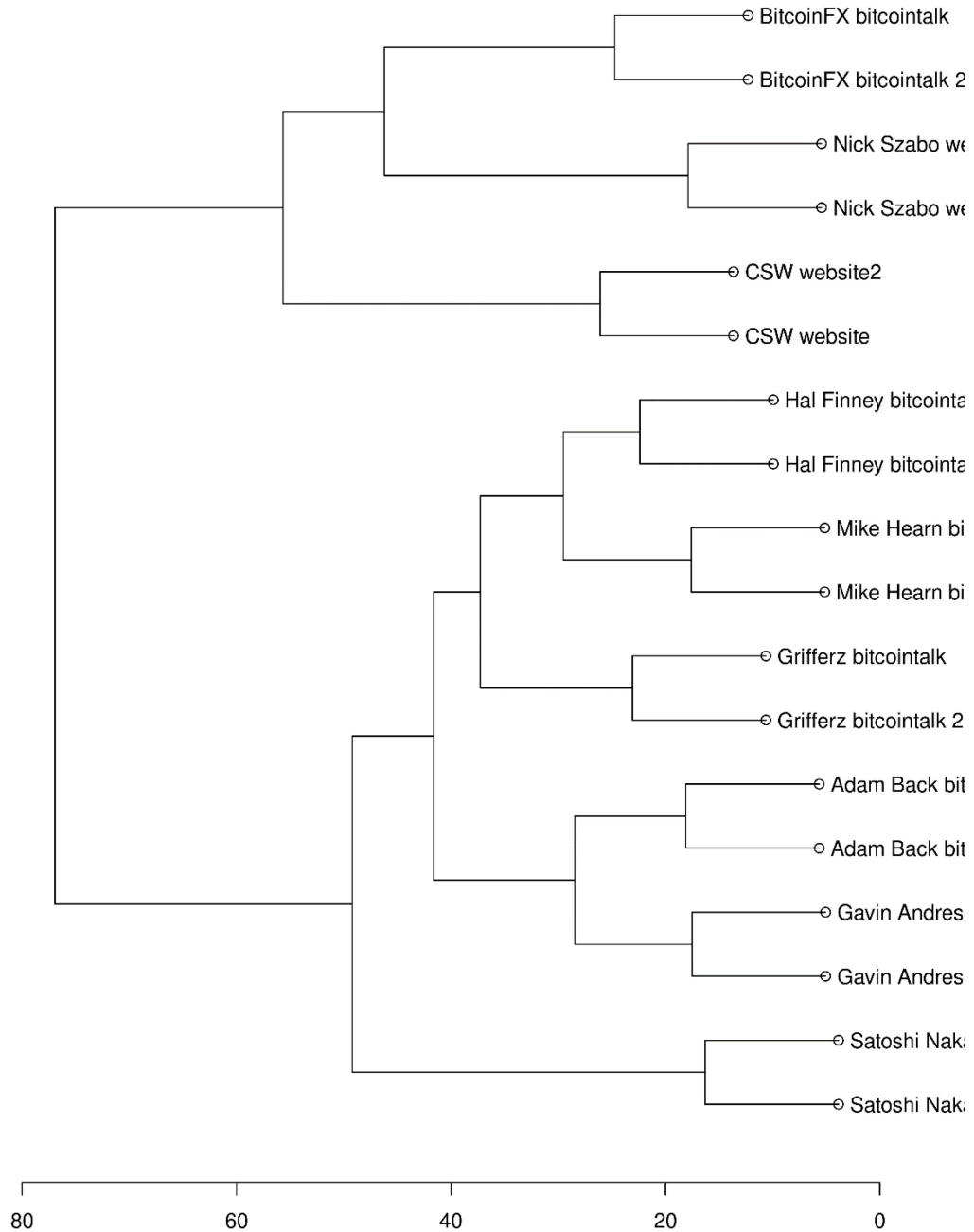
Figure 4.07



The result of function word analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed as a hierarchical clustering dendrogram. The same metrics were used as the ones described in Figure 4a.

In Figure 4.08, we see no unusual clustering or overlaps. Satoshi Nakamoto does not appear particularly close to any other authors. BitcoinFX is on the same branch as CSW and Nick Szabo. The accompanying tSNE map can be found in Chapter 5: Additional Figures, Figure 4.18.

Figure 4.08

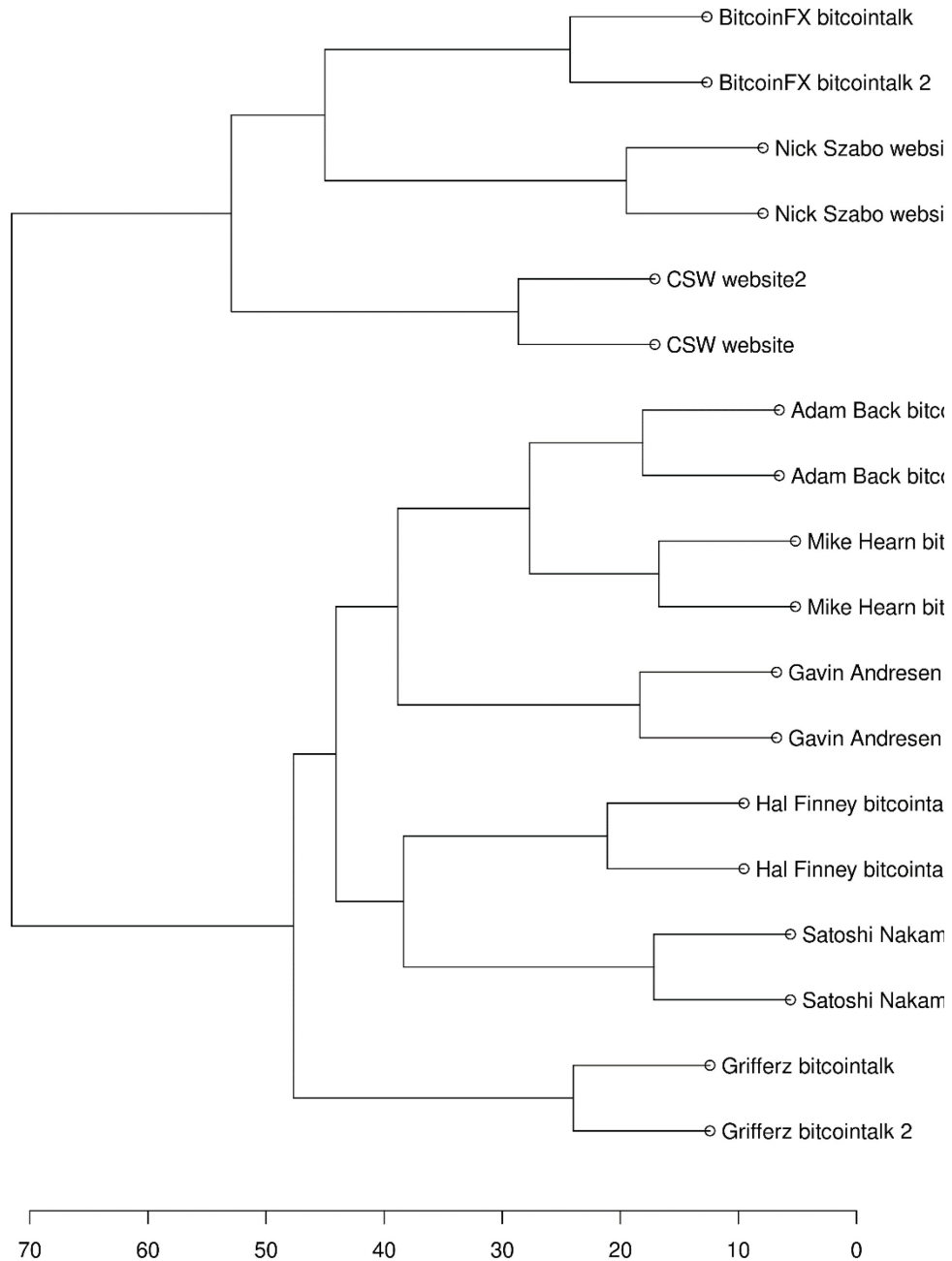


*The result of function word analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed as a hierarchical clustering dendrogram. The same metrics were used as the ones described in Figure 4a.*



Figure 4.09 shows no unusual clustering or overlaps. The closest author to Satoshi Nakamoto is Hal Finney while BitcoinFX clusters with CSW and Nick Szabo on their separate branch. The accompanying tSNE map can be found in Chapter 5: Additional Figures, Figure 4.19.

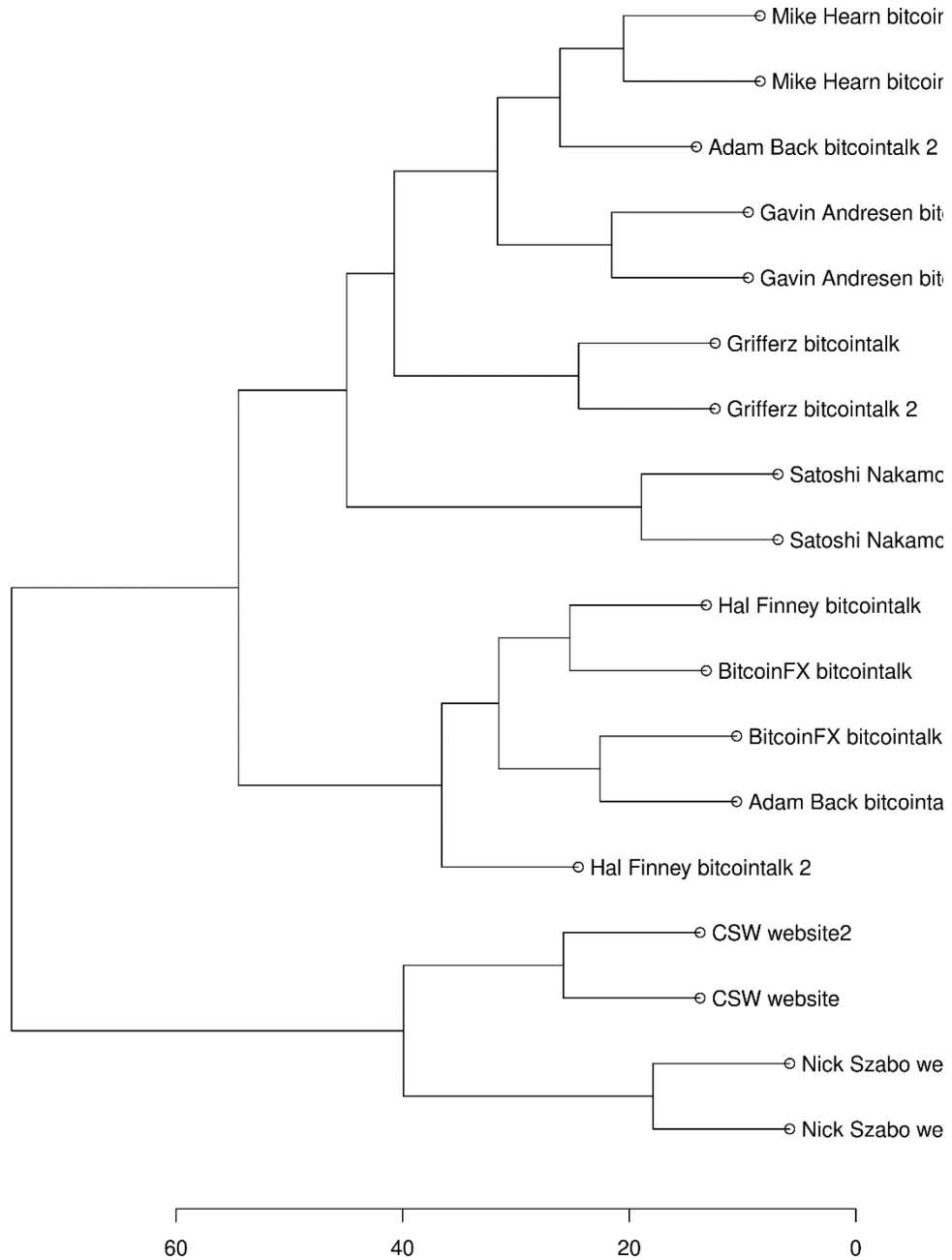
Figure 4.09



*The result of function word analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed as a hierarchical clustering dendrogram. The same metrics were used as the ones described in Figure 4a.*

In Figure 4.10, we can see several unusual clusters and overlaps, none of them involving Nakamoto. Adam Back, Hal Finney and BitcoinFX appear to be mixed in with each other, while one of Back’s samples clusters close to Mike Hearn. CSW and Nick Szabo form a separate branch. The accompanying tSNE map can be found in Chapter 5: Additional Figures, Figure 4.20.

Figure 4.10



*The result of function word analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed as a hierarchical clustering dendrogram. The same metrics were used as the ones described in Figure 4a.*

As we can see, the trend of CSW and Nick Szabo clustering separately from the others continues across all of our function word analyses. We have seen BitcoinFX appear close to them 3 times (Figures 4.04, 4.08 and 4.09). Multiple authors overlapped on 4 occasions: In Figures 4.03 and 4.04, Hal Finney's samples were divided, one clustering with Satoshi Nakamoto and the other one with Mike Hearn. In Figure 4.07, one of Finney's samples appeared closer to Hearn than to Finney's own second sample. Finally, Figure 4.10 shows one of BitcoinFX's samples clustering with one of Finney's and one of Backs' texts. Back's other sample appeared close to Mike Hearn. As mentioned previously, 4 out of 10 times, the closest to Nakamoto was Finney (Figures 4.02, 4.03, 4.04 and 4.09). The remaining 6 times, nobody clustered particularly close to Nakamoto but, as exemplified in Figures 4.11-4.20, Finney still retained his tendency to appear close by.

## 3 Results

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In this research, I started every wave of analyses by comparing all the samples with each other. Each author's samples were divided into two files in order to illustrate how samples by the same author would usually cluster. After this initial analysis, I went on to repeat it 10 times with each set being reduced to 5,000 randomized tokens. All the results were saved in form of tSNE maps, hierarchical clustering dendrograms and BoW models.

