

Medium as Message

A Case for Blockchain as an Art Medium

Eva Gentner

Dissertation

Master of Studies in History of Art and Visual Culture,
Trinity Term 2022

University of Oxford

Abstract

NFTs, their aesthetic and artistic value, as well as their high-priced sales, have been the subject of various controversial discussions since the beginning of 2021. However, the ongoing debate is mainly focused on NFTs as collectibles and does not include the role and potential of the blockchain itself as a profound part of artistic practice. In my dissertation, I argue that blockchain represents a new medium for art which, like every other art medium, influences how its art is constituted, produced, perceived, and consumed. In concordance with its medium, blockchain art is, as I will demonstrate, inherently programmable and decentralised. Firstly, I will expound the idea and basic concepts of blockchain technology. Secondly, blockchain art will be placed in an art-historical context, revealing the continuation and resumption of certain pre-existing issues and questions of twentieth-century and contemporary artistic practice. Thirdly, I will distinguish between examples where blockchain technology is used as a means for dissemination, and artworks where the blockchain is specifically addressed, applied, and leveraged as an inherent part of the artistic concept, constituting the art form: *blockchain art*. Lastly, I will argue that this art form represents and exemplifies the democratic nature of its underlying technology, mediating the vision of decentralisation, an alternative to current societal structures. These observations and conclusions are made possible through an introduction, discussion, and analysis of examples of blockchain art.

Contents

On blockchain technology and art.....	3
Contextualising blockchain art.....	12
Blockchain art and its constitution.....	22
Mediating a vision	31
Bibliography	40
Acknowledgements.....	44

On blockchain technology and art

Art can enact change. Blockchain is a technology that has been introduced to bring change to the financial system, shifting power from singular instances to a decentralised network of peers. The blockchain is also a medium for art. Since the beginning of 2021, the profusion of NFT production and high-priced sales have led to controversy in public discourses, ranging from admiration to astonishment and contempt.¹ However, ongoing debates are mainly focused on NFTs as collectibles. The intensity of their commercial success has eclipsed the aesthetic, creative and social merits of other types of art-making related to blockchains, therefore disregarding the role and potential of the medium itself as a profound constituent of artistic practice. In my dissertation, I argue that blockchain represents a medium for the novel art form *blockchain art*. I focus attention on the constitution of this art form which, as I will demonstrate, reflects on and, is determined by, the intrinsically programmable and decentralised nature of its medium.

NFTs, and their influence on artistic practice, are novel occurrences and academic research, touching upon aesthetic, conceptual, or philosophical considerations, has not yet been comprehensively conducted.² Therefore, this dissertation is intended to provide a first introduction to blockchain art, and to blockchain as a medium *for* art. I have identified four main questions, covering different perspectives on how these phenomena can be assessed. Firstly, I will ask about the principles of blockchain technology and how they are, under certain circumstances, related to artistic production. Secondly, questions are raised as to how blockchain art resumes issues of the twentieth-, and early twenty-first-century art historical context. Thirdly, with respect to other creative productions relying on blockchain technology, I outline the characteristics of blockchain art. The concluding chapter is focused on the relevance of this art form as a phenomenon of the present. The overarching goal of this

¹ Various sensational headlines represent the ongoing public discussion: ‘Are NFTs really art?’ <https://www.theguardian.com/technology/2022/mar/14/are-nfts-really-art> (20 May 2022); ‘“I went from having to borrow money to making \$4m in a “day”: how NFTs are shaking up the art world’ <https://www.theguardian.com/artanddesign/2021/nov/06/how-nfts-non-fungible-tokens-are-shaking-up-the-art-world> (20 May 2022).

² Catlow et al. published a work comprising artistic and theoretical contributions about the intersection between blockchains and art in general. It has been published *prior* to the introduction of NFTs and, consequently, the blockchain as a medium for art is not discussed. R. Catlow, et al. (eds), *Artists Re:Thinking the Blockchain* (Liverpool 2017). Articles, reflecting on NFT use cases related to the art market, exist, often with an emphasis on economic perspectives, for instance: D. MacDonald-Korth, et al., *The Art Market 2.0: Blockchain and Financialisation in Visual Arts* (Oxford Internet Institute and The Alan Turing Institute, 2018); B. Patrickson, ‘What Do Blockchain Technologies Imply for Digital Creative Industries?’, *Creativity and Innovation Management*, 30/3 (2021), pp. 585–595; or A. Whitaker, ‘Art and Blockchain: A Primer, History, and Taxonomy of Blockchain Use Cases in the Arts’, *Artivate*, 8/2 (2019), pp. 21–46.

dissertation is to introduce blockchain as an analytical subject, and in doing so, elucidate the deeply entrenched relation between content and medium as constituents of the art form's meaning. Examples of blockchain art throughout this dissertation help to illustrate such considerations and reveal how the envisioned change of blockchain technology is reflected by the art itself.

Blockchain technology evokes a multiplicity of associations, ranging from technological innovation and the hope for (global) democracy, to financial freedom, investment speculation, and cyber criminality. NFTs and blockchain art are closely related to this discussion given their dependence on the technology. Any appreciation of blockchain art requires an understanding of its constituents, in particular, the structures and functions of blockchains, non-fungible tokens (NFTs) and cryptocurrencies. Accordingly, the comprehension of these concepts involves a multidisciplinary approach that includes engineering, computer and data science, economics, and other fields depending on the depth of analysis. An isolated consideration of aesthetics or art historical questions, therefore, appears impractical, and to some extent irrelevant as the message is, as explored in this dissertation, also derived from the medium. Concepts, correlations, and in particular the vision of blockchain, are not intuitively graspable and, as a consequence, might appear untrustworthy. While the technology and its vision can take on an immense complexity, it is not my intention, and also out of my scope, to describe and analyse the multi-layered relation between all the parts of this system. Instead, I attempt to convey its fundamental concepts, and the potential it offers to individual humans and societies. Looking at the art that uses and thematises blockchains will make the technology itself more accessible and show one example of how it can be used. In the following, I will explain some of the basic technical principles and then transition to a first example of blockchain art which combines technical premises with conceptual and aesthetic considerations.

The fundamental vision behind blockchain technology is decentralisation. Decentralisation means the shift of power from one instance to a multitude of peers, which is, within the context of blockchain technology, applied to a financial model. This seemingly simple and broad idea entails wide-ranging consequences as it is supposed to increase transparency, efficiency, and eventually equality within and across electronic systems of finance.³ The basic idea of the

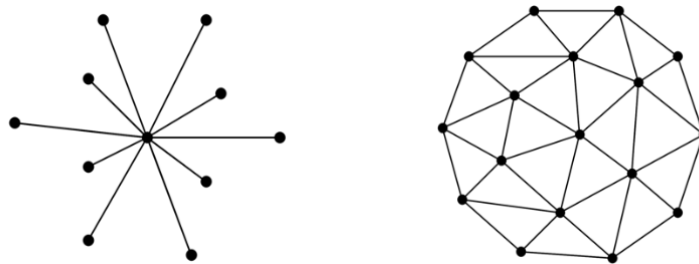
³ Blockchain technology was first described by Satoshi Nakamoto in the whitepaper *Bitcoin: A Peer-to-Peer Electronic Cash System* in 2009. More information on blockchains in general can be found here: D. Tapscott and A. Tapscott, *Blockchain Revolution. How the Technology behind Bitcoin and other Cryptocurrencies Is Changing the World* (London, 2019); and A. Lewis, *The Basics of Bitcoins and Blockchains. An Introduction to Cryptocurrencies and the Technology that Powers Them* (Coral Gables, 2021).

technology can be broken down to three principles: (1) a distributed ledger system which (2) creates a network to store data in a (3) trustworthy way. Firstly, a distributed ledger system means that, instead of relying on a centralised instance that holds all decisive power, a network is introduced where this power is distributed among a multitude of actors where, consequently, no single instance possesses the majority of votes or shares. A centralised instance can be a single person, like a judge, or institutions, such as universities or banks, whereas these bodies are entitled to declare a certain matter as valid. Then, a ledger, for instance a record-keeping book, is where verified records are stored. The most prominent example is offered by the finance industry. Banks and financial services (centralised ledgers), for example HSBC or Visa, verify account balances and transactions. Alternative models, in turn, rely on a *distributed* ledger system where a consensus needs to be achieved in order to enact changes. In short, traditional models require a middleman, or a trusted third party, whereas alternative models skip this position and distribute the power over many peers. Secondly, a blockchain is nothing else but a digital archive where data is stored. In the first instance, the technology was developed to record transactions. However, it is arbitrary what kind of data it contains. Other examples might comprise health data, certificates, or voting results. This information is utterly sensitive, and granting safety and privacy has highest priority. In fact, this is the most delicate, but also the decisive factor and leads to the third requirement: blockchains must be reliable and secure. Faulty or manipulated data can lead to wrong account balances or transactions might not be verified, which, in both cases, can have wide-ranging financial consequences.

None of the three aspects are new on their own; it is their combination that creates a novel, immensely powerful, model. Yet comprehending its potential, especially considering the involved risks, requires a brief comparison between decentralised and centralised models. There are instances where centralised approaches undoubtedly offer the best solutions. For example, a fire brigade or public transport system functions effectively with one expert body taking on the responsibility to overlook and regulate those specific systems. However, in other areas like politics, autocratic systems are vehemently criticised. We acknowledge the risks related to centralised power that might lead to its abuse, to the preference of certain groups or individuals, and consequently, discrimination towards others. Developed nations demand democracy. Nevertheless, many parts of our societal structure are based on centralised approaches. As shown, the financial system relies on banks and services; elections are run by single bodies; also, the art market mostly relies on galleries and auction houses to conduct sales. In case there is an issue related to the middlemen, or the mediating instance is problematic

in some way, the entire system is affected and might collapse. Corruption is a serious issue when it comes to elections as, for instance, the recent political climate in Venezuela over the last several years has shown. Banks are among those institutions often criticised for their lack of transparency. The art market, likewise, is dominated by price and value-determining instances. In short, for many of these cases we have no other option than to simply trust certain bodies and services, even if they may not be trustworthy. Such reliance on centralised entities may even work to reinforce defective systems.

By removing power from a single instance towards a multitude of peers, a system becomes more resistant against fraud. Compared to a one-party model, where the entire unit is spoiled in cases where the centralised party becomes malicious, a democratically organised model consisting of, for instance, ten parties, is considerably more secure—a malicious actor would have to convince, at least, five other participants to achieve the majority of voting power. Therefore, the more peers are involved, the more decentralised, democratic, and, most importantly, the more secure the system becomes.



Centralised (left) and distributed system (right). Visualisation: Marcel Nießner.