### 3.1 The Hapax Method

The hapax method of authorship attribution, being a relatively new method developed at Palacký University in Olomouc, is not yet very widely known. However, there has already been done enough research to prove its accuracy, and I believe I was able to demonstrate that in this study as well. The differences between individual authors were not as wide as with other methods, but they were still visible, and we could still clearly see them cluster consistently. Unlike the other methods, hapax analysis does not seem to be too dependent on stylistic factors.

During the hapax analyses, no author clustered consistently enough with another to be able to definitively conclude that they are identical, but it is still notable that a few names repeatedly appeared close to each other and even overlapped several times. These clusters always included Finney and almost always Nakamoto. Aside from the explicit overlaps, the repeated randomized analyses turned up many similarities between Hal Finney and Satoshi Nakamoto.

### 3.2 N-gram Analysis

N-gram analysis is a well-established method of authorship attribution. In this research, I used both character and word n-grams, and quickly noticed that texts written for different purposes and audiences were all clustering far away from the others. I speculated in the previous chapter that this might be due to the differing register and likely usage of longer sentences/words in the blogs, but an absolute conclusion would require more research.

The word 2-gram analysis showed almost overwhelmingly that the closest to Satoshi Nakamoto is Mike Hearn, with them clustering next to each other in 8 out of 10 of our randomized analyses. The second closest was Hal Finney who appeared next to Nakamoto the remaining 2 times with Mike Hearn still remaining nearby. There were, however, no overlaps of multiple authors. The samples originating from websites (Craig Steven Wright and Nick Szabo) often showed up far away from the

other authors, their apparent distance being a likely result of the distortion I mentioned in the previous paragraph.

The character 3-gram analysis saw a return of Hal Finney as the closest author to Satoshi Nakamoto. An overwhelming 9 out of 10 times, Finney clustered the closest to Nakamoto out of everyone, and we also saw the surprise appearance of Gavin Andresen as a potential candidate. In every instance, Andresen was a close second to Finney and he even surpassed him on one occasion. We saw one cluster where Nakamoto and Finney overlapped. Like previously, Nick Szabo and Craig Steven Wright tended to form a separate cluster.

### **3.3 Function Words**

Function words analysis, another well-established method of authorship attribution, had similar results to the ones shown by the n-gram analysis. The results were consistent with both previously employed methods but were, once again, somewhat distorted by the apparent effect of stylistic differences. This is likely resulting from the fact that different occasions and audiences prefer different function words.

During the function word analysis, we saw Hal Finney once again stand out as he continued to cluster closer to Nakamoto than anyone else. He appeared outright next to Nakamoto in 4 out of 10 of our analyses and remained the closest to him (relative to everyone else) most of the time. No other outstanding candidates came up during this wave of analyses. As already mentioned, Craig Steven Wright and Nick Szabo tended to form their own cluster with BitcoinFX joining them occasionally.

## 4 Conclusion

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This thesis aimed to uncover the identity of Satoshi Nakamoto, the creator of Bitcoin and pioneer of much of the technology and ideology behind cryptocurrencies in general. Despite the fact that Satoshi Nakamoto is not as hotly debated as he was a few years ago, I believe the question of his identity is still, at the very least, of great cultural interest. Bitcoin gave rise to countless other cryptocurrencies, many of which were able to find wide adaptation due to being more flexible. The Ethereum blockchain currently hosts many projects, and its currency, Ether, is the second most valued cryptocurrency at the moment. Regardless of where this technology ends up going, its impact on the second decade of the 21<sup>st</sup> century is undeniable.

The methods I employed in order to determine the authorship of the posts behind the Satoshi Nakamoto account on [bitcointalk.org](https://bitcointalk.org) were hapax analysis, word 2-gram analysis, character 3-gram analysis, and function word analysis. Going into this research, I had no prior beliefs pertaining to Nakamoto's true identity, but the Barely Sociable video essays and Wright's claims did spark my interest in Adam Back and Craig Steven Wright in particular. These two candidates were, in fact, the catalyst for starting this research, and it was therefore very interesting to find no proof that either of them was particularly likely to have authored Nakamoto's writings. In fact, neither Back nor Wright ever clustered noticeably close to Nakamoto. Keeping in mind the handicap of not having a collection of forum posts or short messages from Wright to compare, I can only conclude that more research will need to be done in order to find a more concrete answer. With Wright's recently started Twitter page, there is the possibility to repeat this study with a better collection of writings in the future.

Nick Szabo, being the second candidate from whom I have not been able to collect forum posts, tended to cluster close to Craig Steven Wright throughout the majority of my analyses, lending more credence to the fact that the similarity of the overall style made them seem more alike.

Mike Hearn, another popular candidate, stood out in one of the four waves of analyses (word 2-grams) but did not come up much in the other three. Gavin Andresen was the second closest to Nakamoto in a few instances, mostly throughout the randomized character 3-gram analyses. Neither Hearn nor Andresen seem to be likely candidates, as we could see the clustering from sample pairs from each author was much more consistent than their occasional proximity to Nakamoto.

The two random forum users I selected as control authors, BitcoinFX and Grifferz, did not stand out in any of the analyses. Interestingly, BitcoinFX tended to be the only [bitcointalk](https://bitcointalk.org)-based author who, on several occasions, clustered closer to

Craig Steven Wright and Nick Szabo than to the other forum users. There is no immediately apparent reason for this anomaly, but it does point towards fact that the difference between the website and the online forums environment should not be seen as a finality. Grifferz, despite writing in a way seemingly more akin to Nakamoto (more formal language with less typos and more consistent British spelling), often clustered further away from Nakamoto than BitcoinFX did.

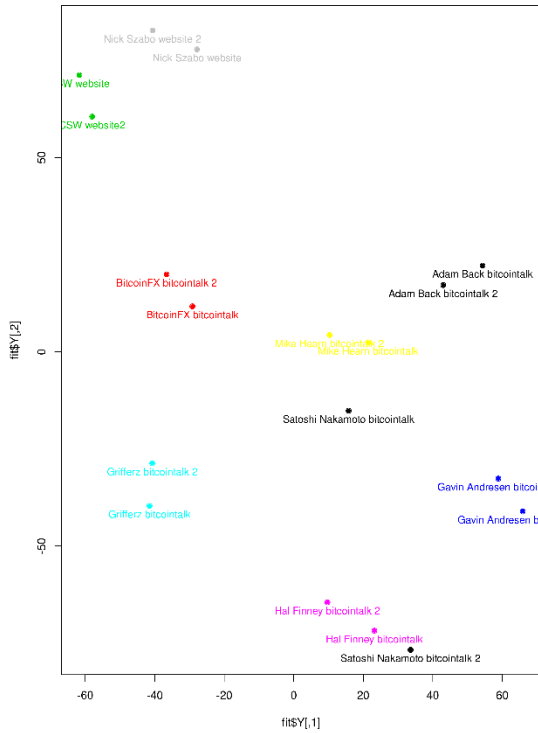
Finally, the most interesting candidate is Hal Finney. The late American software developer and cryptographer featured prominently throughout most of this research. In 18 out of the 40 randomized analyses I performed, Hal Finney appeared as the closest author to Satoshi Nakamoto. However, he did not particularly stand out in the unreduced, non-randomized analyses. Ultimately, despite being the closest to Satoshi Nakamoto out of all the authors, the results are not conclusive enough to say with any amount of certainty that Hal Finney is Nakamoto. While these results are very interesting and should not be disregarded, more research will be necessary.

A number of possible authorship attribution methods I did not utilize in this research include LIWC (Linguistic Inquiry and Word Count) (Tausczik & Pennebaker, 2007), a computer program used to statistically measure emotional tone, formality and other social and psychological aspects based on the vocabulary used. Average word or sentence length has also seen adaption for the purposes of authorship attribution (Kruh, 1988 & Yule, 1938), and may bring some interesting results if applied to this group of authors and texts.

It should be mentioned that I decided to work with the assumption that Satoshi Nakamoto is a single person – or rather that the posts on [bitcointalk.org](http://bitcointalk.org) were all authored by one and the same person. My reasoning for this decision is that it seems unlikely for a group of individuals to be so dedicated to appearing as a single person, as to share an online account and actively post messages from it. It would have been more convenient to start individual accounts for every member and either act as mere bitcoin users, or publicly declare their part in the project. The fact that Nakamoto's texts clustered systematically and the same way as the other authors (i.e., without any irregularities) does point to likely having only one author. However, the possibility of the Satoshi account being shared cannot be completely ruled out and until the real Nakamoto is definitively found, there is no real way to ascertain with any confidence whether the short posts on [bitcointalk.org](http://bitcointalk.org) came from one or multiple authors. Finally, aside from my opinion on the forum account, I do not make any assumptions about the programmer(s) behind the project itself. If the account was managed by a different person from the actual creator of bitcoin, then this research only seeks to find the identity behind the Satoshi account owner.

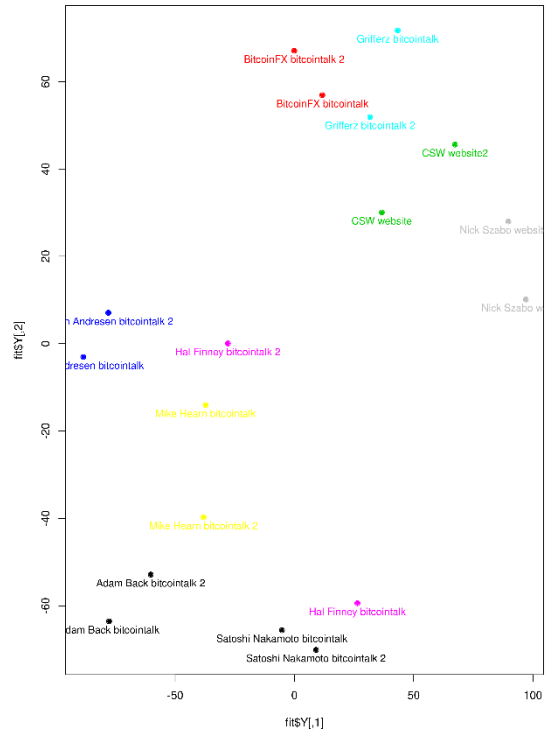
## 5 Additional Figures

Figure 1.11 (belongs with Figure 1.01, pp. 23)



The result of a hapax analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed by  $t$ -distributed stochastic neighbor embedding. The same metrics were used as the ones described in Figure 1.01.

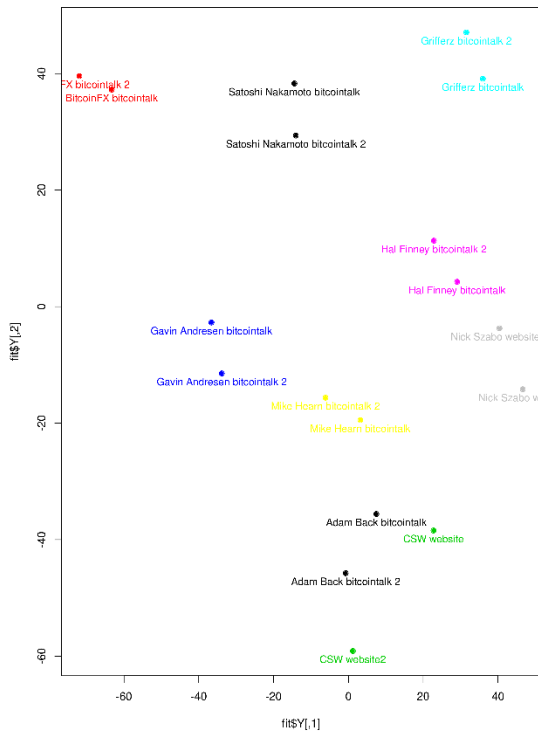
Figure 1.12 (belongs with Figure 1.02, pp. 24)



The result of a hapax analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed by  $t$ -distributed stochastic neighbor embedding. The same metrics were used as the ones described in Figure 1.02.

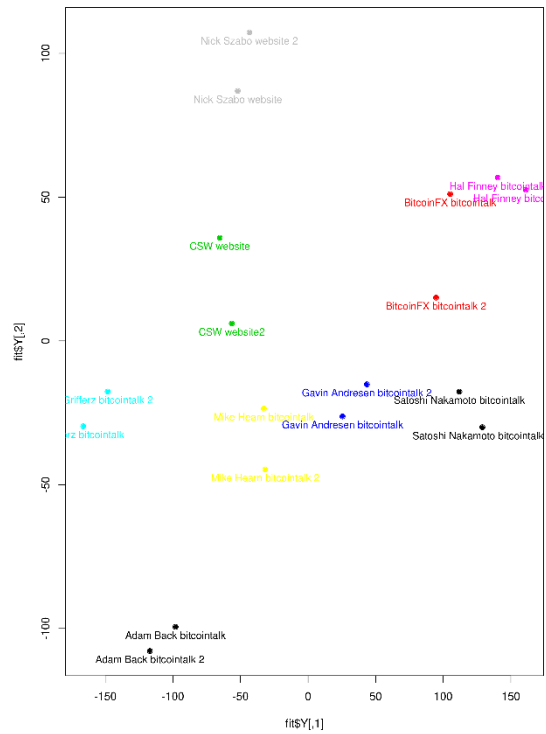


Figure 1.13 (belongs with Figure 1.03, pp. 25)



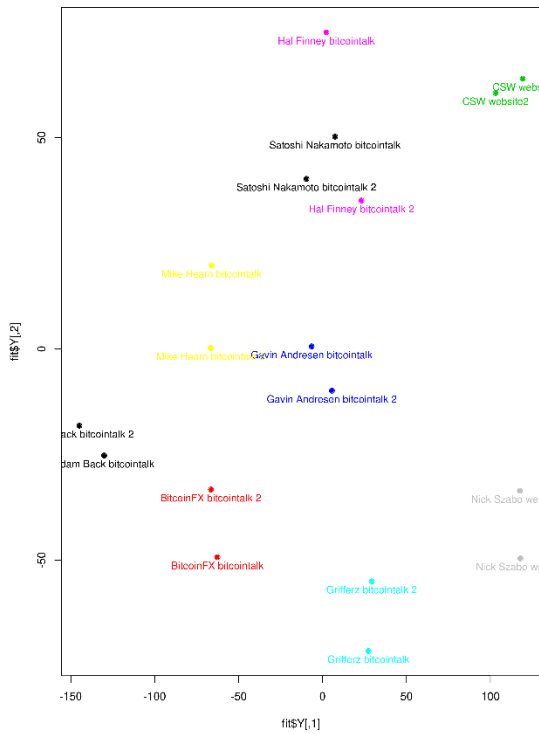
The result of a hapax analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed by *t*-distributed stochastic neighbor embedding. The same metrics were used as the ones described in Figure 1.03.

Figure 1.14 (belongs with Figure 1.04, pp. 26)



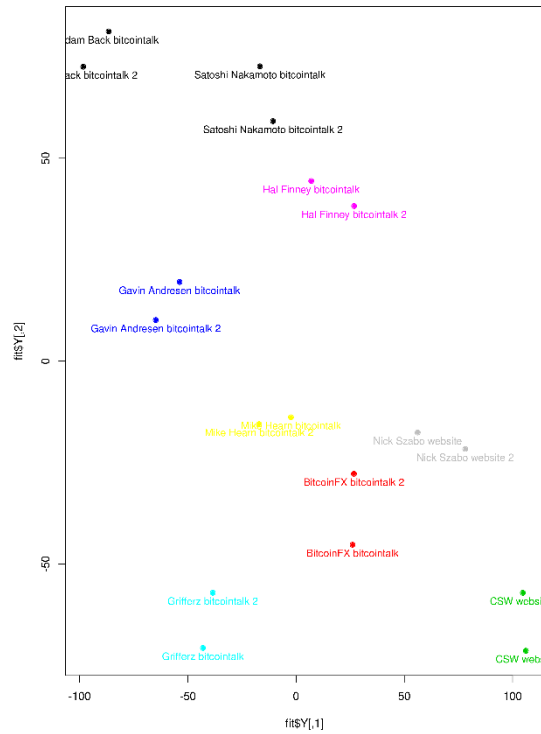
The result of a hapax analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed by *t*-distributed stochastic neighbor embedding. The same metrics were used as the ones described in Figure 1.04.

Figure 1.15 (belongs with Figure 1.05, pp. 27)



The result of a hapax analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed by  $t$ -distributed stochastic neighbor embedding. The same metrics were used as the ones described in Figure 1.05.

Figure 1.16 (belongs with Figure 1.06, pp. 28)



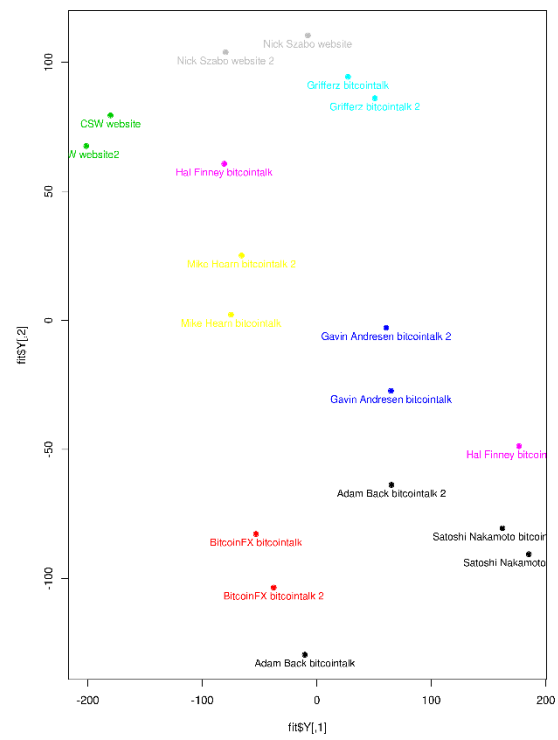
The result of a hapax analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed by  $t$ -distributed stochastic neighbor embedding. The same metrics were used as the ones described in Figure 1.06.

Figure 1.17 (belongs with Figure 1.07, pp. 29)



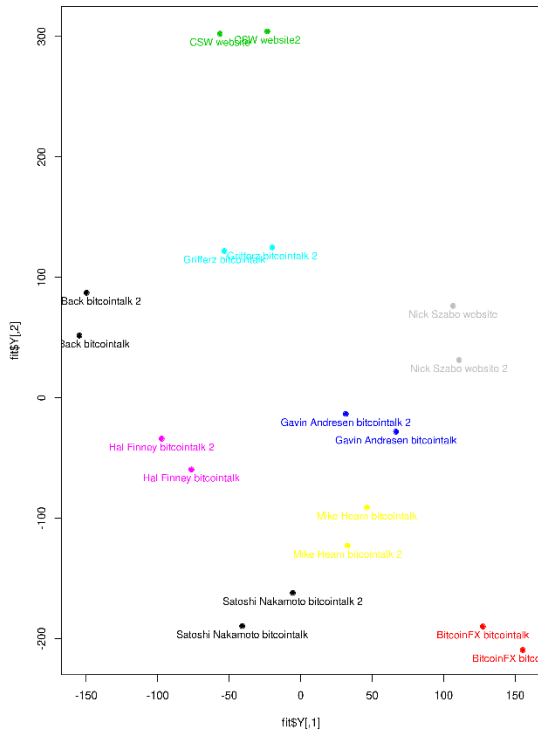
The result of a hapax analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed by  $t$ -distributed stochastic neighbor embedding. The same metrics were used as the ones described in Figure 1.07.

Figure 1.18 (belongs with Figure 1.08, pp. 30)



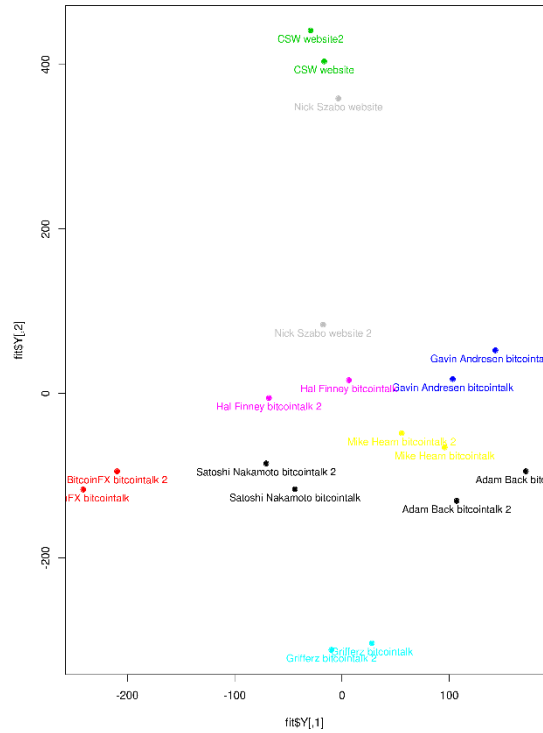
The result of a hapax analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed by  $t$ -distributed stochastic neighbor embedding. The same metrics were used as the ones described in Figure 1.08.

Figure 1.19 (belongs with Figure 1.09, pp. 31)



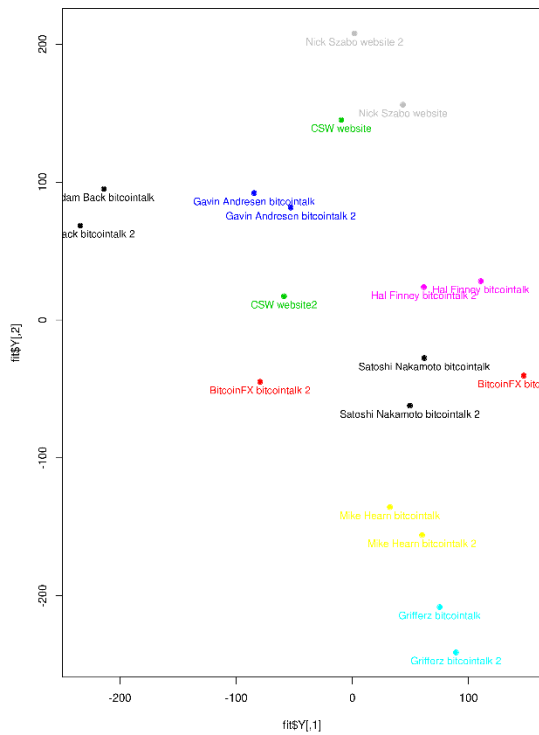
The result of a hapax analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed by  $t$ -distributed stochastic neighbor embedding. The same metrics were used as the ones described in Figure 1.09.

Figure 1.20 (belongs with Figure 1.10, pp. 32)



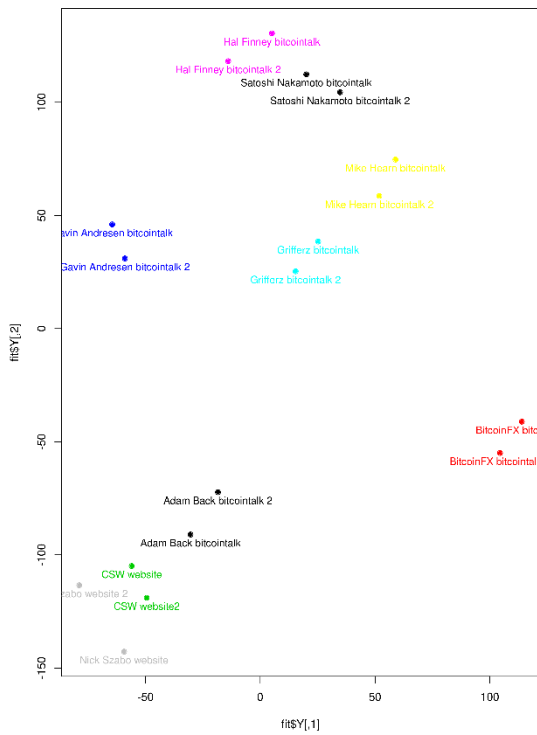
The result of a hapax analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed by  $t$ -distributed stochastic neighbor embedding. The same metrics were used as the ones described in Figure 1.10.

Figure 2.11 (belongs with Figure 2.01, pp. 37)



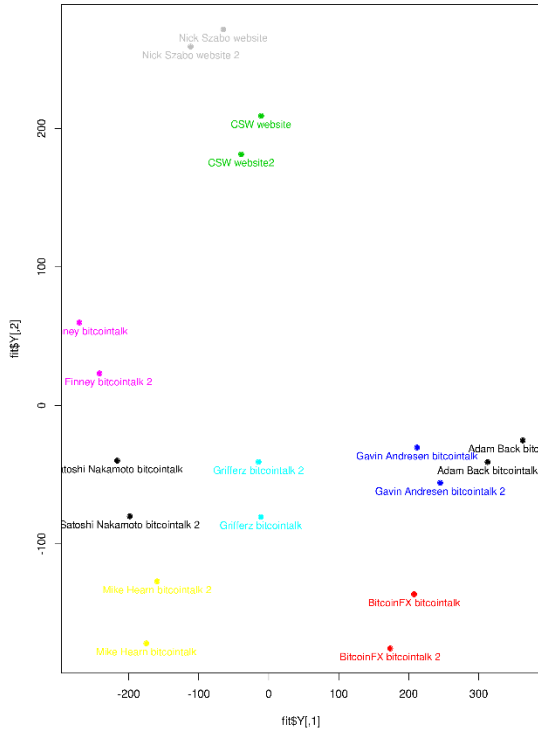
The result of a 2-gram word analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed by t-distributed stochastic neighbor embedding. The same metrics were used as the ones described in Figure 2.01.

Figure 2.12 (belongs with Figure 2.02, pp. 38)



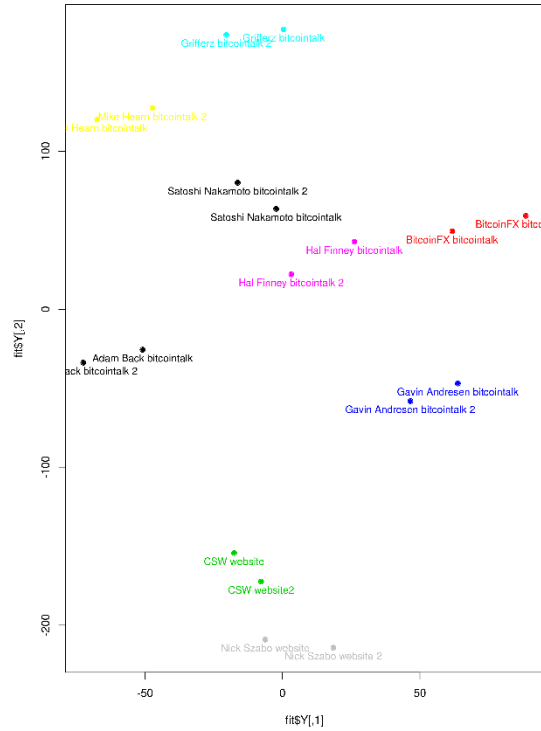
The result of a 2-gram word analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed by t-distributed stochastic neighbor embedding. The same metrics were used as the ones described in Figure 2.02.