Indeed, there are various profound challenges, flaws, and problematic issues related to blockchain technology which yet need to be resolved. The ecological footprint of certain blockchains, especially Bitcoin, is unacceptably high due to a technical mechanism which requires an immense amount of computing power. The shift towards an entirely digital payment system requires high cyber-security standards, as funds might be irrevocably lost, which has happened in the past. Even after more than a decade since the introduction of Bitcoin, blockchain technologies only have a few real world applications due to the complexity of their implementation into traditional environments. However, every technology comes with trade-offs. These issues, amongst others, are well known and are being addressed by a spectrum of newly emerging alternatives to Bitcoin. In my dissertation, I focus on the Cardano blockchain. Cardano is environmentally friendly and significantly more sustainable as a so-called ‘proof-

of-stake’ protocol is used, which requires, compared to Bitcoin’s ‘proof-of-work’ mechanism (mining), 17,800 times less energy.⁴ Also, Cardano has been developed on the basis of scientific research in the areas of cryptography, game theory, and more, which provides a technically sustainable foundation.⁵ It is essential to acknowledge that blockchain technology does *not* equal blockchain or cryptocurrency. Introducing *DendroRithms*, an example of blockchain art, will allow me to disentangle the relation between these entities, and expand on other aspects, such as block production and in what terms the blockchain serves as a medium for art.

DendroRithms is a digital art installation released as an NFT collection between February and May 2022 by the artist duo MICK + WOUT. The term *NFT* is misleading and oftentimes is used imprecisely. It is the acronym for ‘non-fungible token’ and means the *proof of ownership* over a specific digital asset. These assets are attached to the NFT and might include an image, an audio file, or even a degree certificate. Therefore, an NFT is neither the actual artwork, nor necessarily related to art at all. This opens the question of how NFTs relate to blockchains. As indicated, a blockchain essentially is a decentralised data repository. Its main use case is to store transaction data of cryptocurrencies. Every blockchain operates its own cryptocurrency; Ethereum’s token is called *Ether*, whereas Bitcoin is eponymous for both the blockchain *and* currency. Singular units of a certain currency are called ‘fungible tokens’, as opposed to ‘non-fungible tokens’. By analogy, a one-pound coin is a fungible token of the currency *British Pounds*; it is interchangeable (fungible) with another Pound, or equally two fifty-pence coins. Picasso’s *Guernica*, for example, is unique (*non-fungible*) as no identical unit exists. Non-fungible entities, indeed, can be traded against a certain number of fungible tokens. NFTs and cryptocurrencies are both digital assets while only NFTs are unique. It is possible to store transaction data from fungible *and* non-fungible tokens on a blockchain, as they are technically similar entities.

⁴ M. Platt, et al., ‘The Energy Footprint of Blockchain Consensus Mechanisms Beyond Proof-of-Work’ (unpublished paper, 2021, IEEE 21st International Conference on Software Quality, Reliability and Security Companion QRS-C), p. 1139. The Linux Foundation has published a report on the carbon footprint of NFTs, stating that ‘blockchain technology is not inherently bad for the environment; the consensus mechanism chosen determines environmental and social impact’, and highlights Cardano as a favourable example. A. Majer, ‘The Carbon Footprint of NFTs: Not All Blockchains Are Created Equal’, foreword by D. Barbosa (2022), https://linuxfoundation.org/wp-content/uploads/LFResearch_HL_NFT_Report_22Apr22_FINAL.pdf (15 June 2022), p. 18. More information about the technical conception of both mechanisms can be found in Tapscott/Tapscott, pp. 31–33.

⁵ All published academic research papers related to Cardano can be found here: ‘IOHK Library’ <https://iohk.io/en/research/library/> (10 June 2022).

Now, *DendroRithms* is a collection of 839 pieces, where every instance has been minted as an NFT. ‘Minting’ is the act of creating a digital asset that is attached to a record on the blockchain. ‘Collection’, in the specific context of blockchain art, refers to the entirety of pieces that belong to and constitute one work of art. Thus, the artwork consists of 839 individual pieces, which are *collectively* owned by a multitude of people, as it is often the case for blockchain art. The following link will open a webpage that shows multiple NFTs, each of them containing one *Dendro*. Due to their digital nature, it is possible to present *original* works of art, rather than facsimiles.⁶

[DendroRithms](#)

DendroRithms was conceptually and aesthetically inspired by dendrochronology, a scientific method that allows the determination of the age of trees by analysing their growth rings. In analogy to tree sections, a *Dendro* symbolises a conceptual cross section through the blockchain as an organism, dissecting and visually representing its principles. Tree rings mark the passing of years, and thus conceptually, visualise elapsing time. Blockchains disclose a similar pattern: in periodic intervals, blocks are produced. A block is an artificial unit that contains the records of all transactions made during a specific time period. Due to the consensus mechanism, a block is only produced if the majority of network participants (>51%) validate the contents of an entire block. As it is impractical to validate every single transaction on its own, blocks were introduced to validate them in bundles. Once such an entity has been validated, its contents are *encrypted*, hence the often used prefix *crypto-*, and it is no longer possible to make changes. Immutability is a core principle of the technology as it assures the secure storage of information.⁷

Every *Dendro* is created by an algorithm. An algorithm, also referred to as ‘code’, includes a set of rules that processes certain values and, consequently, determines the visual output. Therefore, the image of a *Dendro* is only one part of what constitutes the installation, assigning

⁶ By clicking on the link—it might take some time until all contents are loaded—you will see a digital wallet which is the entity where assets are stored. Often, we have British Pounds, but also non-monetary items like passport photographs in our physical wallet. The same applies to digital wallets. This example contains a certain amount of ADA [A], the cryptocurrency of Cardano, as well as NFTs. By clicking on a certain example, you will see the artwork in detail, along with more information. This wallet is owned by the author.

⁷ Network participants are people who run a server that contains all information of a blockchain and therefore actively contribute to its maintenance and operation. Cardano, for instance, has more than 3,000 peers. Anyone with an adequate technical understanding and infrastructure can contribute. Every blockchain has its own protocol with varying operational models. More information on consensus mechanisms and immutability can be found here: Tapscott/Tapscott, pp. 30–33; or Lewis, pp. 331–333.

the code with equal relevance.⁸ This duality of an invisibly operating algorithm, containing all required information, and its visible product, be it an image, application or website, which people mainly interact with, is fundamental in software engineering in general and reflects how blockchains are constituted. It also reveals the difference between *blockchain* and *blockchain technology*. The latter reflects all rules and requirements which are transcribed to lines of code. A blockchain, consequently, is the actual product that is in use. Even though it is this entity, which is present and tangible, it would not exist without its underlying algorithm. This applies to commercial products as much as to algorithmically generated art.

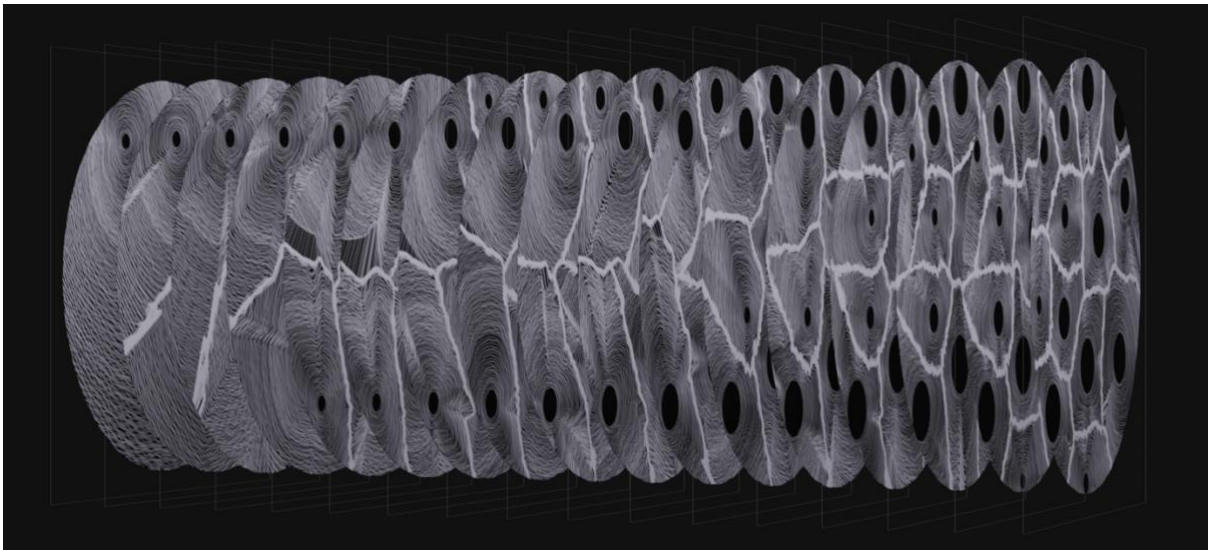
DendroRithms is an interactive work. The collection's composition required input from every person who bought a *Dendro* and individual choices are reflected in each piece, as well as the entire collection. Buyers were presented with two choices. Firstly, one could choose a colour from a selection whereas every colour forms an independent sub-collection, or rather sub-chain, of the overall project. Secondly, one had to decide whether a core should be added or not. This decision was always related to the previous piece that had been created as part of this chain; if there were three existing cores, one could choose between a piece with either three or four cores. If a buyer refused to add one, the piece would show the same number as the previous one, or, after a predefined time, the number would decrease. As a result, *Dendros* of the same colour form a linear chain where every newly added piece is tied to its predecessor.⁹ In tree sections, a core represents the starting point of growth and every year a new layer is added. *DendroRithms*, as well as blockchains, also add new layers to an existing system, visualising the continuous growth, sometimes interrupted by periods of depression, mirroring the choices individuals made. The more people participate, contribute, and mint, the more cores are added, and more variety occurs; or, metaphorically, the more distributed the network becomes.

The interaction between a subject and a group is a main theme of *DendroRithms*. Each core reminds of the sphere of influence of one individual, reflecting its position within an amalgam of various players. When another player joins, the equilibrium is distorted and a new group dynamic has to be established. In game theory, as well as actor network theory, these dynamics are explored—both theories are relevant for blockchain technology as they enable predictions

⁸ The algorithm can be found as part of a documentation: 'Source code of DendroRithms' <https://github.com/wout/dendro/blob/main/dendro.cr> (26 April 2022). The role of algorithms in artistic practice, as well as generative art will be defined in the next chapter.

⁹ If you return to the wallet, you will be able to see such a sub-chain of the colour *naples yellow*. Certain *Dendros* are missing within this sequence, for example *Dendro0778*, which are in the possession of other holders. This implies that sub-chains are owned by many people instead of a single person.

about individual interactions with a network. The relation between individual and group, buyer and sellers, and also between code and image, is designed by the artists, although some variables always remain out of their control. For example, one part of the algorithm is a randomness factor which influences the aesthetics of every piece and its details, such as the exact position of the cores or the course of the lines. Working with probability and predictability, again, is not only part of this artwork, but also a condition of blockchain design.



DendroRithms sub-chain of the colour *porcelain*. Visualisation: Mateu Walker.

A *Dendro* represents a static snapshot of a moment in time. As is the case in photography, every piece is a witness of one specific moment that ontologically belongs to the past right after its creation. The depiction of, and oscillation between, reality and past—the aesthetics of what Roland Barthes called the ‘that-has-been’¹⁰—correlates with the conception of blocks in a blockchain. Each entry immutably represents an issue that has had its relevance at this specific moment. In analogy to block production, where new blocks are enclosed to a continuous string of preceding information, *DendroRithms* reflects the evolution of singular entities, strung together in multiple linear sequences.

But in what terms can a blockchain be understood as a medium for art? When we make a regular payment, it is possible to add further information to the payment slip, such as a reference number or annotations. The same applies to NFTs: additional information—for example, text, links, or code—can be included in the metadata. The following link, referring to *Dendro0777*, displays this:

¹⁰ R. Barthes, *Camera Lucida. Reflections on Photography* (London, 2000), pp. 76f.