Figure 2.13 (belongs with Figure 2.03, pp. 39)



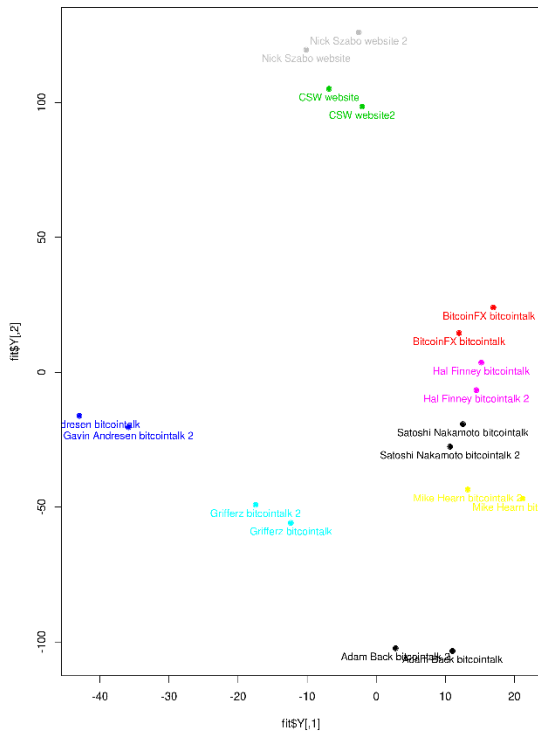
The result of a 2-gram word analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed by *t*-distributed stochastic neighbor embedding. The same metrics were used as the ones described in Figure 2.03.

Figure 2.14 (belongs with Figure 2.04, pp. 40)



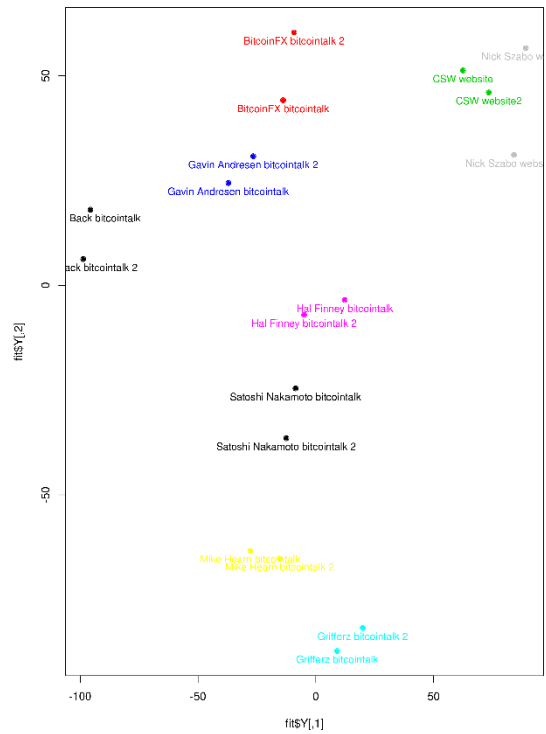
The result of a 2-gram word analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed by *t*-distributed stochastic neighbor embedding. The same metrics were used as the ones described in Figure 2.04.

Figure 2.15 (belongs with Figure 2.05, pp. 41)



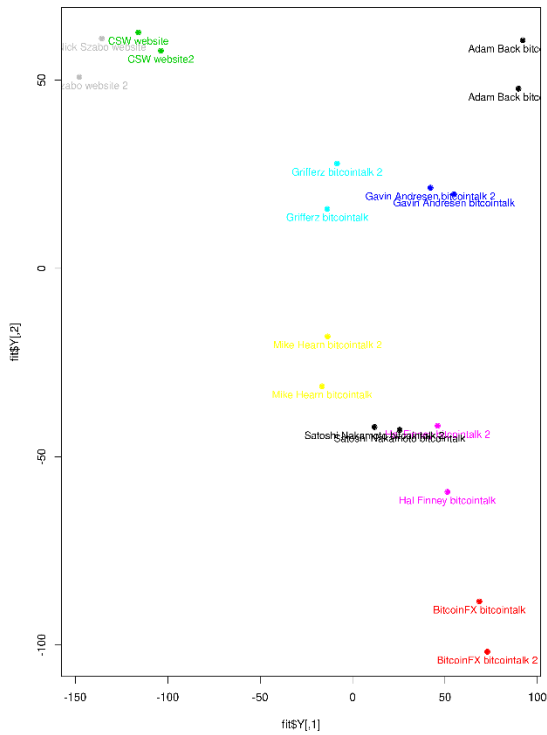
The result of a 2-gram word analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed by  $t$ -distributed stochastic neighbor embedding. The same metrics were used as the ones described in Figure 2.05.

Figure 2.16 (belongs with Figure 2.06, pp. 42)



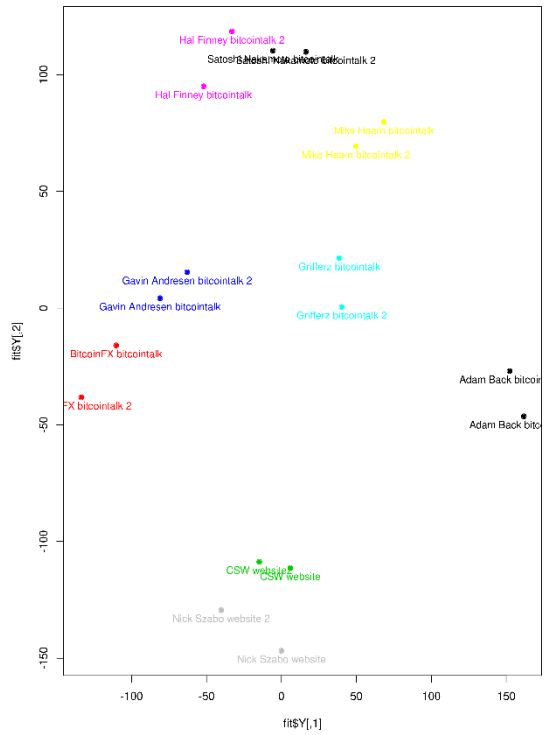
The result of a 2-gram word analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed by  $t$ -distributed stochastic neighbor embedding. The same metrics were used as the ones described in Figure 2.06.

Figure 2.17 (belongs with Figure 2.07, pp. 43)



The result of a 2-gram word analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed by *t*-distributed stochastic neighbor embedding. The same metrics were used as the ones described in Figure 2.07.

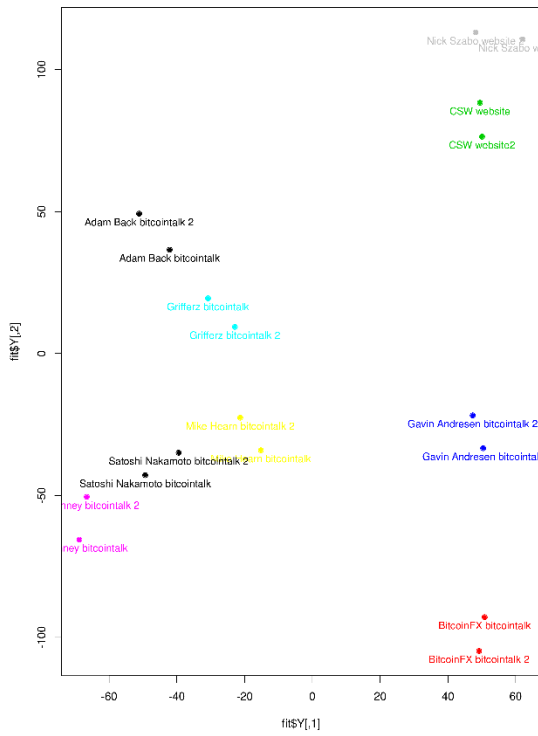
Figure 2.18 (belongs with Figure 2.08, pp. 44)



The result of a 2-gram word analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed by *t*-distributed stochastic neighbor embedding. The same metrics were used as the ones described in Figure 2.08.

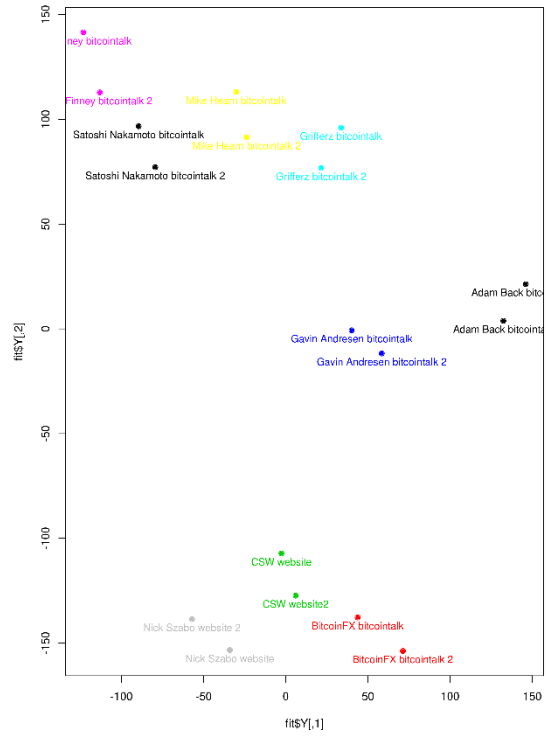


Figure 2.19 (belongs with Figure 2.09, pp. 45)



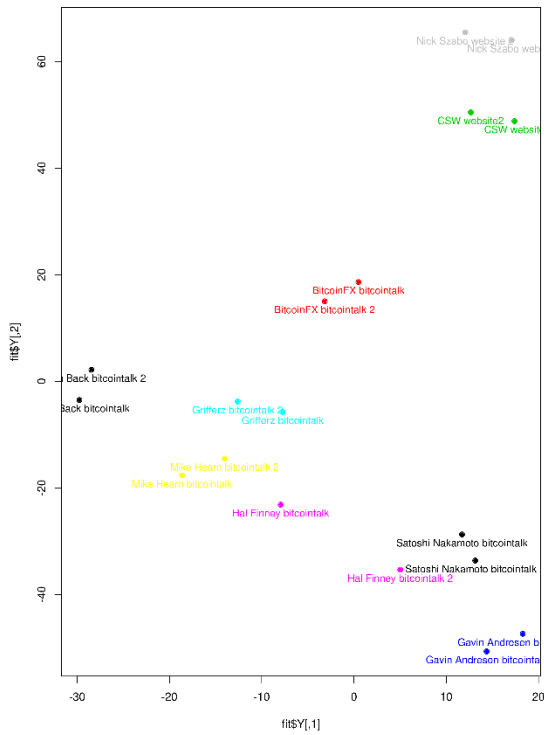
The result of a 2-gram word analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed by  $t$ -distributed stochastic neighbor embedding. The same metrics were used as the ones described in Figure 2.09.

Figure 2.20 (belongs with Figure 2.10, pp. 46)



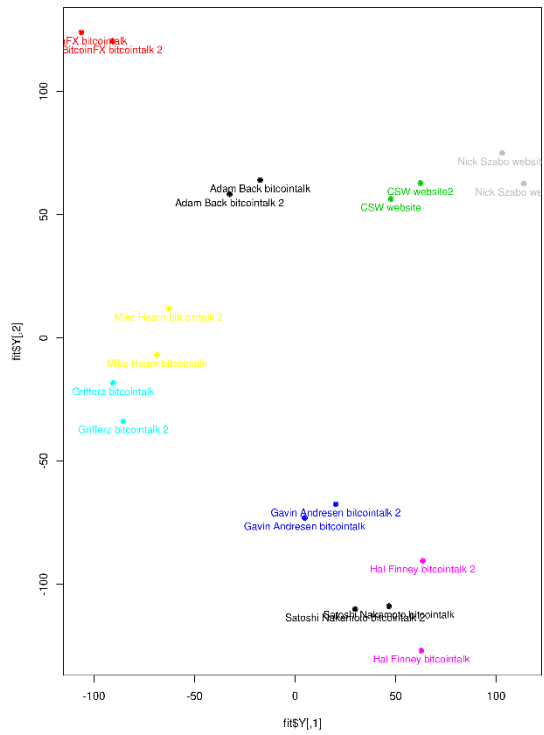
The result of a 2-gram word analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed by  $t$ -distributed stochastic neighbor embedding. The same metrics were used as the ones described in Figure 2.10.

Figure 3.11 (belongs with Figure 3.01, pp. 51)



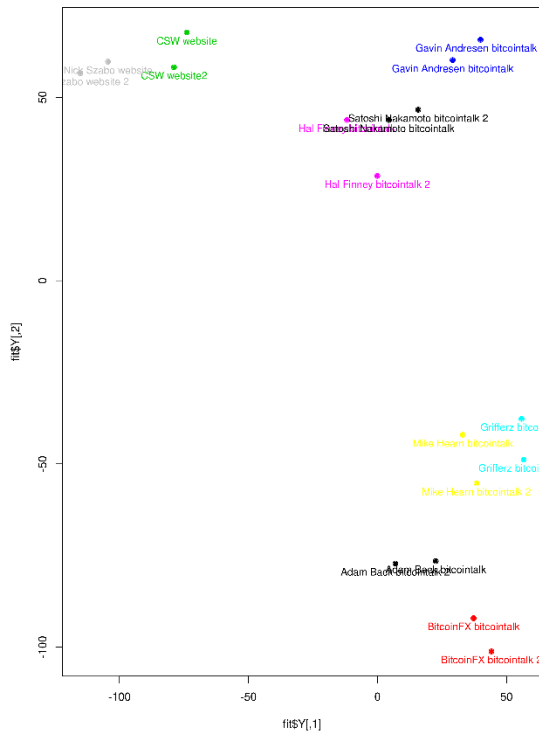
The result of a 3-gram character analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed by  $t$ -distributed stochastic neighbor embedding. The same metrics were used as the ones described in Figure 3.01.

Figure 3.12 (belongs with Figure 3.02, pp. 52)



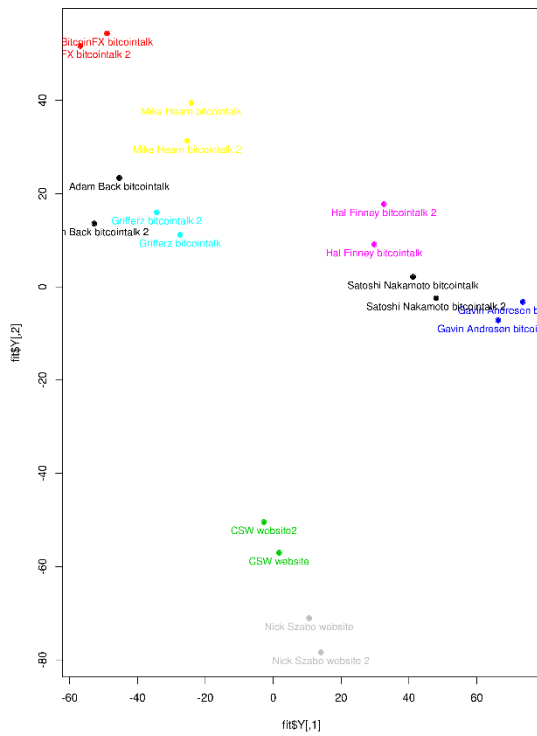
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Figure 3.13 (belongs with Figure 3.03, pp. 53)



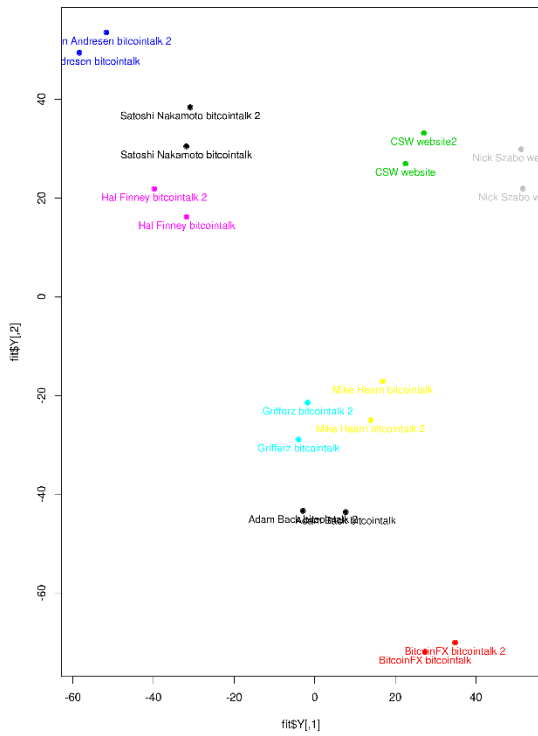
The result of a 3-gram character analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed by *t*-distributed stochastic neighbor embedding. The same metrics were used as the ones described in Figure 3.03.

Figure 3.14 (belongs with Figure 3.04, pp. 54)



The result of a 3-gram character analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed by *t*-distributed stochastic neighbor embedding. The same metrics were used as the ones described in Figure 3.04.

Figure 3.15 (belongs with Figure 3.05, pp. 55)



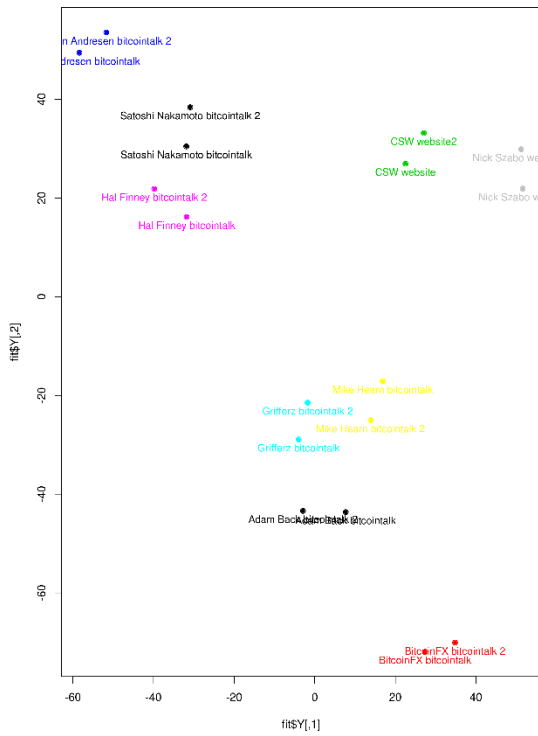
The result of a 3-gram character analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed by *t*-distributed stochastic neighbor embedding. The same metrics were used as the ones described in Figure 3.05.

Figure 3.16 (belongs with Figure 3.06, pp. 56)



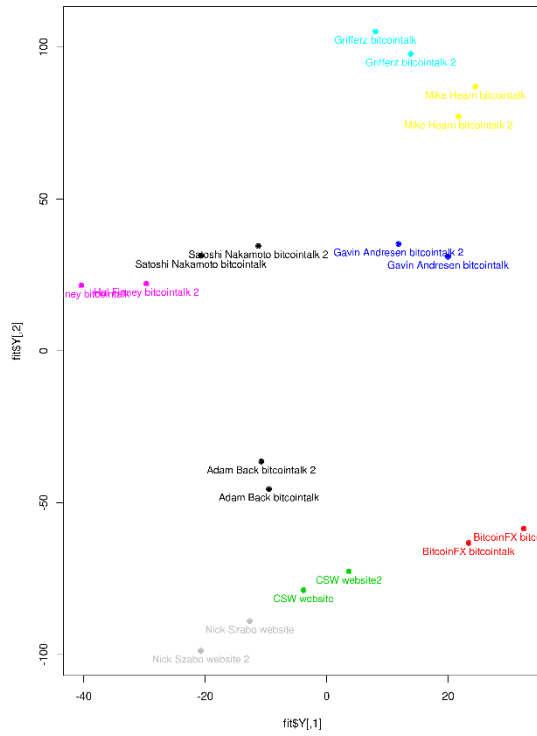
The result of a 3-gram character analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed by *t*-distributed stochastic neighbor embedding. The same metrics were used as the ones described in Figure 3.06.

Figure 3.17 (belongs with Figure 3.07, pp. 57)



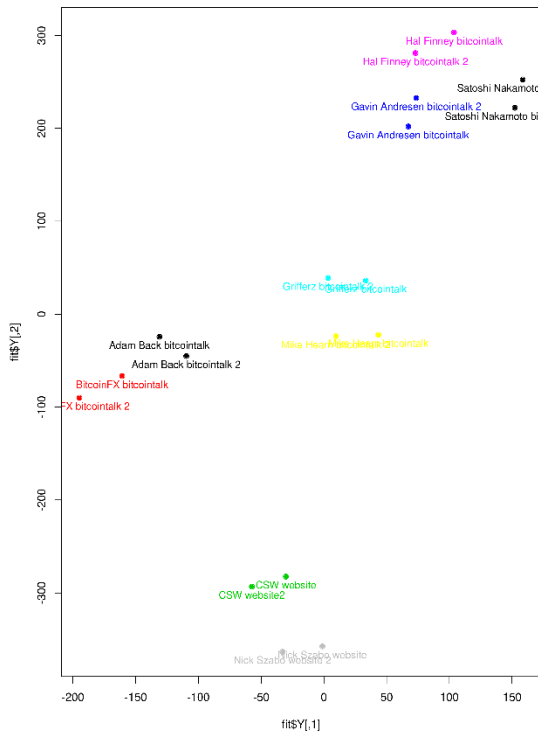
The result of a 3-gram character analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed by *t*-distributed stochastic neighbor embedding. The same metrics were used as the ones described in Figure 3.07.

Figure 3.18 (belongs with Figure 3.08, pp. 58)



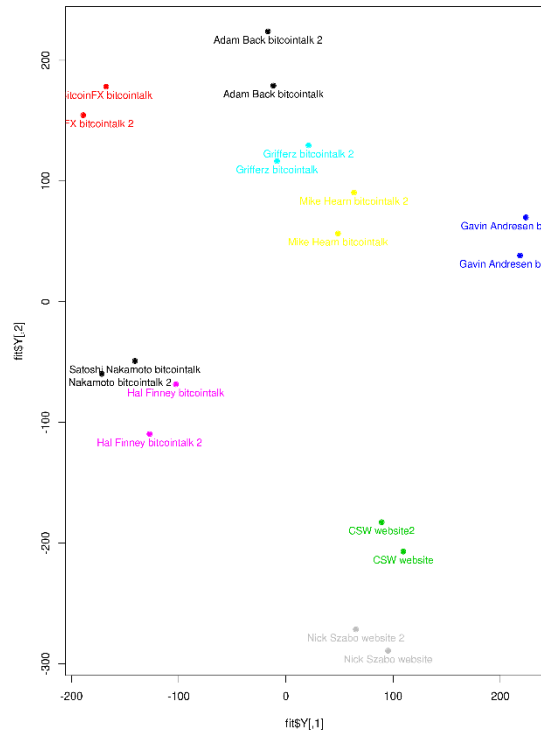
The result of a 3-gram character analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed by *t*-distributed stochastic neighbor embedding. The same metrics were used as the ones described in Figure 3.08.

Figure 3.19 (belongs with Figure 3.09, pp. 59)



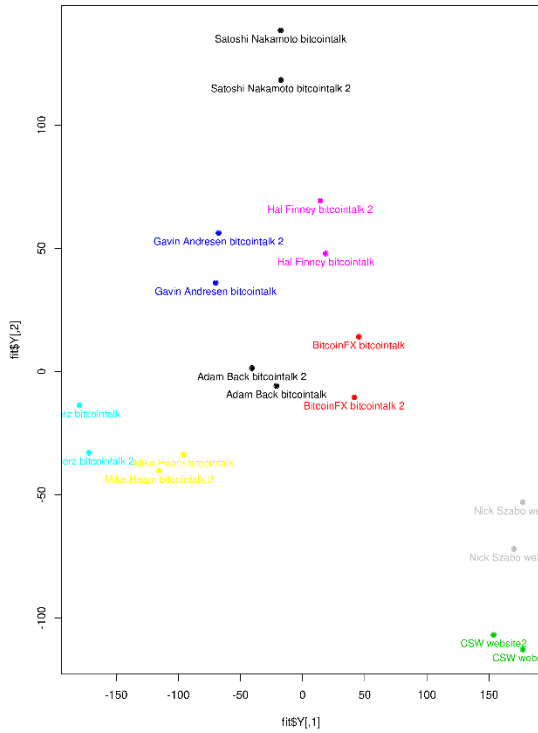
The result of a 3-gram character analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed by *t*-distributed stochastic neighbor embedding. The same metrics were used as the ones described in Figure 3.09.

Figure 3.20 (belongs with Figure 3.10, pp. 60)



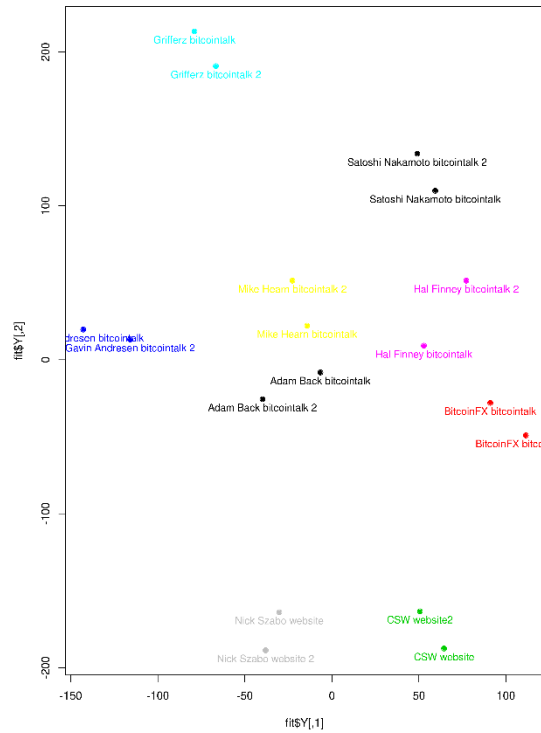
The result of a 3-gram character analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed by *t*-distributed stochastic neighbor embedding. The same metrics were used as the ones described in Figure 3.10.

Figure 4.11 (belongs with Figure 4.01, pp. 65)



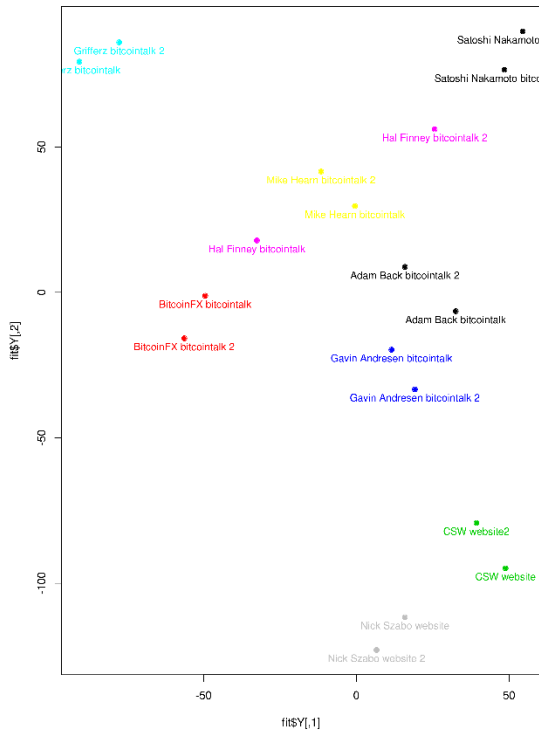
The result of a function word analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed by *t*-distributed stochastic neighbor embedding. The same metrics were used as the ones described in Figure 4.01.

Figure 4.12 (belongs with Figure 4.02, pp. 66)



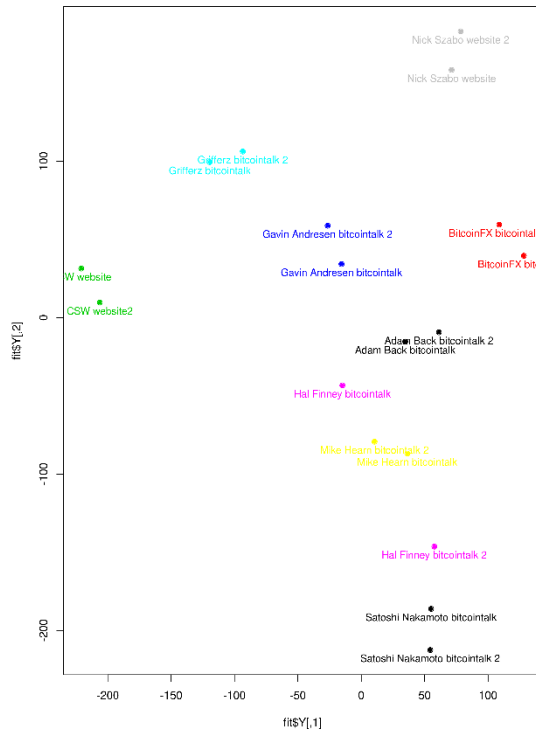
The result of a function word analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed by *t*-distributed stochastic neighbor embedding. The same metrics were used as the ones described in Figure 4.02.