Dendro0777: Code and Image

Parts of the algorithm *and* an image of *Dendro0777* is stored in the metadata of this NFT. As a result, the blockchain becomes the carrier of the artwork as the NFT comprises all parts that constitute it. The NFT itself—this must be emphasised again—is generally solely the *certificate of ownership* that refers to, *or* contains, an artwork, rather than being the artwork itself. It would have been possible to only include the image of each *Dendro* and store its code elsewhere, for example on a webserver or computer. Instead, MICK + WOUT decided to include everything in the NFT, utilising the medium in a conceptual way, and also making the code available to everyone. Open-source code is, to some extent, a necessity within the blockchain industry as network operators are required to have access to it. In general, open-source stands for transparency. Exactly because the algorithm and information about *DendroRithms* are public, people are able to work with it and make their own creations as the visualisation of *Dendro* sales data shows.



Timeline of *DendroRithms* sales sorted by colour. Visualisation: Vanoz.

DendroRithms symbolises the growth of a living organism, utilising methods of programming while the collection is collectively owned by a multitude of individuals. It reflects on the blockchain as an entity that requires shared efforts to keep it alive, that tracks and mirrors every single interaction with it, and is kept in constant change and growth. Blockchain technology envisions the evolution of a global, inclusive and participatory network, providing a trusted infrastructure based on security and transparency, while remaining completely digital, online and encoded. *DendroRithms* enables a visual experience of some of the inherently non-visual principles and conditions related to blockchains, recreating interactive and tangible chains of artworks, using the blockchain itself as a medium.

Contextualising blockchain art

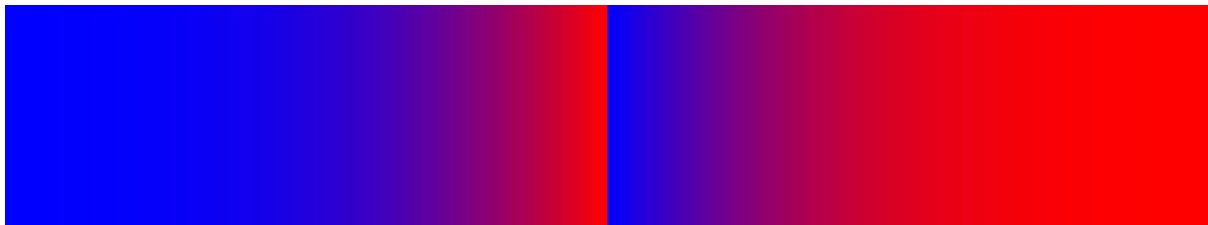
Blockchain art must be understood as the continuation and consequence of twentieth and early twenty-first century events, rather than as an unprecedented and isolated occurrence. NFTs primarily offer a new way of disseminating artwork and other information in digital environments. However, as *DendroRhythms* has shown, the technology induces conceptual experimentation with the medium itself. Thus far, I have demonstrated some of the basic principles of blockchains, implicitly outlining the dual constitution of meaning in art, derived from its content and medium. Also, I have used the term ‘blockchain art’ to describe art that uses, and reflects on, the blockchain as its medium. By introducing a second artwork, which discloses these features of blockchain art and, thus, qualifies it as a representative of this artform, I will explain in what terms blockchain art can be considered as another link in a continuous string of art movements, idea history, and technological advances. Intersections and differences will be presented between blockchain art and other art forms, such as mass art, which is specified by formal qualities, and art movements that are driven by a conceptual definition, such as abstract and especially generative art.

unsigned_algorithms is created by Alexander Watanabe, a former architect with a broad spectrum of interests in parametric architectural design, photography, and programming, all of which are reflected in this artwork. The artwork consists of 31,119 unique pieces, in short *unsigs*, which were created by means of programming and minting NFTs on the Cardano blockchain. The collection represents an abstract colour study of the RGB colour model; the digital equivalent to traditional (analogue) colour theory. Unlike models that are based on the *subtraction* of colours from natural white light, occurring when colour pigments (paint) are mixed, the RGB model is *additive*, using the light emission of screens. The base colours *red*, *green* and *blue* are used to create the entire colour spectrum. As opposed to subtractive models, white light is generated when blending equal parts of all three base colours.¹¹

[unsigned algorithms](#)

¹¹ The following wallet belongs to Grancho. As these artworks thematise colour as a phenomenon, the resolution of your screen will influence the quality of the visual experience. The higher the resolution, the better will *unsigs* be represented. I recommend choosing one specific piece, for example *unsig09453*, and open it in full screen mode (rectangle above image).

Every *unsig* exhibits a unique combination of colour gradients, with certain patterns constituting their base structure. In analogy to a prism that breaks light into its full spectrum of different wavelengths, the colour gradients of *unsigs* are modelled by these patterns which define how the gradients blend into each other. As a result, some pieces reveal a single linear gradient, others consist of iterations of the same gradient, following different curves, and again others are a complex assembly of various patterns with different orientations. The plethora of mixing options provided by the RGB colour wheel is explored, not only showing the gradual and soft transition of base and mixed colours, but also the effects that strong contrasts provoke. *unsigned_algorithms* grapples with the intensity and brightness of colour as a *digital* phenomenon, the consequence of additive light mixing. It enables spectators to experience the effects of digital colour diversity on the visual perception.



Alexander Watanabe, *unsig00238*, detail, 16k png, minted as NFT on Cardano, 2021.

In 1940, Clement Greenberg characterised abstract art as a phenomenon of ‘historical justification’ and explained the emphasis on immersive size, colour, basic forms, and flatness in painting as a logical consequence and premise of the canvas as medium.¹² Main figures in abstract painting, like Mark Rothko or Barnett Newman, aimed to evoke a metaphysical experience through the encounter of the spectator with large-scale colour fields. By choosing an abstract style for his artwork, Watanabe transferred *some* of these conditions—colour, abstract forms, and flatness—into a digital environment. Due to the limitations of a non-analogous medium, resulting in rather small display options depending on the dimensions of the monitor, extraordinary image sizes could not be used as a way to induce a reaction in the spectator. Instead, Watanabe leveraged the remarkably high colour intensity and brilliance of the digital environment to evoke an immersive effect. A *study* implies the repetitive assessment of a certain phenomenon. Rothko’s and Newman’s body of work reveal a continuous exploration of colour. Watanabe brought this exploration of colour to a different medium by using other techniques, resulting in a study that would not have been possible to create with

¹² C. Greenberg, ‘Towards a Newer Laocoon’ (1940), in Ch. Harrison and P. Wood (eds), *Art in Theory 1900–2000. An Anthology of Changing Ideas* (Malden/Oxford, 2003), p. 567.

analogue measures. However, it becomes evident that such a digital environment creates fundamentally different premises, resulting in works which equally adopt and break with the tradition. The emotional response to the exposure of colour in a digital, as well as an analogue, context, eventually, always remains a subjective experience.

With the advance of internet technology and digitisation, a wave of new technologies and media were introduced to art practice, inherently influencing the art itself. Blockchain technology appears to be yet another occurrence amongst others. The debate of the past century has been shaped by Walter Benjamin's view on the reproducibility of art, as well as Marshal McLuhan's advocacy of the importance of the medium itself, both influencing the intellectual perception of (mass) media.¹³ Greenberg's dismissal of mass art as a form of kitsch in 1939 raised questions about differences in the qualities of art and mass culture.¹⁴ The debate became even more present with the wide adoption of television shows, cartoons, or comic books in the past seventy years. It led to an academic sentiment which is rather hesitant towards mass art because, according to Noël Carroll, in order to be accessible for a wide audience with varying backgrounds, the level of complexity would need to be reduced.¹⁵ Following Carroll's definition of mass art as art, which is created for mass production, mass consumption and distribution, and made by means of mass technology,¹⁶ NFTs, in most cases, must be considered as mass media. The introduction of NFTs, as indicated at the beginning of this dissertation, created a public response, either hyping or downplaying the ongoing events, which is comparable to the emergence of mass media some decades ago. Carroll critiques the 'distinction between so-called high art and popular art [... which] serves to mark off an élite class from, presumably, everyone else'.¹⁷ I follow his stance as the definition of what is 'high' and 'popular' mostly remains subjective. Within every art form, the level of complexity, skill, thought, and relevance varies. This applies to mass media and its productions whereas, as shown, NFTs belong to as well.

During a panel discussion at the Museum of Contemporary Art in Toronto in May 2022, titled *The Medium is the Message: Cardano and Blockchain Art: The "Global Village" realized through "on-chain" Digital Art*, Watanabe's artwork *unsigned_algorithms* was discussed in the

¹³ W. Benjamin, 'The Work of Art in the Age of Mechanical Reproduction' (1936), in Ch. Harrison and P. Wood (eds), *Art in Theory 1900–2000. An Anthology of Changing Ideas* (Malden/Oxford, 2003), pp. 520–527; M. McLuhan and Q. Fiore, *The Medium Is the Message*, ed. J. Agel (London, 1967).

¹⁴ C. Greenberg, 'Avant-Garde and Kitsch' (1939), in Ch. Harrison and P. Wood (eds), *Art in Theory 1900–2000. An Anthology of Changing Ideas* (Malden/Oxford, 2003), pp. 539–549.

¹⁵ N. Carroll, *A Philosophy of Mass Art* (Oxford, 1998), p. 195.

¹⁶ *Ibid.*, p. 196.

¹⁷ *Ibid.*, p. 178.

light of McLuhan's body of thought.¹⁸ Unlike, for example, television shows, blockchain art does not follow a one-to-many broadcasting pattern. Instead, and this is, in fact, what separates NFTs to some extent from other mass media, blockchain technology relies on a peer-to-peer network where potentially everyone with access to a computer and is well-versed with the technology can communicate with everyone. This difference sustainably influences the dynamics of the art market as artists have the chance to take on the entire responsibility for their sales process. Nevertheless, having access to a global audience, instead of a local community mostly dependant on galleries, brings other challenges, such as the requirement of a certain technological and economic expertise.

Like *DendroRithms*, *unsigned_algorithms* is created by means of programming. Due to its relevance for blockchain art, I will focus in more depth on this art form. Philip Galanter has provided a definition of generative art which serves as the starting point for further exploration:¹⁹

Generative art refers to any art practice where the artist uses a system, such as a set of natural language rules, a computer program, a machine, or other procedural invention, which is set into motion with some degree of autonomy contributing to or resulting in a completed work of art.

It becomes evident that generative art is not limited to an art practice that involves computer-based programming, as is the case within this context. In fact, generative art can cover digital *and* analogue works. The complexity and extent of the basic principles is presumably the reason why no synoptic work, neither on the entirety of generative art, nor on generative art based on programming, has been published.²⁰ Attempts were made to introduce a more specific taxonomy, covering sub-categories such as computer art, computer-generated art, or interactive art.²¹ However, as these attempts do not give any information on what such a system, as described by Galanter, might look like, Alan Dorin et al. delivered a framework for a better comprehension.²² According to them, such a system consists of *entities*, 'the

¹⁸ 'Creative Conversations: Blockchain Art and NFTs' https://moca.ca/events/creative-conversations-blockchain-art-and-nfts_panel-01/ (29 May 2022).

¹⁹ Ph. Galanter, 'What is Generative Art? Complexity Theory as a Context for Art Theory' (unpublished paper, 2003), http://www.philipgalanter.com/downloads/ga2003_paper.pdf (4 June 2022), p. 4.

²⁰ A small number of monographs is available which focus on the practical aspects of programming to create generative art. Theoretical considerations are only marginally covered, for instance, within introductory chapters, as in M. Pearson, *Generative Art. A Practical Guide Using Processing* (Shelter Island, NY, 2011), pp. 1–10.

²¹ Boden/Edmonds have identified eleven categories in total. M. A. Boden and E. A. Edmonds, 'What Is Generative Art?', *Digital Creativity*, 20/1–2 (2009), pp. 37f. Monographs exist that cover some of these sub-categories, such as D. McIver Lopes, *A Philosophy of Computer Art* (Abingdon, 2010); or Ch. Paul, *Digital Art*, 3rd edn (London, 2015), pp. 124–138.

²² A. Dorin et al., 'A Framework for Understanding Generative Art', *Digital Creativity*, 23/3–4 (2012), pp. 239–259.

subjects upon which a generative artwork's processes act';²³ then, *processes*, 'the mechanisms of change that occur within a generative system'.²⁴ Further they posit, *environmental interaction* as the influence on the operational system, and, lastly, *sensory outcomes* as the resulting artwork. In the following, I will use the term 'programmable art' as an art form that comprises, on one hand, an input (entities) and an algorithm (process), written by a human and executed by a *computer* (!), and, on the other hand, the product of that algorithm (sensory outcome) which can include, for instance, an image, audio, or text file. This simplified definition is intended to specifically serve the purpose of this dissertation. I will use the term 'programmable art' instead of 'generative art', as, for example, Galanter does, to emphasise the programmability of the input, as well as the importance of the computing process itself. This, in turn, reflects the characteristics of blockchains. In contrast, 'generative art' highlights the (static) nature of the output.



Input (left), algorithm (middle), and sensory outcome (right).
Visualisation: Marcel Nießner.

Previously, only the sensory outcomes of *unsigned_algorithms* were discussed. However, it is, as the artist emphasises, the input and the algorithm which constitute the 'actual artwork'.²⁵ All *unsigs* were created by the same algorithm while differing input parameters are responsible for the aesthetics of every piece. Simultaneously to the launch of the collection, Watanabe published a documentation that explains how *unsigs* are generated.²⁶ It was compiled especially for people who are not capable of reading code and, therefore, able to retrieve this information from the algorithm itself. This highlights the importance of the underlying idea and reveals that *unsigs* share some characteristics with conceptual art where the idea of an artwork is (significantly) more relevant than its sensory representation. While a definition of conceptual art oftentimes must remain vague due to the diversity of the artworks it seeks to cover, parts of Sol LeWitt's *Paragraphs on Conceptual Art* are well suited to characterise Watanabe's intentions: 'When an artist uses a conceptual form of art, it means that all of the

²³ A. Dorin et al., p. 8.

²⁴ Ibid., p. 9.

²⁵ 'What is Unsigned Algorithms? A chat with #Unsig founder Alex', YouTube (uploaded 28 August 2021) <https://www.youtube.com/watch?v=tHe2WU7NQYg> (18 June 2022), starting at 11:11, 'The code is the "art"'.
²⁶ 'Programmable NFT. Exploring the medium of blockchain-based art, its potential and impact on art' https://docs.google.com/presentation/d/1A2lA659QM0NdjkCi84itPaWpPxq7PDe7moruwJ8N0V0/edit#slide=id.gd9d03af5fa_0_161 (20 May 2022).

planning and decisions are made beforehand and the execution is a perfunctionary affair. The idea becomes a machine that makes the art'.²⁷ In this case, the algorithm is the idea.

As MICK + WOUT did it, inputs, algorithm, and resulting images were all placed in the metadata of the NFT. In fact, this approach itself is an artistic statement. The metadata is meant to store information about the asset that is contained. As this information eventually will be stored in a block, the character space available in the metadata is highly limited to 16 kB. Every artwork stored in the metadata, a so-called 'on-chain' works, has to comply with this limitation. This restricts the possibilities of the artwork but it also leads to a conceptual interaction with the medium. Watanabe was the first one on the Cardano blockchain who stored his artwork on-chain.²⁸ To emphasise the relevance of this method, it must be mentioned that most works simply include a *link* to an image on an external webserver where the digital asset is stored. In other words, these works only engage marginally with the blockchain as their medium, using it mainly as a means for dissemination. *unsigned_algorithms* is a direct critique of this approach. Watanabe argues that 'on-chain art is more than just a storage container for existing forms, it can and should be its own medium to be explored'.²⁹ As the inputs, the code, and the sensual output are included in the NFT, the blockchain effectively *contains* the message. Everyone who has access to LeWitt's instructions for his wall drawings has the possibility to recreate the sensory representation of these instructions. The same applies to *unsigs*; it is possible to recreate every image by individually executing the code.³⁰ Watanabe alludes to the immutability of blockchains because, as long as Cardano exists, *unsigned_algorithms* is immutable too as the information for every piece can be retrieved from its NFT. Conceptual art often questions the definition of what constitutes an artwork. These questions reappear in the context of programmatic art, and especially blockchain art, as such works include multiple components whereas their roles in relation to each other are not necessarily clearly delineated.

²⁷ S. LeWitt, 'Paragraphs on Conceptual Art' (1967), in Ch. Harrison and P. Wood (eds), *Art in Theory 1900–2000. An Anthology of Changing Ideas* (Malden/Oxford, 2003), p. 846. More information about the history and spectrum of conceptual art can be found in T. Godfrey, *Conceptual Art* (London/New York, 1998), especially pp. 4–16.

²⁸ There were few examples on other blockchains before. But as NFT standards vary depending on the blockchain, different solutions have to be developed mostly independently and Watanabe paved the way for future on-chain art on Cardano. The limited space in the metadata is partially the reason for the multitude of pixelated NFT projects as a reduced resolution leads to this aesthetic.

²⁹ 'Programmatic NFT. Exploring the medium of blockchain-based art, its potential and impact on art', p. 6.

³⁰ Instructions on how to do so, even suitable for people without programming skills, can be found here: alexanderwatanabe, 'unsigned_algorithms' https://github.com/alexanderwatanabe/unsigned_algorithms/blob/main/unsig_gen.ipynb (19 June 2022).

unsig00000, the first piece in the collection, differs from every other *unsig* as it is the only one that comprises the *entire* algorithm. Analysing the structure of it becomes relevant for a holistic understanding of the artwork and the nature of programmatic art in general. As indicated, varying input parameters define the specifications of every piece. Instead of writing 31,119 algorithms with minor differences, every *unsig* (except for *unsig00000*) solely contains its individual parameters and a *reference* to this specific piece. Therefore, only *unsig00000* is complete in itself which makes this method highly efficient and technically elegant.³¹

[unsig00000: algorithm](#)

unsig00000 constitutes the ‘negative’, or the ‘DNA’, of the rest of the collection. The piece also visually differs as its sensory outcome, a black square, marks the total absence of colour—a consequence of the absence of input parameters. Four of these parameters exist, each containing different options (see visualisation below): (1) the distribution, a mathematic function, defining the basic structure of the other parameters; (2) a multiplier, specifying the number of iterations that are applied; (3) the rotation; and (4) colour, using the RGB model. These parameters provide, in analogy to genetic code, the characteristics for layers. These layers, in turn, are comparable to chromosomes, which eventually define specific traits. Every *unsig* includes between zero and six of these layers (properties). In analogy to the RGB model, which relies on the addition of colour, layers are stacked on top of each other and result in the final image. Based on this setup, 50,063,860 different combinations are possible, whereof less than one percent effectively has been selected as part of the collection. The algorithm, along with the input parameters, spans a matrix of possible combinations where every *unsig* represents the transformation of a possibility into an actual manifestation.

³¹ The following link will display the algorithm. The sensory outcome of *unsig00000*, a black square, can be viewed here: ‘unsig00000’ <https://pool.pm/0e14267a8020229adc0184dd25fa3174c3f7d6caadcb4425c70e7c04.unsig00000> (19 June 2022). It is owned by @adaboy98669717.



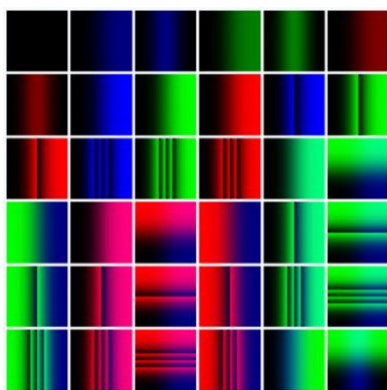
unsigned_algorithms cheat sheet. Every property (right) consists of a combination of all four parameters (left). *unsigs* include between zero and six of these properties. Cheat sheet: Marcel Nießner.

Comprehending the basics of the algorithm, as it can be found in the metadata of *unsig00000* in the link above, not only discloses the simplicity of its constitution, but it also reveals conceptual similarities to other building disciplines, especially to architecture. In a first step, certain coding libraries are imported, which include all required references, similar to the way architectural references are assembled prior to the actual design process. Then, by defining the dimensions of the *unsig*, the space for the eventual image, or, metaphorically, the ground for the building, is created and marked out. Thirdly, the input parameters, or the building blocks, are imported. The most important part, however, is the modelling, where the parameters are arranged: the distribution creates the basic structure, while the multiplier modifies this structure again and defines its final shape. The rotation sets the orientation and colour is applied. Or metaphorically: firstly, the structure is built, then additional elements like walls are added which shape the building, and lastly, the finalised structure is embellished and painted. In a final step, the algorithm projects the model onto the initially created space and exports the image.

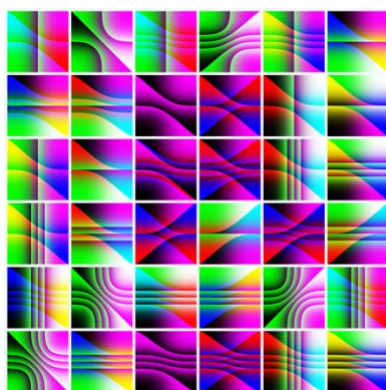
The simplicity of the algorithm contrasts the complexity and abundance of possible visual results that can be derived from it. Moreover, its particular constitution reveals the decisions and preferences of Watanabe. The artist used two specific arguments, `<uint32>` and `<uint8>`, in the code to define the multiplier parameter; arguments that are usually *not* used within this context and, therefore, would be considered as a technical mistake. To present an analogy from architecture, Daniel Liebeskind and Frank Gehry explored and pushed the limitations of building materials and statics, questioning what was considered as ‘adequate’ architecture, designing buildings which retrieve their particular appearance from the exhaustion of these limitations. Watanabe used the arguments to play with the possibilities of programming and to demonstrate his abilities to control the tool, while assigning them the key role of the entire artwork. The multiplier, in fact, is the defining entity on a conceptual and visual level, as it creates the structure of *unsigs* and, therefore, is responsible for the refraction and overflow of colours. To conclude this chapter, I will outline a parallel to photography.