Figure 4.13 (belongs with Figure 4.03, pp. 67)



The result of a function word analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed by *t*-distributed stochastic neighbor embedding. The same metrics were used as the ones described in Figure 4.03.

Figure 4.14 (belongs with Figure 4.04, pp. 68)



The result of a function word analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed by *t*-distributed stochastic neighbor embedding. The same metrics were used as the ones described in Figure 4.04.

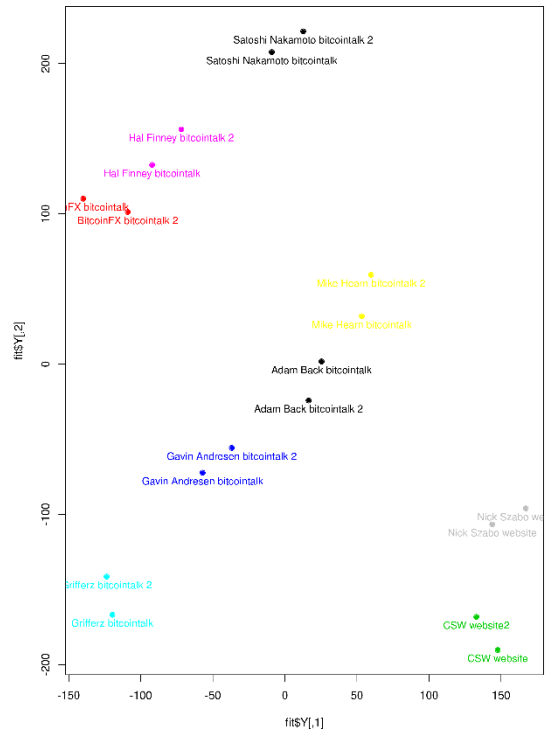


Figure 4.15 (belongs with Figure 4.05, pp. 69)



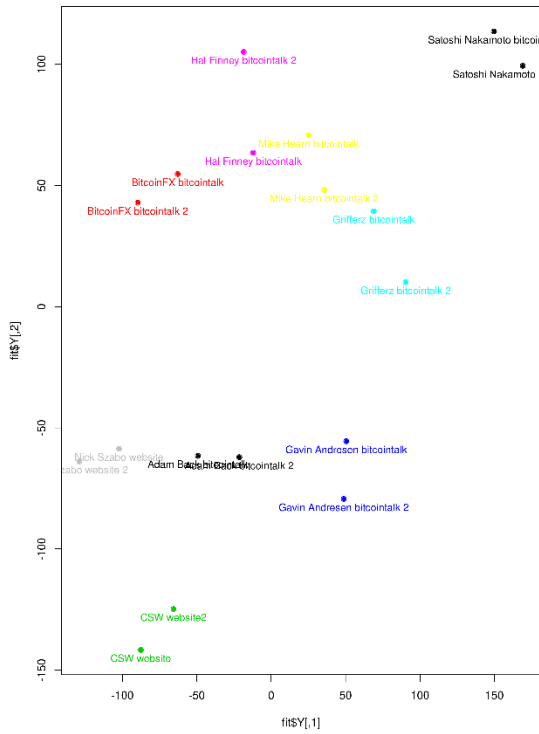
The result of a function word analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed by *t*-distributed stochastic neighbor embedding. The same metrics were used as the ones described in Figure 4.05.

Figure 4.16 (belongs with Figure 4.06, pp. 70)



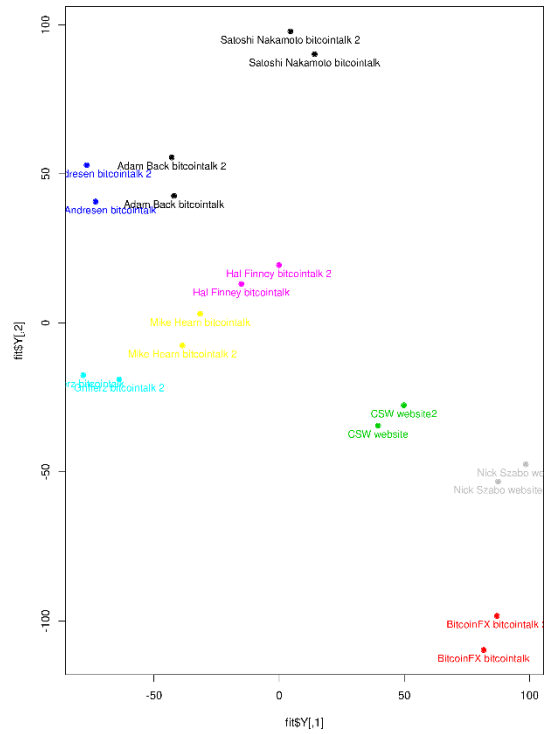
The result of a function word analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed by *t*-distributed stochastic neighbor embedding. The same metrics were used as the ones described in Figure 4.06.

Figure 4.17 (belongs with Figure 4.07, pp. 71)



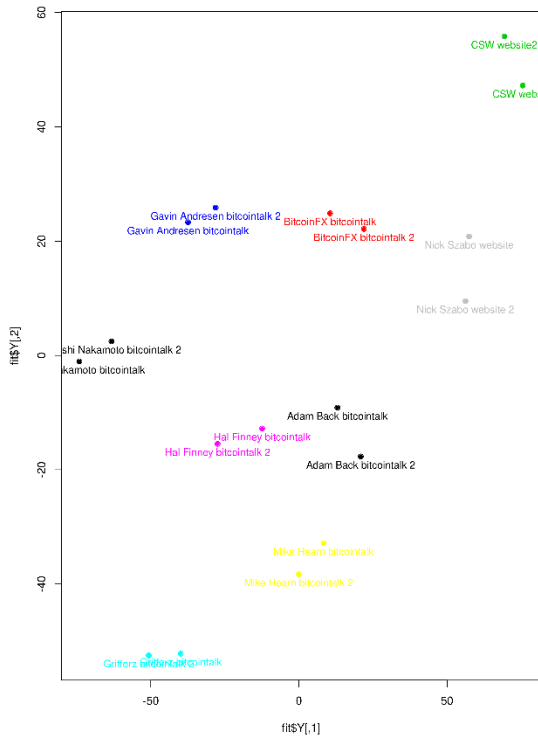
The result of a function word analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed by *t*-distributed stochastic neighbor embedding. The same metrics were used as the ones described in Figure 4.07.

Figure 4.18 (belongs with Figure 4.08, pp. 72)



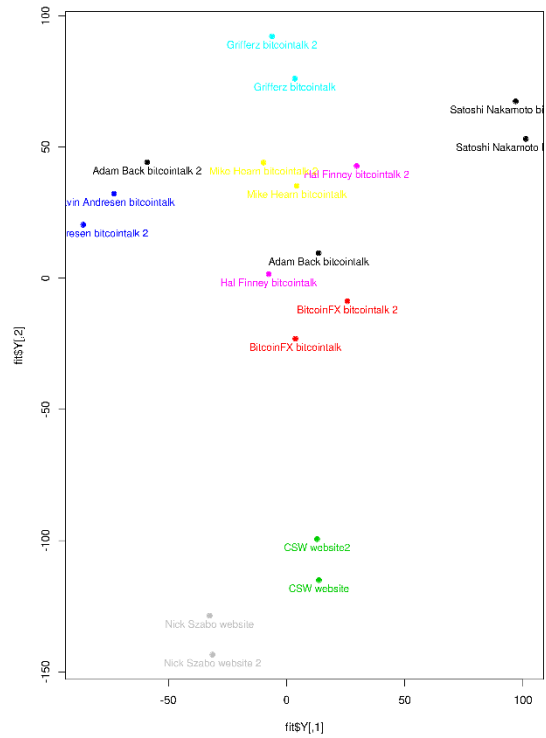
The result of a function word analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed by *t*-distributed stochastic neighbor embedding. The same metrics were used as the ones described in Figure 4.08.

Figure 4.19 (belongs with Figure 4.09, pp. 73)



The result of a function word analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed by *t*-distributed stochastic neighbor embedding. The same metrics were used as the ones described in Figure 4.09.

Figure 4.20 (belongs with Figure 4.10, pp. 74)



The result of a function word analysis of all 18 samples from 9 authors, tokenized and reduced to 5,000 tokens and randomized, portrayed by *t*-distributed stochastic neighbor embedding. The same metrics were used as the ones described in Figure 4.10.

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## 6.2 Footnotes

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- <sup>22</sup> <https://bitcointalk.org/index.php?topic=58579.msg691432#msg691432>
- <sup>23</sup> <https://bitcointalk.org/index.php?topic=1013053.msg11003988#msg11003988>
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- <sup>27</sup> <https://bitcointalk.org/index.php?topic=3311.msg46756#msg46756>
- <sup>28</sup> <https://bitcointalk.org/index.php?topic=3238.msg45461#msg45461>
- <sup>29</sup> <https://bitcointalk.org/index.php?topic=176432.msg1877928#msg1877928>
- <sup>30</sup> <https://bitcointalk.org/index.php?topic=3414.msg48309#msg48309>
- <sup>31</sup> <https://bitcointalk.org/index.php?topic=3293.msg46396#msg46396>
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- <sup>41</sup> <https://bitcointalk.org/index.php?topic=180020.msg1887984#msg1887984>
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68 <https://bitcointalk.org/index.php?topic=80.msg698#msg698>

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## 6.3 Analyzed Material

### 6.3.1 Satoshi Nakamoto

Set 1:

<https://bitcointalk.org/index.php?topic=6.msg31#msg31> (accessed 09.04.2022)  
<https://bitcointalk.org/index.php?topic=10.msg38#msg38> (accessed 09.04.2022)  
<https://bitcointalk.org/index.php?topic=12.msg41#msg41> (accessed 09.04.2022)  
<https://bitcointalk.org/index.php?topic=13.msg49#msg49> (accessed 09.04.2022)  
<https://bitcointalk.org/index.php?topic=12.msg54#msg54> (accessed 09.04.2022)  
<https://bitcointalk.org/index.php?topic=27.msg170#msg170> (accessed 09.04.2022)  
<https://bitcointalk.org/index.php?topic=27.msg156#msg156> (accessed 09.04.2022)  
<https://bitcointalk.org/index.php?topic=43.msg388#msg388> (accessed 09.04.2022)  
<https://bitcointalk.org/index.php?topic=43.msg376#msg376> (accessed 09.04.2022)  
<https://bitcointalk.org/index.php?topic=47.msg283#msg283> (accessed 09.04.2022)  
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<https://bitcointalk.org/index.php?topic=27.msg170#msg170> (accessed 09.04.2022)  
<https://bitcointalk.org/index.php?topic=22.msg223#msg223> (accessed 09.04.2022)  
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<https://bitcointalk.org/index.php?topic=48.msg327#msg327> (accessed 09.04.2022)  
<https://bitcointalk.org/index.php?topic=43.msg376#msg376> (accessed 09.04.2022)  
<https://bitcointalk.org/index.php?topic=57.msg415#msg415> (accessed 09.04.2022)  
<https://bitcointalk.org/index.php?topic=55.msg481#msg481> (accessed 09.04.2022)  
<https://bitcointalk.org/index.php?topic=59.msg414#msg414> (accessed 09.04.2022)  
<https://bitcointalk.org/index.php?topic=54.msg1135#msg1135> (accessed 09.04.2022)  
<https://bitcointalk.org/index.php?topic=129.msg1131#msg1131> (accessed 09.04.2022)  
<https://bitcointalk.org/index.php?topic=83.msg809#msg809> (accessed 09.04.2022)  
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<https://bitcointalk.org/index.php?topic=83.msg719#msg719> (accessed 09.04.2022)  
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<https://bitcointalk.org/index.php?topic=84.msg1579#msg1579> (accessed 09.04.2022)  
<https://bitcointalk.org/index.php?topic=43.msg1323#msg1323> (accessed 09.04.2022)  
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<https://bitcointalk.org/index.php?topic=177.msg1814#msg1814> (accessed 09.04.2022)  
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<https://bitcointalk.org/index.php?topic=202.msg2133#msg2133> (accessed 09.04.2022)  
<https://bitcointalk.org/index.php?topic=246.msg2077#msg2077> (accessed 09.04.2022)  
<https://bitcointalk.org/index.php?topic=241.msg2071#msg2071> (accessed 09.04.2022)  
<https://bitcointalk.org/index.php?topic=391.msg3308#msg3308> (accessed 09.04.2022)  
<https://bitcointalk.org/index.php?topic=286.msg2947#msg2947> (accessed 09.04.2022)  
<https://bitcointalk.org/index.php?topic=318.msg2903#msg2903> (accessed 09.04.2022)