NFTs reveal a technical analogy to photography.³² At the time of its advent, photography was not considered a self-contained art form and it took decades until this perception changed. The intrinsic aesthetic of remembrance and temporality is solely one example that discloses photography as an art form, reaching far beyond its use as a means of reproduction. *unsigned_algorithms* reveals a conceptual parallel to photography. As only a fraction of all potential combinations has been realised within the collection, every *unsig* resembles a snapshot of one specific case in a multitude of possible options. In analogy to a photograph which provides a subjective reflection of what inherently cannot be depicted in its totality—namely reality—every *unsig* reflects on its own parameters while the reference to *unsig00000* indicates an encompassing system of higher complexity. The entirety of all pieces, strung together in a specific sequence, builds an overarching narrative, processing the possible combinations of the chosen input parameters. The collection resembles a film reel, consisting of various stills, which is equally a condensation of what would have been possible. On a more philosophical level, *unsigs*, as photography in general, trigger considerations about the relation between a single entity and its surrounding structure; about the subjectivity of an isolated perspective and how it changes when its position is located within an overarching system, indicating that what we perceive as reality is always an approximation of what ontologically cannot be grasped by a singular entity.

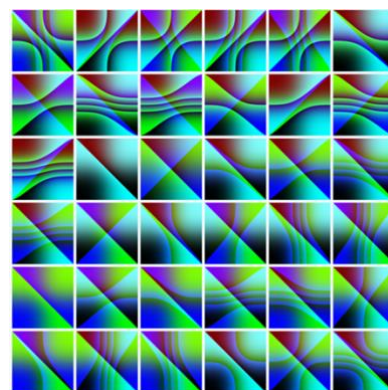
³² Considerations about the nature of photography can be found in Barthes *Camera Lucida*.



Alexander Watanabe,
unsig00000–00035, minted as NFTs on
Cardano, 2021. Own screenshot.



Alexander Watanabe,
unsig09924–09960, minted as NFTs on
Cardano, 2021. Own screenshot.



Alexander Watanabe,
unsig17604–17640, minted as NFTs on
Cardano, 2021. Own screenshot.

Repetition, iteration, and modification of a coherent core idea constitute a metaphor of circular movements, reflecting the nature of *unsigned_algorithms*. The code itself is infinitely applicable and repeatable; it strictly and exclusively computes given inputs and transforms them into an output while every *unsig* is circling back to *unsig00000* to retrieve the required code. The stacking of properties creates variability on a vertical dimension, and the overarching narrative adds to this variability on a horizontal level. These iterations reveal the variations *and* limitations of always the same three base colours. Eventually, the title *unsigned_algorithms* refers to a concept in computer programming called *unsigned integers*. It describes the behaviour of certain values when they are translated into a different representational model, for example, binary code into the hexadecimal system. These integers are part of the aforementioned arguments that define the *multiplier* parameter which is, as shown, responsible for the multiplication of given values and the aesthetics of *unsigs*. Due to a specificity of unsigned integers, processes are induced to start over again once they have reached the end of a unit. The conception of the artwork is condensed in this detail.

The circular movements of *unsigned_algorithms* metaphorically exemplify the reappearance and continuity of thought and methodology in different contexts, media, and times. Blockchain art has intersections with conceptual art, and it relies on similar means as mass art. Further, it is programmatic, and therefore a sub-category of generative art, ontologically belonging to the broad category of digital art. I used this specific artwork as a representative example of blockchain art to demonstrate how this art form can, and must, be integrated into a broader art historical context, continuing certain aspects of preceding art movements and their related debates while using different methods and tools. Eventually, the occurrence of blockchain as a novel medium brings new perspectives on existing concepts and approaches.

Blockchain art and its constitution

A blockchain can be used as a place to store, and as a technology to disseminate, digital assets. However, these characteristics do not necessarily constitute the blockchain as an actual art medium. Greenberg argued that '[p]urity in art consists in the acceptance, willing acceptance, of the limitations of the medium of the specific art'.³³ Partially in alignment with this statement, I define 'art medium' as the physical, or immaterial, entity which explicitly influences the constitution of the art, which is created on this specific medium, through its own limitations, or rather characteristics. This implies that, in order to be considered as an art medium, the blockchain must influence the art it contains with its own intrinsic features in a way no other medium would do. I will expound these characteristics by returning to *DendroRithms* and *unsigned_algorithms* as examples of blockchain art and, in addition, delineate what I do *not* include in this category.

In public discourse, all types of art and creative productions related to blockchain technology are mostly summarised under the term 'NFT'. As a consequence, this has become a buzzword. As already emphasised, such a naming is imprecise and misleading as it solely refers to a technical functionality rather than providing information about the qualitative nature of what it relates to. However, three different phenomena related to art production can be identified at this point. By introducing them, I intend to give a brief overview of the kind of art that is supported by blockchain technology. As is the case for any other attempt of classifying art (forms), definitions remain loose due to the impossibility of absolute statements and overlapping categories. The first phenomenon encompasses every form of digital art attached to an NFT. The current labelling as 'NFT' is certainly used for marketing purposes as it highlights the novelty of the technology. I assume that, once its adoption is more advanced, this general classification will become less relevant and rather a piece of additional information related to an artwork. Similarly, when discussing paintings, we only specify whether a painting is a work made on canvas or wood if it is relevant. Then, the second phenomenon are so-called PFPs, which is the abbreviation for *Pro-File Pictures*. Their emergence is closely related to the introduction of NFTs. However, the conceptual interaction with their medium is limited, which is why they must be considered separately. After providing some basic information about the first two categories, I will focus on the third group, which constitutes an independent art form—blockchain art.

³³ Greenberg (1940), p. 566.



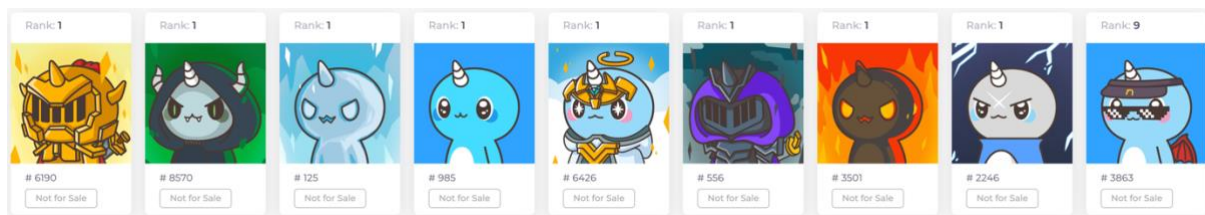
NyteLyte, *Going out West*, mixed media collage, minted as NFT on Cardano, 2021.

The collage *Going out West* is a digital artwork, minted as an NFT on Cardano and, thus, belongs to the first category. It reflects on, and pointedly mocks, a position which marks the ‘in between’: the stance in between an overwhelming nature and consumerism (of the American society), between privilege, marginality and loneliness, between post-modern reminiscences and contemporary exploration of technology, and the balance between analogue and digital media. NyteLyte, a mixed-media artist living in Anchorage, Alaska, dedicates her work to questions of belonging, identity, and the human gaze, using means of colour and light.

Many of her works were never published until she could disseminate them by means of NFTs. I introduce this artwork to show the spectrum of art production related to blockchain technology. The collage is not an example of blockchain art and it has not been created in response to this technology. Nevertheless, NyteLyte’s digital artworks become accessible thanks to blockchain ecosystems. The artist’s body of work is influenced by her socio-demographic and geographic location. However, the art scene in Anchorage is small and the options of making a living from art making are limited. McLuhan’s vision of a global village has become relevant for artists like NyteLyte, while using NFTs for art dissemination offers a possible solution. *Going out West* exemplifies how blockchain technology can be leveraged by artists around the globe.

PFPs (Pro-File Pictures) share many similarities with collectibles. Mass distribution of digital assets by means of NFTs made such collectibles highly popular, as there are no logistical restraints for collection sizes that encompass a high number of pieces. Baseball cards, in analogy, are successful as collectibles for various reasons: they are accessible to anyone, and buying and trading them offers excitement. As one cannot pick the specific cards when purchasing a bundle, opening that bundle always includes a surprising element. Cards are, due to artificial rarities, a potential investment. PFPs disclose the same characteristics. Usually, one main figure serves as the basic type for an entire collection. A selection of attributes and traits,

such as clothing, or accessories, are added to this base figure, creating variety. These attributes and traits define the rarities of PFPs. Using this mechanism to generate minimal visual diversity, and, simultaneously, artificial rarity, was a simple way of creating emotional involvement, and, therefore, a demand and market. A great amount of PFP projects exist. Some of them reveal a higher complexity than others. For example, in some cases, efforts are made to build entire online communities, in other cases, additional perks are provided, such as the access to video games which one can play with their PFPs as a character or avatar.



Yummi Universe, *Yummi* #6190, #8570, #125, #985, #6426, #556, #3501, #2246 and 3863, algorithmically generated PFPs, minted as NFTs on Cardano, 2021. Own screenshot.

PFPs reveal certain psychological effects related to digital ownership in general. People started collecting these kinds of NFTs, for instance, *Yummis*, and, as the name *Pro-File Picture* indicates, they are used as simulacra of their owners on social media. Taking on an identity, which one can choose freely, reveals the appeal of the digital realm, where traditional values and rules do not necessarily apply. This phenomenon is twofold: on one hand, people gain access to online communities and to like-minded people, which creates interaction and a sense of belonging. On the other hand, PFPs have become in many cases yet another status symbol. People buy NFTs because there is, apparently, a wish to *own* an asset; otherwise, one could simply save the image to one's device. PFPs, as any other digital asset, are purchased, either to communicate a certain message to the public, to make a monetary investment, to support an artist, or, a combination of these issues. Indeed, reasons for personal connection with specific works occur as well. However, PFPs can be understood as the continuation of social phenomena, such as collecting trading cards, that occurred as part of pop culture, and were transferred to a digital environment, showcasing the influence and effects of online anonymity.

The third phenomenon is what I refer to as blockchain art; artworks which require, and reflect, on the blockchain as their specific medium. Watanabe's reaction to collectibles was, 'But why would anyone spend money for a link to a jpeg?'.³⁴ Both *unsigned_algorithms* and

³⁴ A. Watanabe, 'NFTs: why would anyone pay for a link to a JPG?' <https://archinect.com/forum/thread/150312287/nfts-why-would-anyone-pay-for-a-link-to-a-jpg> (18 June 2022).

DendroRithms were created as a critique of the prevalence of PFPs in the NFT scene. MICK + WOUT questioned the randomness of purchasing mechanisms which has led to ‘flipping’—the behaviour of buyers who purchase a multitude of pieces until they get a rare example, while immediately listing everything else on the secondary market. This, indeed, reduces the appreciation and valuation of the items in many cases to predetermined and artificial rarities. The interactive minting model of *DendroRithms* addressed and impeded this speculative flipping behaviour. As every buyer was presented with certain options for their *Dendro*, influencing their individual piece, as well as the overall collection, rarities—for instance, the number of cores of a certain colour—could not be predetermined. MICK + WOUT questioned and prevented an encounter with the artwork constrained by a potential monetary value derived from its artificially created rarity status. Both *DendroRithms* and *unsigned_algorithms* are artworks that were adjusted to the idiosyncrasies and limitations of their medium, contrasting other types of art which use blockchain technology. I will now inductively demonstrate why these artworks could not be accommodated by any other art medium, and, more importantly, how their characteristics form a genuine art form. Both examples happen to be programmatic artworks. I will outline why blockchain art is intrinsically programmatic and, in addition, argue that it also exhibits a decentralised nature.

Programmatic art differs from other art forms in terms of constitution, (im)materiality, and accessibility. The relation between programmer, computer, algorithm, and outcome appears to be complex due to an uncertain distribution of agency. In addition, programming as a profession is closely associated with the advance in internet technology and engineering rather than with artistic practice. Some of these factors make the art form less intuitively graspable than others and might cause the earlier described lack of comprehensive academic research on the topic. A rather negative sentiment, in combination with an unfamiliarity, has also arisen with regards to NFTs and blockchain art. By introducing *DendroRithms* and *unsigned_algorithms*, I intended to provide guidance on how programming as an artistic skill can be approached as a method of creative expression. In a brief digression, I will describe some of these qualities and issues in relation to previous examples and in the context of blockchain art, attempting to make programmatic art more accessible.

The constitution of programmatic art offers parallels to music compositions, performative, and conceptual art. In each of these cases, the artist composes a set of rules—for example, a score, instructions, or an algorithm—which defines the eventual artwork. An intermediary is sometimes required to execute the script. In programmatic art, as previously defined, a

computer is the executing agent and the realisation is, thus, not subject to human exposure. The entirely digital procedure, indeed, affects the outcome as well as our perception of the work. We are used to seeing the indented, and unintended, *human* subtleties. These include, for example, personal interpretations or missed chords in music performances, emphasising the artistic ability and skillset of the author, as well as the performer. This applies even more to artworks without intermediaries such as paintings where we can experience the hand of the painter through their brushstrokes. While every single music or art performance is slightly different due to human interpretation, the sensory outcome of a programmatic artwork is *always* identical in case this is intended. *unsig00001* will look the exact same way every single time when the according parameters are processed by the algorithm.

A computer *precisely* translates the input into an output, following the rules of the script. The absence of human agency during the processing might lead to the impression that the outcome is static and impersonal. However, the opposite is the case. A computer intrinsically does not exhibit agency, and, consequently, there is no room for interpretation. Every output offers an immediate and unfiltered experience of all decisions the artist made, while the algorithm itself resembles a transcript of their thinking process to achieve the given output. We can retrace the decisions which MICK + WOUT made to define the core structure of each *Dendro* by looking at the code, for example, the width and opacity of the stroke. Reading an algorithm would be comparable to reading Picasso's thoughts while he painted *Guernica*, witnessing the sequence of his actions and decisions. An algorithm not only contains the instructions for an artwork, but it also reveals the approach the artist pursued when creating this artwork. It discloses the capabilities of the artists, parts of their thinking process, and, ultimately, parts of their personality. Code can be art, and this type of art is intimate.

```

11 struct Dendro
12   CORE_ANGLES = (8..18) # min/max number growth angles
13   CORE_DIST   = 7.0     # min distance between cores
14   CORE_LIFETIME = (15..25) # min/max lifetime of a core
15   CORE_R_INIT  = 2.0     # initial core radius
16   CORE_R_MAX   = (5..8) # variable max core radius
17   CORE_RATE    = {0.8, 1.5} # min/max growth rate
18   CORE_TRIES   = 500     # max tries to find new position
19   FILL         = %(#111111) # background colour
20   LAYER_DIST   = 0.4     # distance between layers
21   LAYER_FLOW   = 400     # the max number of layers
22   LAYER_FALLOFF = 60     # number of layers for spacing
23   LAYER_MAX    = 0.5     # max usable layer distance
24   LAYER_REDUCE = 20      # flow reduction step per core
25   LAYER_SMOOTH = 0.15    # smoothing of bezier curve
26   LAYER_SPACING = {1.1, 0.8} # start/end layer spacing
27   POINT_DIST   = 1.25    # distance between layer points
28   PREDICT_DIST = 2.0     # predicted growth deactivation
29   SECTOR_NUM   = 360 * 10 # growth deactivation sectors
30   SIZE_DOC     = 4096    # document size for export
31   SIZE_VB      = 100     # viewBox size
32   STROKE_OPACITY = {0.85, 0.95} # min/max stroke opacity
33   STROKE_WIDTH  = {0.12, 0.18} # min/max stroke width

```

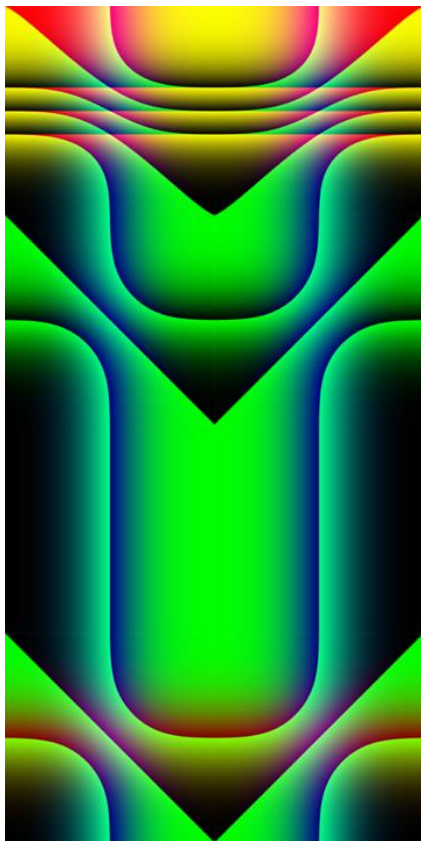
MICK + WOUT, *DendroRithms*, lines 11–33 of the algorithm, included in *Dendro0000*, minted as NFT on Cardano, 2022. Own screenshot.

Another characteristic of programmatic artworks is their immateriality. We are used to physically encountering artworks, and, moreover, to experiencing the *physicality* of them. Even though we visually experience a generated image on a computer screen in a, to some extent, comparable way as we see an oil painting hanging on a wall, we automatically realise that the setting is different. By touching the computer screen, we touch the displaying medium rather than an *unsig* or *Dendro*, or the actual blockchain itself. It is inherently impossible to physically grasp programmatic art, except in cases where the output is transferred onto a secondary medium, such as a print. All primary components of the artwork—inputs, algorithm, and output—remain immaterial. This not only affects how programmatic art is encountered, but also where. Neither the location of the artwork, nor of the spectator, matter. NFTs can be accessed anywhere, given there is an internet connection. When browsing the internet for *Guernica*, various facsimiles can be found and explored. However, the original can only be seen within the walls of the Museo Reina Sofia in Madrid. As opposed to this, everyone with the correct weblink can see an original *unsig* or *Dendro*.

Programmatic art, as defined in this context, intrinsically belongs to digital art. Above's questions regarding originality and reproducibility are related to the confined history of this art form. A fundamental issue related to the immaterial nature of digital art is, at least partially, the absence of hardware which makes art scarce (non-fungible) and, therefore, sellable. The invention and mass adoption of the computer, the internet, and the world wide web have brought a plethora of new possibilities to art practice. However, the past seventy years have been characterised by the struggle to integrate these various novel media and techniques for art making into the art market. Due to their reproducibility, digital assets required either a material counterpart that could be sold, or measures to restrict access to the artwork. For example, this could be done through websites that require login credentials, or by using watermarks. Alternatively, digital photographs can be printed. They can, in other words, be transferred onto a different medium, to be sold. Such solutions often appear impractical, inelegant and do not make sense. In summary, a major issue related to digital art was the lack of an appropriate way of commodifying it, in combination with, especially in the case of programmatic art, an incomprehension of the matter itself. The invention of a method that grants digital scarcity was not only crucial for *digital* currencies (cryptocurrencies), but also for *digital* art. NFTs create digital scarcity which enables, for the first time, the growth of an adequate market for immaterial art forms. However, a blockchain is not only a means for art dissemination. By

returning to the blockchain as an art medium, I will distinguish between *quantitative* and *qualitative* aspects which characterise and define this art form.

DendroRithms and *unsigned_algorithms* could not, in the form they exist, have been created in any other medium. Besides others,³⁵ MICK + WOUT and Watanabe catered to the specifications of NFTs and blockchain technology. NFTs, as means for mass dissemination, influenced the *quantitative* aspects. Firstly, it became possible to work with extensive collection sizes. While programmatic art theoretically also allows experiments with digital seriality, the phenomenon appeared after the introduction of NFTs. *DendroRithms* and *unsigned_algorithms* both grapple with the collection size as a conceptual component. Unlike PFPs, where, in the majority of all cases, every single item is a standalone piece, every *Dendro*, as well as every *unsig*, must be understood as an independent piece and, equally, as a part of an overarching composition. The number of 31,119 *unsigs* is not arbitrary but reflects a series of choices Watanabe made in terms of what should, and must not, be included.³⁶ A consequence



Jim Sanders, composition of *unsig*03577, 03604, 00498, 00503, 00040, 00042, 07931, and 07935, 2021.

of the variance and seriality is that single *unsigs* can be combined in a multitude of possible matching (or *not* matching) compositions which creates an additional layer of complexity, influencing our perception of, and relation to, the entirety of the collection. The second quantitative aspect is the sales process which has become part of the design in both cases; for example, every minter influenced the overall art installation when buying a *Dendro*. Watanabe, on the other hand, released *unsigs* in three phases at different price levels, playing with psychological factors. The third quantitative factor, eventually, is the digitisation of an entire art scene; storage, sale, and display are carried out digitally. In the case of *unsigs*, the use of the RGB colour model required a digital solution for the sale and display. Printing *unsigs* would have meant transferring them onto a different medium and necessarily

³⁵ A small number of artists and programmers are working on blockchain art on the Cardano blockchain. These are, among others, Steel, TurboEgon, ThisCrazyLife, Charles Machin, Abstract Potato, and Gregor Neumayr.

³⁶ 'Programmatic NFT. Exploring the medium of blockchain-based art, its potential and impact on art', p. 18.

converting the RGB model into CYMK, which is used for print media, and thus distorting a core principle of the artwork.

Moreover, blockchain art is *qualitatively* affected by the decentralised and programmable nature of the blockchain itself. I will explain what these terms mean and subsequently apply them to blockchain art. As shown, blockchains are data storages. In contrast to other entities that are capable of doing so—for instance, cloud servers such as Amazon Web Service (AWS)—blockchains offer programmability. This means, on a highly abstracted level, certain rules can be applied to data. These rules are formulated as algorithms which, in most cases, follow the basic programming principle of *if-then-else*: *if* a specific case occurs, *then* a predefined action is induced, *else* another rule is applied. For example, *if* a certain amount of money has been sent to an account, *then* an NFT is sent to wallet 1, *else* the NFT is sent to wallet 2. Indeed, these rules can be highly complex and multi-layered. Programmability is an additional layer of utility, which makes the blockchain a ‘dynamic’ entity, and marks an essential difference to conventional and ‘static’ data storages. Comparably, the archive of the V&A in London is a static entity where items are stored. But when some of its contents become part of an exhibition, these items are brought into a context where new relations among them are established. Working with, or programming, the contents of a blockchain means bringing static entities into a context and creating connections. Therefore, blockchains are intrinsically programmable. Moreover, blockchains as data storages are, as outlined earlier, decentralised. This means that a *multitude* of peers—people or bodies providing a network node who, eventually, produce blocks—are *collectively* responsible for the maintenance of a blockchain, and, additionally, all information that is contained is also *collectively* owned. In analogy, the Ashmolean Museum collaborates with various institutions, such as the Bodleian Libraries and the University of Oxford, collectively preserving, researching, and exhibiting a myriad of cultural goods.