<https://bitcointalk.org/index.php?topic=397.msg3524#msg3524> (accessed 09.04.2022)  
<https://bitcointalk.org/index.php?topic=393.msg3510#msg3510> (accessed 09.04.2022)  
<https://bitcointalk.org/index.php?topic=437.msg3807#msg3807> (accessed 09.04.2022)  
<https://bitcointalk.org/index.php?topic=434.msg3770#msg3770> (accessed 09.04.2022)  
<https://bitcointalk.org/index.php?topic=364.msg3559#msg3559> (accessed 09.04.2022)  
<https://bitcointalk.org/index.php?topic=461.msg5337#msg5337> (accessed 09.04.2022)  
<https://bitcointalk.org/index.php?topic=461.msg4169#msg4169> (accessed 09.04.2022)  
<https://bitcointalk.org/index.php?topic=461.msg5769#msg5769> (accessed 09.04.2022)  
<https://bitcointalk.org/index.php?topic=571.msg5740#msg5740> (accessed 09.04.2022)  
<https://bitcointalk.org/index.php?topic=648.msg6751#msg6751> (accessed 09.04.2022)  
<https://bitcointalk.org/index.php?topic=642.msg6701#msg6701> (accessed 09.04.2022)  
<https://bitcointalk.org/index.php?topic=628.msg6508#msg6508> (accessed 09.04.2022)  
<https://bitcointalk.org/index.php?topic=338.msg6307#msg6307> (accessed 09.04.2022)  
<https://bitcointalk.org/index.php?topic=632.msg7090#msg7090> (accessed 09.04.2022)  
<https://bitcointalk.org/index.php?topic=770.msg8798#msg8798> (accessed 09.04.2022)  
<https://bitcointalk.org/index.php?topic=750.msg8140#msg8140> (accessed 09.04.2022)  
<https://bitcointalk.org/index.php?topic=645.msg8137#msg8137> (accessed 09.04.2022)  
<https://bitcointalk.org/index.php?topic=721.msg8114#msg8114> (accessed 09.04.2022)  
<https://bitcointalk.org/index.php?topic=645.msg7712#msg7712> (accessed 09.04.2022)  
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<https://bitcointalk.org/index.php?topic=1063.msg13211#msg13211> (accessed 09.04.2022)  
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<https://bitcointalk.org/index.php?topic=64.msg21766#msg21766> (accessed 09.04.2022)  
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<https://bitcointalk.org/index.php?topic=1790.msg28959#msg28959> (accessed 09.04.2022)  
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Set 2:

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<https://bitcointalk.org/index.php?topic=2208.msg29165#msg29165> (accessed 09.04.2022)



<https://bitcointalk.org/index.php?topic=84.msg729#msg729> (accessed 09.04.2022)

<https://bitcointalk.org/index.php?topic=1790.msg28917#msg28917> (accessed 09.04.2022)

<https://bitcointalk.org/index.php?topic=1790.msg28715#msg28715> (accessed 09.04.2022)

<https://bitcointalk.org/index.php?topic=644.msg28643#msg28643> (accessed 09.04.2022)

<https://bitcointalk.org/index.php?topic=2162.msg28549#msg28549> (accessed 09.04.2022)

<https://bitcointalk.org/index.php?topic=2151.msg28313#msg28313> (accessed 09.04.2022)

<https://bitcointalk.org/index.php?topic=1735.msg26999#msg26999> (accessed 09.04.2022)

<https://bitcointalk.org/index.php?topic=1790.msg28696#msg28696> (accessed 09.04.2022)

<https://bitcointalk.org/index.php?topic=2151.msg28228#msg28228> (accessed 09.04.2022)

<https://bitcointalk.org/index.php?topic=1931.msg25449#msg25449> (accessed 09.04.2022)

<https://bitcointalk.org/index.php?topic=1986.msg25154#msg25154> (accessed 09.04.2022)

<https://bitcointalk.org/index.php?topic=1931.msg25138#msg25138> (accessed 09.04.2022)

<https://bitcointalk.org/index.php?topic=1976.msg25119#msg25119> (accessed 09.04.2022)

<https://bitcointalk.org/index.php?topic=1931.msg24662#msg24662> (accessed 09.04.2022)

<https://bitcointalk.org/index.php?topic=1931.msg24438#msg24438> (accessed 09.04.2022)

<https://bitcointalk.org/index.php?topic=1334.msg24101#msg24101> (accessed 09.04.2022)

<https://bitcointalk.org/index.php?topic=1901.msg24095#msg24095> (accessed 09.04.2022)

<https://bitcointalk.org/index.php?topic=1850.msg22952#msg22952> (accessed 09.04.2022)

<https://bitcointalk.org/index.php?topic=1786.msg22119#msg22119> (accessed 09.04.2022)

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<https://bitcointalk.org/index.php?topic=321086.msg3453043#msg3453043> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=293307.msg3440283#msg3440283> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=321086.msg3438121#msg3438121> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=131443.msg3424118#msg3424118> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=310323.msg3346530#msg3346530> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=303761.msg3273512#msg3273512> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=300102.msg3219725#msg3219725> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=299005.msg3213333#msg3213333> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=178011.msg3179711#msg3179711> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=128442.msg3162569#msg3162569> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=183.msg3162561#msg3162561> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=288298.msg3111910#msg3111910> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=287351.msg3104709#msg3104709> (accessed 12.04.2022)

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<https://bitcointalk.org/index.php?topic=260749.msg2791092#msg2791092> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=252931.msg2696066#msg2696066> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=251447.msg2684424#msg2684424> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=225236.msg2391744#msg2391744> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=226196.msg2380783#msg2380783> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=221111.msg2370887#msg2370887> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=221111.msg2369053#msg2369053> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=221111.msg2361639#msg2361639> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=221111.msg2360913#msg2360913> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=223007.msg2359756#msg2359756> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=221111.msg2359724#msg2359724> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=220530.msg2324290#msg2324290> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=220273.msg2320603#msg2320603> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=175156.msg2318052#msg2318052> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=214883.msg2260402#msg2260402> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=212380.msg2226916#msg2226916> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=210130.msg2226486#msg2226486> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=203989.msg2132193#msg2132193> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=202111.msg2113412#msg2113412> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=196138.msg2113288#msg2113288> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=196138.msg2100394#msg2100394> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=199947.msg2090345#msg2090345> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=195642.msg2043717#msg2043717> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=196367.msg2042966#msg2042966> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=189350.msg2037447#msg2037447> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=192880.msg2020116#msg2020116> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=192880.msg2007067#msg2007067> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=192181.msg1990885#msg1990885> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=179464.msg1990810#msg1990810> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=191425.msg1987832#msg1987832> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=191765.msg1986115#msg1986115> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=145496.msg1985563#msg1985563> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=191425.msg1985498#msg1985498> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=189792.msg1985439#msg1985439> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=189792.msg1967890#msg1967890> (accessed 12.04.2022)

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<https://bitcointalk.org/index.php?topic=182992.msg1913758#msg1913758> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=181168.msg1897036#msg1897036> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=180020.msg1885226#msg1885226> (accessed 12.04.2022)

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<https://bitcointalk.org/index.php?topic=175026.msg1821877#msg1821877> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=157141.msg1794856#msg1794856> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=169681.msg1764550#msg1764550> (accessed 12.04.2022)

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<https://bitcointalk.org/index.php?topic=160306.msg1723484#msg1723484> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=160306.msg1722532#msg1722532> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=162522.msg1711886#msg1711886> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=162336.msg1707686#msg1707686> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=160785.msg1699835#msg1699835> (accessed 12.04.2022)

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<https://bitcointalk.org/index.php?topic=156334.msg1665231#msg1665231> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=156641.msg1663216#msg1663216> (accessed 12.04.2022)

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<https://bitcointalk.org/index.php?topic=148211.msg1581733#msg1581733> (accessed 12.04.2022)

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<https://bitcointalk.org/index.php?topic=144964.msg1541225#msg1541225> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=144984.msg1541191#msg1541191> (accessed 12.04.2022)

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<https://bitcointalk.org/index.php?topic=145154.msg1539795#msg1539795> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=144895.msg1539692#msg1539692> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=144895.msg1537333#msg1537333> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=144895.msg1537235#msg1537235> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=144895.msg1537055#msg1537055> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=144421.msg1531776#msg1531776> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=144295.msg1530454#msg1530454> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=142151.msg1529545#msg1529545> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=141879.msg1511465#msg1511465> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=141865.msg1510995#msg1510995> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=2623.msg1510975#msg1510975> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=140233.msg1503099#msg1503099> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=140233.msg1496306#msg1496306> (accessed 12.04.2022)  
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<https://bitcointalk.org/index.php?topic=140313.msg1493954#msg1493954> (accessed 12.04.2022)  
<https://bitcointalk.org/index.php?topic=140078.msg1491378#msg1491378> (accessed 12.04.2022)  
<https://bitcointalk.org/index.php?topic=139390.msg1490312#msg1490312> (accessed 12.04.2022)  
<https://bitcointalk.org/index.php?topic=139702.msg1488287#msg1488287> (accessed 12.04.2022)  
<https://bitcointalk.org/index.php?topic=139390.msg1488185#msg1488185> (accessed 12.04.2022)  
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<https://bitcointalk.org/index.php?topic=139390.msg1484096#msg1484096> (accessed 12.04.2022)  
<https://bitcointalk.org/index.php?topic=138752.msg1479445#msg1479445> (accessed 12.04.2022)  
<https://bitcointalk.org/index.php?topic=126024.msg1474773#msg1474773> (accessed 12.04.2022)  
<https://bitcointalk.org/index.php?topic=138000.msg1471895#msg1471895> (accessed 12.04.2022)  
<https://bitcointalk.org/index.php?topic=137866.msg1471782#msg1471782> (accessed 12.04.2022)  
<https://bitcointalk.org/index.php?topic=6785.msg1469004#msg1469004> (accessed 12.04.2022)  
<https://bitcointalk.org/index.php?topic=135567.msg1461393#msg1461393> (accessed 12.04.2022)  
<https://bitcointalk.org/index.php?topic=136795.msg1457862#msg1457862> (accessed 12.04.2022)  
<https://bitcointalk.org/index.php?topic=4571.msg1450235#msg1450235> (accessed 12.04.2022)  
<https://bitcointalk.org/index.php?topic=135856.msg1447313#msg1447313> (accessed 12.04.2022)  
<https://bitcointalk.org/index.php?topic=135406.msg1442338#msg1442338> (accessed 12.04.2022)  
<https://bitcointalk.org/index.php?topic=94155.msg1440523#msg1440523> (accessed 12.04.2022)  
<https://bitcointalk.org/index.php?topic=133832.msg1438121#msg1438121> (accessed 12.04.2022)  
<https://bitcointalk.org/index.php?topic=134318.msg1438101#msg1438101> (accessed 12.04.2022)

### 6.3.4 Hal Finney

Set 1:

<https://bitcointalk.org/index.php?topic=155054.msg1643833#msg1643833> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=270898.msg2901342#msg2901342> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=216982.msg2703136#msg2703136> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=175156.msg2677193#msg2677193> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=160833.msg1896971#msg1896971> (accessed 10.04.2022)  
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<https://bitcointalk.org/index.php?topic=173164.msg1808457#msg1808457> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=156390.msg1659654#msg1659654> (accessed 10.04.2022)  
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<https://bitcointalk.org/index.php?topic=154290.msg1635481#msg1635481> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=151389.msg1625268#msg1625268> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=132008.msg1416027#msg1416027> (accessed 10.04.2022)  
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<https://bitcointalk.org/index.php?topic=128042.msg1400661#msg1400661> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=67508.msg1153102#msg1153102> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=103172.msg1138884#msg1138884> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=100899.msg1108086#msg1108086> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=68121.msg804338#msg804338> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=68895.msg804319#msg804319> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=23081.msg290622#msg290622> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=9611.msg192038#msg192038> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=12523.msg173787#msg173787> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=11947.msg171847#msg171847> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=11765.msg169026#msg169026> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=10666.msg152988#msg152988> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=9818.msg142070#msg142070> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=7830.msg134361#msg134361> (accessed 10.04.2022)

<https://bitcointalk.org/index.php?topic=8714.msg128711#msg128711> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=8662.msg125804#msg125804> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=7955.msg116670#msg116670> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=7830.msg115016#msg115016> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=7638.msg113337#msg113337> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=7357.msg109385#msg109385> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=5687.msg84160#msg84160> (accessed 10.04.2022)  
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<https://bitcointalk.org/index.php?topic=5499.msg82333#msg82333> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=5371.msg79009#msg79009> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=5079.msg78944#msg78944> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=5333.msg78245#msg78245> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=4983.msg76739#msg76739> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=5188.msg75831#msg75831> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=5024.msg73800#msg73800> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=5027.msg73733#msg73733> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=4981.msg73061#msg73061> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=4853.msg71714#msg71714> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=4858.msg71568#msg71568> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=4888.msg71567#msg71567> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=4858.msg71549#msg71549> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=266.msg71540#msg71540> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=4555.msg70889#msg70889> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=4801.msg70830#msg70830> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=4822.msg70817#msg70817> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=4719.msg70805#msg70805> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=4782.msg70107#msg70107> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=4779.msg70100#msg70100> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=4608.msg70095#msg70095> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=4749.msg69861#msg69861> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=4448.msg69209#msg69209> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=4708.msg68607#msg68607> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=4555.msg68129#msg68129> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=4546.msg67594#msg67594> (accessed 10.04.2022)  
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<https://bitcointalk.org/index.php?topic=4358.msg63619#msg63619> (accessed 10.04.2022)  
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<https://bitcointalk.org/index.php?topic=4297.msg63139#msg63139> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=227.msg63135#msg63135> (accessed 10.04.2022)  
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<https://bitcointalk.org/index.php?topic=4278.msg62539#msg62539> (accessed 10.04.2022)  
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<https://bitcointalk.org/index.php?topic=4137.msg60484#msg60484> (accessed 10.04.2022)

<https://bitcointalk.org/index.php?topic=4170.msg60432#msg60432> (accessed 10.04.2022)

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<https://bitcointalk.org/index.php?topic=4149.msg60110#msg60110> (accessed 10.04.2022)

<https://bitcointalk.org/index.php?topic=4022.msg59338#msg59338> (accessed 10.04.2022)

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<https://bitcointalk.org/index.php?topic=4009.msg57790#msg57790> (accessed 10.04.2022)

<https://bitcointalk.org/index.php?topic=3835.msg54625#msg54625> (accessed 10.04.2022)

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<https://bitcointalk.org/index.php?topic=3381.msg47935#msg47935> (accessed 10.04.2022)

<https://bitcointalk.org/index.php?topic=3311.msg47934#msg47934> (accessed 10.04.2022)

<https://bitcointalk.org/index.php?topic=3373.msg47537#msg47537> (accessed 10.04.2022)