Under the premise that each art form has its specific medium which utilises, emphasises, and leverages the characteristics of this art form, blockchain art is required to be *programmable* and *decentralised*. *DendroRithms* and *unsigned_algorithms* offer both characteristics. On one hand, methods of programming were used for their creation and the same *if-then-else* principles applied as for blockchains. Static issues were put into a context and a set of rules was in both cases used to generate a certain outcome. Watanabe applied the three basic colours to a distribution function to create *unsigs*. MICK + WOUT worked with the external decisions of the buyer as one input to shape every *Dendro*. On the other hand, *DendroRithms* and

unsigned_algorithms are decentralised artworks, as they are collectively owned by a multitude of individuals. The size of the collection potentially allows for a big number of owners. For instance, there are currently 2,312 people in the possession of at least one *unsig*.³⁷ In addition, it also implies that pieces which constitute the overall artwork can be accessed by anyone, regardless of whether it is owned by them or not.

The programmatic nature of the artworks, indeed, influences the aesthetic, which is oftentimes entirely abstract. The conceptual accessibility of programmatic art, in comparison to, for example, figurative art, is less dependent on the spectator's familiarity with the given context of the artwork, such as the local circumstances of a depicted issue. For instance, Picasso's *Guernica* must be understood within its historical context which was strongly affected by Nazi Germany and the Franco regime. Therefore, meaning in abstract art has to be constituted by other means, for example, by using colour as a phenomenon that can trigger an emotional response due to its immersive nature. Then, also the shared ownership, due to a potentially global reach, demands, to some extent, a universal comprehensibility of its idea. However, this requirement is inherently fulfilled by its own constitution as both programmatic *and* decentralised aspects lead to a sensory outcome which offers these qualities. As a result, these characteristics even enhance each other. Blockchain technology as a global movement, where nation states and borders are of minor relevance, requires and, thus, offers inclusivity. Blockchain art, in turn, adopts these requirements and visually represents them. The artform adopts the conceptual dimension of its medium. I will provide a holistic interpretation of both artworks in the last chapter.

Currently, there is an abundance of NFT projects appearing, exposing qualitative differences; some disclose an artistic purpose, some solely show interest in financial merits, and yet others reveal the intention to explore a new tool and medium. As outlined in the first chapter, blockchains encompass a variety of existing concepts and technologies. While none of its components are novel, it is their combination which creates a new technology. The same applies to blockchain art. It is a subcategory of generative art, belongs to digital art and shares certain qualities with mass art. However, the technical idiosyncrasies—its programmatic and decentralised nature—define the overall constitution and are leading to a socio-political dimension, as the requirement of a global accessibility reveals. The discussed artworks are first

³⁷This number is derived from JPG store, an NFT market place on Cardano: 'jpg.store' https://www.jpg.store/collection/unsigned_algorithms?tab=items&sortBy=price-low-to-high&saleType=buy-now (18 June 2022).

examples of this artform which reflect on the potential of a new medium and indicate where further exploration possibly could lead to. There might be other media in the future which will be able to accommodate it. Nevertheless, blockchain art, in its current form, constitutes an autonomous artform, reflecting technological advance and artistic practice.

McLuhan revealed a holistic comprehension of what an art medium constitutes when he states, ‘[a]ny understanding of social and cultural change is impossible without a knowledge of the way media work as environments.’³⁸ This societal aspect is an inherent part of blockchains as they are primarily created to provide a (financial) platform for direct interaction. In the last chapter, I will return to the vision behind blockchains—decentralisation. I will demonstrate how blockchain art mediates this vision, highlighting, as McLuhan argues, how ‘the environment that man creates becomes his medium for defining his role in it’.³⁹

Mediating a vision

Since Duchamp, we acknowledge the indispensable and systematic openness of what must be considered as art. Good art, as I perceive it, reflects, criticises, or comments on certain past or current issues that concern the human condition; art that enables us to take on new perspectives and triggers different ways of seeing. In some cases, art transcends criticism, and instead, creates a vision as a response to a certain phenomenon, suggesting a favourable alternative to what initially has been criticised, providing inspiration, hope and optimism for what is ahead of us. Art, in this way, is aimed for innovation and progress, and a desirable future. For the *documenta11* from 2002, Okwui Enwezor claimed and helped to promote universal ideals beyond colonial legacies. Artworks from around the globe were exhibited and presented to an equally global audience. His transcultural practice became not only an active form of protest against existing, mostly Western, standards, but also suggested an alternative approach that marked another step towards a more inclusive art historical practice. His role as the curator became ephemeral; what came to the forefront was their commonly pursued goal. This conveyance of a *shared* vision, exceeding the scope of singular exhibited works, as it was achieved during the *dokumenta11*, can, in my opinion, become a work of art itself. By exposing a vision to an external audience, an act of actualisation, or even materialisation, takes place,

³⁸ McLuhan/Fiore, p. 26.

³⁹ Ibid., p. 157.

turning an imagination into a more concrete and tangible opportunity. Art, therefore, can enact change.

Blockchain as a medium (for art) provides—to return to McLuhan’s words—an environment for human interaction. In this last chapter, I will demonstrate how a shared vision has been introduced with the invention of blockchain technology, promoting inclusion and distributed power, while inspiring various artists to work with this theme. In presenting a last work of blockchain art, I elaborate the role of technology and art within a broader context. This analysis reveals our subjectively connotated relation to information, but also how blockchain art in general forces us to question our own perspective. Eventually, it will allow me to provide a holistic approach on how blockchain art must be analysed in the context of its medium.⁴⁰

[TX scope](#)

TX_scope is an on-chain work, created in May 2022, showcasing the growth of the Cardano blockchain by visualising actual data derived from it. It is a collaboration of the programmable.art guild with Patrick Rivenbark as creative and Ben Shippee as developer. Using the blockchain as an infrastructure, the artwork visualises what is otherwise only accessible to people with programming skills: it shows *actual* blockchain data. Every block includes, on one hand, meta information, such as its own ID, or size, and, on the other hand, the transactions (tx). *TX_scope* displays the size of the most recent block in real-time. A block can contain data of up to a maximum of 88 kB in text format while the effectively used space varies for every block. By showing how much of this (character) space is used, or, in other words, how ‘full’ a block is, *TX_scope* brings basic information to the foreground, simultaneously emphasising its dependency on other metrics in order to gain value from this information. The fact that a block, for instance, had a size of 66 kB, is rather meaningless. Translating the absolute value into a relative creates a context; given the maximum size of 88 kB, 75% of it would be used. The work consists of five pieces, each of a size of 14,16 kB, which equals the maximum number of pieces that could be fitted into one block. Also here, the programmable.art guild intended to create a context for these values. By choosing a highly simplistic visual language, all attention is directed to the information which is displayed. Unlike other forms of data visualisation, such as online dashboards or real-time tracking services, the

⁴⁰ The following artwork belongs to the author.

intention behind *TX_scope* goes beyond the display of this data and also explores *how* a message is conveyed.

Data tells a story. Depending on its mode of representation, for example in the form of graphs, formulas, or also abstract shapes, slightly different aspects of a dataset are highlighted which, eventually, defines the message. Data attains its usefulness, presuming utility is aimed for, when it is placed in a context. The artwork covers various modes, accessed by pressing the keys 2, 3, 4, *I*, and *P*. For each view, the base information is shown under slightly different circumstances. Modes 2, 3, and 4 explore the ‘depth’ of the block; visualised are the number, size and type of the contained transactions. These transactions also account for the overall block size. Modes *I* and *P* provide context. Displaying the previous block (mode *P*) adds a temporal element. Unlike every other mode, for *I*, no additional information was added. Instead, in analogy to an architectural figure-ground plan and its inversion, this mode displays the space of a block which is left *unused*. The result is a change in perspective: either we look at a fact, or at the potential that has not been realised.⁴¹

To refine the previous statement, data does not tell *one* story—it tells *many*. The act of weaving single strings together to form a coherent, or *incoherent*, narrative is not only creative, but also, considering how data is used to form narratives to prove, or disprove, issues in science, politics, and other fields, immensely powerful. MICK + WOUT and Watanabe both used data as inputs for certain variables to specifically alter the visual outcome. By contrast, the programmable.art guild took one step back and brought the data itself, the building block of every blockchain, into the spotlight. The interactive, informative, and dynamic nature of this work differs from previously shown examples due to its temporal component: it is neither a static image, nor a snapshot of a moment in time, but an ever-evolving entity with a changing informational content. It becomes possible to experience the pace, metaphorically the pulse, of the Cardano blockchain and how its scope is gradually incremented with every new block, visualising the used, and moreover, the unused space which potentially could have been filled with more transactions. By offering different modes, we are enabled to experience different perspectives. Shifting them *in general* to a more abstract level, other narratives are opened up relating to space usage as the overall theme of *TX_scope*.

‘Space’ is a universal concept and its word meaning covers many facets. The programmable.art guild implicitly alluded to this multitude of possible narratives. For instance,

⁴¹ There is more technical information available related to block production. A list can be found here: ‘Blockfrost.io ~ API Documentation’ <https://docs.blockfrost.io/> (18 June 2022).

switching between looking at the used and unused space evidently refers to the meaning of space as an empty area. Then, space, indeed, covers a spatial component, comprising a three-dimensional entity, using the vectors [x / y / z] to define it. As this three-dimensionality could not be achieved on a two-dimensional display, the third dimension—responsible to create depth—is conceptually induced by the modes 2, 3, 4 which go into the ‘depth’ of the block usage, visualising data of a different granularity. Space, furthermore, is a fundamental building block of the physical concept ‘space-time’. As described, adding the previous block as a reference to an earlier point in time, the fourth dimension, time, has been introduced as well. Eventually, a ‘space’ is the gap between two words—as it was placed in the title *TX_scope*. The artwork reveals a curiosity about ‘space’ as a broad concept, about data and its narratives. In fact, its simplistic language invites people to familiarise themselves with a novel technology and its basic elements which otherwise would remain hidden and inaccessible. Metaphorically, *TX_scope* reflects the exploration of the ‘crypto space’, an immaterial entity beyond our reach, opening this ‘space’ to people who are less technophile.

John Berger expounded on the different ways of seeing, dismantling *how* we look at artworks influences *what* we see.⁴² He described how the placement of works in differing contexts, for instance, in juxtaposition with other works, alters our perception of them. Berger also described how reproductions change our relation to art in general.⁴³ Indeed, these observations apply to more than works of art. Hence, what if a subject itself appears incomprehensible or is of a complexity which makes it intricate to decipher? What if we do not even understand how to approach it? Blockchain technology is indeed such a subject. Looking at, and grappling with, the art that is reflecting on blockchains is an alternative way of experiencing the technology as artworks provide a different context and, therefore, allow an alternative perspective on it. *DendroRithms*, *unsigned_algorithms* and *TX_scope* explicitly engage with concepts related to their medium. Examining them leads to an interpretation on a more abstract level. As I demonstrate below, these artworks might inspire a reflection on the role of individual humans as part of a society, as well as the dynamics related to these social structures. These works, furthermore, help to illuminate the conditions and consequences of our own actions.