<https://bitcointalk.org/index.php?topic=3336.msg46899#msg46899> (accessed 10.04.2022)

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<https://bitcointalk.org/index.php?topic=3311.msg46756#msg46756> (accessed 10.04.2022)

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<https://bitcointalk.org/index.php?topic=3149.msg44209#msg44209> (accessed 10.04.2022)

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<https://bitcointalk.org/index.php?topic=3089.msg43857#msg43857> (accessed 10.04.2022)

<https://bitcointalk.org/index.php?topic=1737.msg43220#msg43220> (accessed 10.04.2022)

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<https://bitcointalk.org/index.php?topic=2371.msg31847#msg31847> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=2338.msg31826#msg31826> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=2331.msg31218#msg31218> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=1790.msg30480#msg30480> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=2267.msg30170#msg30170> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=1790.msg29919#msg29919> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=1790.msg29887#msg29887> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=2244.msg29861#msg29861> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=2211.msg29659#msg29659> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=2188.msg29223#msg29223> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=2205.msg29010#msg29010> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=2200.msg28967#msg28967> (accessed 10.04.2022)  
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<https://bitcointalk.org/index.php?topic=2129.msg27922#msg27922> (accessed 10.04.2022)  
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<https://bitcointalk.org/index.php?topic=1790.msg27496#msg27496> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=1790.msg27484#msg27484> (accessed 10.04.2022)  
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<https://bitcointalk.org/index.php?topic=2062.msg27183#msg27183> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=2077.msg27173#msg27173> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=2077.msg26888#msg26888> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=1790.msg26880#msg26880> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=1735.msg26860#msg26860> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=1790.msg26846#msg26846> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=1735.msg26835#msg26835> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=1047.msg26636#msg26636> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=2011.msg25637#msg25637> (accessed 10.04.2022)

### 6.3.5 Adam Back

#### Set 1:

<https://bitcointalk.org/index.php?topic=1312371.msg13440535#msg13440535> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=180020.msg1888627#msg1888627> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=1312371.msg13428245#msg13428245> (accessed 10.04.2022)  
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<https://bitcointalk.org/index.php?topic=923409.msg10198088#msg10198088> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=911339.msg10037055#msg10037055> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=911339.msg10036466#msg10036466> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=172705.msg1889108#msg1889108> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=180020.msg1890295#msg1890295> (accessed 10.04.2022)  
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<https://bitcointalk.org/index.php?topic=178893.msg1864553#msg1864553> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=1312371.msg13440535#msg13440535> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=180020.msg1888390#msg1888390> (accessed 10.04.2022)  
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<https://bitcointalk.org/index.php?topic=68655.msg10035976#msg10035976> (accessed 10.04.2022)  
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<https://bitcointalk.org/index.php?topic=15672.msg1873483#msg1873483> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=1312371.msg13437179#msg13437179> (accessed 10.04.2022)  
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<https://bitcointalk.org/index.php?topic=4316642.msg39228633#msg39228633> (accessed 10.04.2022)  
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<https://bitcointalk.org/index.php?topic=831527.msg10036702#msg10036702> (accessed 10.04.2022)

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<https://bitcointalk.org/index.php?topic=68655.msg10011663#msg10011663> (accessed 10.04.2022)

<https://bitcointalk.org/index.php?topic=911339.msg10007339#msg10007339> (accessed 10.04.2022)

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<https://bitcointalk.org/index.php?topic=68655.msg9997666#msg9997666> (accessed 10.04.2022)

<https://bitcointalk.org/index.php?topic=68655.msg9997546#msg9997546> (accessed 10.04.2022)

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<https://bitcointalk.org/index.php?topic=68655.msg9991720#msg9991720> (accessed 10.04.2022)

<https://bitcointalk.org/index.php?topic=68655.msg9991472#msg9991472> (accessed 10.04.2022)

<https://bitcointalk.org/index.php?topic=68655.msg9989148#msg9989148> (accessed 10.04.2022)

<https://bitcointalk.org/index.php?topic=68655.msg9989044#msg9989044> (accessed 10.04.2022)

<https://bitcointalk.org/index.php?topic=68655.msg9988878#msg9988878> (accessed 10.04.2022)

### 6.3.6 Mike Hearn

#### Set 1:

<https://bitcointalk.org/index.php?topic=1175321.msg12372347#msg12372347> (accessed 10.04.2022)

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<https://bitcointalk.org/index.php?topic=1033743.msg11163024#msg11163024> (accessed 10.04.2022)

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<https://bitcointalk.org/index.php?topic=924451.msg10195854#msg10195854> (accessed 10.04.2022)

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<https://bitcointalk.org/index.php?topic=911966.msg10015223#msg10015223> (accessed 10.04.2022)

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<https://bitcointalk.org/index.php?topic=522800.msg5820542#msg5820542> (accessed 10.04.2022)  
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<https://bitcointalk.org/index.php?topic=481112.msg5521710#msg5521710> (accessed 10.04.2022)  
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<https://bitcointalk.org/index.php?topic=304060.msg5362503#msg5362503> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=481112.msg5321542#msg5321542> (accessed 10.04.2022)  
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<https://bitcointalk.org/index.php?topic=173220.msg5319920#msg5319920> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=482480.msg5315620#msg5315620> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=480959.msg5315111#msg5315111> (accessed 10.04.2022)  
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<https://bitcointalk.org/index.php?topic=431513.msg4973714#msg4973714> (accessed 10.04.2022)  
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<https://bitcointalk.org/index.php?topic=43616.msg4911365#msg4911365> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=445649.msg4911334#msg4911334> (accessed 10.04.2022)  
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<https://bitcointalk.org/index.php?topic=304060.msg4840682#msg4840682> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=438353.msg4837957#msg4837957> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=438726.msg4835883#msg4835883> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=4483.msg4821581#msg4821581> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=438726.msg4821460#msg4821460> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=293472.msg4816584#msg4816584> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=257803.msg4816559#msg4816559> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=436899.msg4816534#msg4816534> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=433315.msg4816405#msg4816405> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=437070.msg4814035#msg4814035> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=304060.msg4801594#msg4801594> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=431513.msg4801131#msg4801131> (accessed 10.04.2022)  
<https://bitcointalk.org/index.php?topic=304060.msg4801097#msg4801097> (accessed 10.04.2022)

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<https://bitcointalk.org/index.php?topic=270190.msg4800912#msg4800912> (accessed 10.04.2022)  
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<https://bitcointalk.org/index.php?topic=433315.msg4778538#msg4778538> (accessed 10.04.2022)  
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<https://bitcointalk.org/index.php?topic=429264.msg4754276#msg4754276> (accessed 10.04.2022)

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<https://bitcointalk.org/index.php?topic=423427.msg4717322#msg4717322> (accessed 10.04.2022)

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<https://bitcointalk.org/index.php?topic=423427.msg4717030#msg4717030> (accessed 10.04.2022)

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<https://bitcointalk.org/index.php?topic=428777.msg4716845#msg4716845> (accessed 10.04.2022)

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<https://bitcointalk.org/index.php?topic=304060.msg4661227#msg4661227> (accessed 10.04.2022)

<https://bitcointalk.org/index.php?topic=244656.msg4641943#msg4641943> (accessed 10.04.2022)

<https://bitcointalk.org/index.php?topic=419259.msg4641829#msg4641829> (accessed 10.04.2022)

<https://bitcointalk.org/index.php?topic=421608.msg4641767#msg4641767> (accessed 10.04.2022)

<https://bitcointalk.org/index.php?topic=421608.msg4638923#msg4638923> (accessed 10.04.2022)

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<https://bitcointalk.org/index.php?topic=421608.msg4627540#msg4627540> (accessed 10.04.2022)

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<https://bitcointalk.org/index.php?topic=421608.msg4597187#msg4597187> (accessed 10.04.2022)

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<https://bitcointalk.org/index.php?topic=416925.msg4547721#msg4547721> (accessed 10.04.2022)

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<https://bitcointalk.org/index.php?topic=5979.msg4542534#msg4542534> (accessed 10.04.2022)

<https://bitcointalk.org/index.php?topic=5979.msg4530183#msg4530183> (accessed 10.04.2022)

<https://bitcointalk.org/index.php?topic=415314.msg4530045#msg4530045> (accessed 10.04.2022)

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<https://bitcointalk.org/index.php?topic=23501.msg4509152#msg4509152> (accessed 10.04.2022)

<https://bitcointalk.org/index.php?topic=270055.msg4509137#msg4509137> (accessed 10.04.2022)

<https://bitcointalk.org/index.php?topic=5979.msg4506243#msg4506243> (accessed 10.04.2022)

<https://bitcointalk.org/index.php?topic=5979.msg4503733#msg4503733> (accessed 10.04.2022)

<https://bitcointalk.org/index.php?topic=23501.msg4503424#msg4503424> (accessed 10.04.2022)

<https://bitcointalk.org/index.php?topic=407861.msg4464877#msg4464877> (accessed 10.04.2022)

<https://bitcointalk.org/index.php?topic=402638.msg4430621#msg4430621> (accessed 10.04.2022)

<https://bitcointalk.org/index.php?topic=128442.msg4430605#msg4430605> (accessed 10.04.2022)

<https://bitcointalk.org/index.php?topic=403442.msg4364596#msg4364596> (accessed 10.04.2022)

<https://bitcointalk.org/index.php?topic=364567.msg4362994#msg4362994> (accessed 10.04.2022)

<https://bitcointalk.org/index.php?topic=304060.msg4362929#msg4362929> (accessed 10.04.2022)

<https://bitcointalk.org/index.php?topic=399313.msg4362801#msg4362801> (accessed 10.04.2022)

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<http://unenumerated.blogspot.com/2006/11/robot-law.html> (accessed 09.04.2022)

<http://unenumerated.blogspot.com/2007/09/real-options-analysis-for-deep-space.html> (accessed 09.04.2022)

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<http://unenumerated.blogspot.com/2007/08/smart-contracts-watch.html> (accessed 09.04.2022)

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<http://unenumerated.blogspot.com/2011/05/bitcoin-what-took-ye-so-long.html> (accessed 09.04.2022)

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<http://unenumerated.blogspot.com/2008/04/bit-gold-markets.html> (accessed 09.04.2022)

<http://unenumerated.blogspot.com/2005/11/origins-of-joint-stock-corporation.html> (accessed 09.04.2022)

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<https://bitcointalk.org/index.php?topic=5.msg188#msg188> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=35.msg189#msg189> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=23.msg190#msg190> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=22.msg191#msg191> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=22.msg192#msg192> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=30.msg194#msg194> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=36.msg195#msg195> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=34.msg196#msg196> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=50.msg338#msg338> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=51.msg337#msg337> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=40.msg312#msg312> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=45.msg293#msg293> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=42.msg259#msg259> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=44.msg257#msg257> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=42.msg247#msg247> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=38.msg218#msg218> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=37.msg215#msg215> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=36.msg208#msg208> (accessed 11.04.2022)

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<https://bitcointalk.org/index.php?topic=34.msg206#msg206> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=73.msg704#msg704> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=80.msg698#msg698> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=79.msg697#msg697> (accessed 11.04.2022)

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<https://bitcointalk.org/index.php?topic=57.msg445#msg445> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=53.msg354#msg354> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=108.msg933#msg933> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=83.msg816#msg816> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=67.msg814#msg814> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=87.msg791#msg791> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=87.msg786#msg786> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=87.msg785#msg785> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=87.msg783#msg783> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=86.msg755#msg755> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=83.msg752#msg752> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=83.msg728#msg728> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=78.msg3139#msg3139> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=208.msg1953#msg1953> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=208.msg1886#msg1886> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=80.msg1154#msg1154> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=116.msg976#msg976> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=30.msg953#msg953> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=96.msg934#msg934> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=1399.msg16414#msg16414> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=433.msg3801#msg3801> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=271.msg3419#msg3419> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=375.msg3411#msg3411> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=191362.msg1981287#msg1981287> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=172664.msg1840382#msg1840382> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=172664.msg1798387#msg1798387> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=206630.msg2227990#msg2227990> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=206123.msg2162807#msg2162807> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=205789.msg2267493#msg2267493> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=229854.msg2422573#msg2422573> (accessed 11.04.2022)

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<https://bitcointalk.org/index.php?topic=255782.msg2738200#msg2738200> (accessed 11.04.2022)

<https://bitcointalk.org/index.php?topic=253409.msg2738527#msg2738527> (accessed 11.04.2022)

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<https://bitcointalk.org/index.php?topic=507936.msg5621798#msg5621798> (accessed 11.04.2022)

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<https://bitcointalk.org/index.php?topic=3746859.msg52452771#msg52452771> (accessed 12.04.2022)

<https://bitcointalk.org/index.php?topic=577267.msg9199440#msg9199440> (accessed 12.04.2022)

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<https://bitcointalk.org/index.php?topic=508971.msg5631591#msg5631591> (accessed 13.04.2022)

<https://bitcointalk.org/index.php?topic=499580.msg5609317#msg5609317> (accessed 13.04.2022)

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<https://bitcointalk.org/index.php?topic=498496.msg5523765#msg5523765> (accessed 13.04.2022)

<https://bitcointalk.org/index.php?topic=498364.msg5483311#msg5483311> (accessed 13.04.2022)

<https://bitcointalk.org/index.php?topic=498312.msg5482873#msg5482873> (accessed 13.04.2022)

<https://bitcointalk.org/index.php?topic=495233.msg5462805#msg5462805> (accessed 13.04.2022)

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<https://bitcointalk.org/index.php?topic=494607.msg5458045#msg5458045> (accessed 13.04.2022)

<https://bitcointalk.org/index.php?topic=494126.msg5446048#msg5446048> (accessed 13.04.2022)

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<https://bitcointalk.org/index.php?topic=493256.msg5438222#msg5438222> (accessed 13.04.2022)

<https://bitcointalk.org/index.php?topic=492042.msg5437050#msg5437050> (accessed 13.04.2022)

<https://bitcointalk.org/index.php?topic=491299.msg5427167#msg5427167> (accessed 13.04.2022)

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