DendroRithms thematises the dynamics that evolve between an individual and a group, visualising the interplay between action and reaction. By introducing an interactive minting

⁴² J. Berger, *Ways of Seeing* (London, 1972).

⁴³ *Ibid.*, pp. 7–33.

process, MICK + WOUT made each buyer a participant of a network where everyone was offered the exact same amount of agency. Participants were implicitly forced to contemplate their own actions in relation to this network as subsequent pieces were built upon preceding choices. Metaphorically speaking, *DendroRhythms* resembles a chain of decisions that are linked together in sequential order. Part of the artistic intention in this work was to inspire a thought process about the impact of individual actions, not only on the personal realm, but also on the entirety of the overarching system. The result was a collectively created, digital installation, reflecting on the *shared* infrastructure blockchains provide. Coincidentally, the sales of *DendroRhythms* started shortly before, and went on during, the Russian Invasion of Ukraine in February 2022. In the light of these events, the relevance of considerations about the vast impact—be it on a political, economic, or social level—of single instances on a global system, and more importantly, about alternative models which are able to prevent the abuse of power at the expense of other instances, became evident.

unsigned_algorithms comprises 31,119 iterations of the same building blocks, exposing the plethora of options that arise from this premise. The constitution of this artwork—an immense variety of outcomes, all going back to a genesis piece, four input parameters, and combinations of them—makes us reflect on uniqueness, the valuation of certain traits and their relatedness, which, eventually, might remind us of the constitution of our human biology. Watanabe presented a collection of an extensive size that only reflects a fraction of what would have been possible with given input parameters, demonstrating the relation between potential and realisation. A collection of matching and non-matching colour combinations entices us to think about the proximity and interrelatedness of individual entities within the encompassing matrix that has been generated by means of processing and combinatorics.

TX_scope goes in another direction, questioning the boundaries between what is considered to be art, data visualisation, and technical application, and, consequently, how the work itself, and equally, how art and technology in general, is encountered by spectators, or users. The work is interrogatory and explanatory, implicitly addressing the modernist debate as to whether art should, or *must not*, have utility. The legacy of these paradigms are still deeply entrenched in Western culture and we are working on overcoming its fallacies, for example, by promoting a holistic comprehension of art as Enwezor envisioned it for the aforementioned *documenta11*. *TX_scope* can be used as a tool to monitor the blockchain load. Alternatively, it can be seen as a conceptual artwork, playing with the varying semantics of ‘space’. But, in fact, it does not matter, as it can be, and *is*, both. The work oscillates between different modes of what it

displays, and also between how all these instances are seen, equally affecting our relation to every single instance of it.

Being confronted with certain technicalities related to blockchain art triggers critical questions about the technology in general. For instance, the programmatic nature of blockchain art has revealed the strict operating principles of algorithms once they are enacted. Especially in dynamic systems, for example *TX_scope*, where external data inputs are constantly required, chances exist that unforeseen circumstances disrupt the computing process and lead to failure. The relations, and distribution of agency, between technology and humans is delicate and especially relevant for uses cases where mistakes in an algorithm can entail broad consequences related to, for instance, data privacy. Another example concerns the financial accessibility of blockchain art. On one hand, an inherently more inclusive art production and dissemination becomes possible, as people from remote regions may gain access to the art market. On the other hand, purchasing blockchain art uncovers the prevalent dependency on the current financial system. Local currencies are exchanged against cryptocurrencies which, in most cases, are required for the purchase of NFTs. However, exchange rates vary broadly which, still, makes blockchain art intrinsically more accessible for people from financially strong nations. The interaction with blockchain technology when purchasing NFTs forces every buyer to think about this kind of related processes. To summarise, *DendroRithms*, *unsigned_algorithms* and *TX_scope* cause a shift in perspective. This observation does not necessarily apply to all examples of blockchain art. However, I see it as a consequence of their self-reflexive nature: blockchain art reflects on blockchain technology, which, in turn, explicitly aims for a systemic shift. I will disentangle this idea in the following.

Due to the conceptual and abstract nature of blockchain art, where meaning cannot be ‘seen’ immediately, we have to shift our focus on what can be derived mediately, in a broader, more philosophical sense. This emphasises their universal comprehensibility and validity. By analysing the works on an abstract level, we are forced to take on an outside perspective, reflecting on the entirety of presented models. This positioning outside of it makes us, in turn, recognise and reflect the location we usually have *within* such a system. Blockchain art, thus, is self-reflexive. People holding a *Dendro*, *unsig*, or a *TX_scope* become implicitly or explicitly aware of the fact that they are one participant in a wider network of many peers. The meaning of blockchain art is derived from its own constitution which is inextricably linked to the medium. The medium, then, has been built to create an environment where the relation between peers and the entirety of the network is a core issue, intending to shift power from a focal point

towards a multitude of them. This is a systemic shift. Indeed, it concerns in the first instance the financial system, as society majorly relies on the exchange of money, but it is also applicable to other industries such as the art market. The blockchain itself is much more than a medium for art. It stands for peer-to-peer communication and accessibility, for open source and, equally, for the right of ownership. It stands for openness and decentralisation. Whereas blockchain technology is all about shifting power from one instance to many; blockchain art is, implicitly, or explicitly, (about) visualising this shift of perspective. The ideals, potential, *and* issues related to the technology become tangible through blockchain art.

McLuhan offered a succinct overview of media history, stating that '[p]rint technology created the public. Electric technology created the mass. The public consists of separate, fixed points of view. The new technology demands that we abandon the luxury of this posture, this fragmentary outlook'.⁴⁴ His vision of a global village, where the 'fragmentary look' would be replaced by multilateral communication, was only partially realised. Telecommunication, and, since the beginning of the twenty-first century, the world wide web, build an environment based on a 'one-to-many' communicative model. However, this way of broadcasting is still fragmentary as it majorly reflects isolated perspectives of the body which has the power to broadcast. By contrast, the blockchain is an environment that allows a 'many-to-many' communication as power is distributed amongst many peers. The *documenta11* exemplifies the difference between both models. Enwezor expanded the traditional setting of the exhibition from one location to five, spread across the globe. He not only decentralised the exhibition, but he also shared curatorship. A group of people *collectively* organised a *multitude* of events, reflecting *various* perspectives and being accessible by a *multitude* of people. Blockchain technology offers a shared infrastructure. In this sense, it is an environment for human interaction, offering anyone the role they want to take on, be it a sender, or receiver, or both.

MICK + WOUT, Watanabe, and the programmable.art guild are exploring the blockchain as a medium, expressing curiosity about a novel technology and its intersections with art. This curiosity exemplifies the position we, as a global society, are in right now: on the threshold between an analogue and digital realm. Not necessarily in a short-term perspective, but considering the history of art, or rather the human history as a whole, we are on the verge of a digital era with blockchain technology as one of its components. New technologies entail uncertainty and tension. Internet technology, artificial intelligence, as well as blockchain

⁴⁴ McLuhan/Fiore, pp. 68f.

technology are the major inventions in engineering of the past century, questioning traditional models of human interaction. They enable innovation and the exploration of unprecedented possibilities, creating space for encounter, novel ways of expression, and, indeed, provoke new perspectives. The intention behind this dissertation, written in the field of art *history*, is not to describe an issue of the *past*. Instead, this is an expression of my own curiosity about an occurrence of the *here and now* which not only transcends the field of art (history), but also the present, potentially affecting the future.

Without any doubt, there are countless flaws, misconceptions, and sincere risks still present with blockchain technology. The surge of NFT production, in many cases a mere revenue generating machinery without any further (artistic) intention; the psychological effects of consumer culture leading to sometimes highly speculative cryptocurrency trading; or even the halt of entire blockchains—for instance, the Terra blockchain crashed in May 2022, influencing the cryptocurrency market profoundly—expose some of these issues in their extreme forms. However, expecting that a technology that holds the potential to structurally change our financial system, our ways of interaction and communication, and eventually our societal patterns, could be immaculately conceptualised, built, and deployed within less than two decades, is utopian. There is probably not a single invention which brought significant change that came without any issues in the beginning. This applies to blockchain technology itself, as well as its art production. Artists and creatives are experimenting with this new medium in various ways, leading to varying results. This exploration of the unknown, sometimes resulting in failure, is an indication of growth. Blockchain technology is capable of changing profound structures. This implies equally profound changes in order to correct them, otherwise its profundity would either be counterfeit, or irrelevant. Eventually, blockchain technology is much more than a medium for art or platform for money. It affects our individual lives by changing our position within a society. John Perry Barlow wrote *A Declaration of the Independence of Cyberspace* in 1996 whose ideals holistically apply to blockchain technology.⁴⁵

Cyberspace consists of transactions, relationships, and thought itself, arrayed like a standing wave in the web of our communications. Ours is a world that is both everywhere and nowhere, but it is not where bodies live.

We are creating a world that all may enter without privilege or prejudice accorded by race, economic power, military force, or station of birth.

⁴⁵ J. P. Barlow, 'A Declaration of the Independence of Cyberspace' <https://www.eff.org/cyberspace-independence> (14 May 2022).

We are creating a world where anyone, anywhere may express his or her beliefs, no matter how singular, without fear of being coerced into silence or conformity. [...]

We will create a civilization of the Mind in Cyberspace. May it be more humane and fair than the world your governments have made before.

To conclude this dissertation, I will return to art. Besides others, MICK + WOUT, Alexander Watanabe, and the programmable.art guild are exploring the blockchain as an environment to make art while synchronously working towards a common vision. Art is relevant not only because it reflects on issues of the past and the present, but also because, at least in some cases, it makes us imagine what the future might look like. Art possesses the power to make us envision a state that is not (yet) real, and to make us consider actions required to turn such a vision into reality. Art can enact change, and so too might blockchain art. The blockchain itself forms a palimpsest where single strands cannot be decoupled from the entirety: it is a medium for blockchain art, equally, it is the medium for an alternative finance system, and, eventually, blockchain always mediates the overarching vision of decentralisation. And the medium is the message, too.

Bibliography

Primary Sources

- Barlow, J. P., ‘A Declaration of the Independence of Cyberspace’ (1996) <https://www.eff.org/cyberspace-independence> (14 May 2022)
- Majer, A., ‘The Carbon Footprint of NFTs: Not All Blockchains Are Created Equal’ foreword by D. Barbosa (2022), https://linuxfoundation.org/wp-content/uploads/LFResearch_HL_NFT_Report_22Apr22_FINAL.pdf (15 June 2022)
- Nakamoto, S., ‘Bitcoin: A Peer-to-Peer Electronic Cash System’ (2019), <https://bitcoin.org/en/bitcoin-paper> (28 April 2022)
- Watanabe, A., ‘NFTs: why would anyone pay for a link to a JPG?’ <https://archinect.com/forum/thread/150312287/nfts-why-would-anyone-pay-for-a-link-to-a-jpg> (18 June 2022)
- alexanderwatanabe, ‘unsigned_algorithms’ https://github.com/alexanderwatanabe/unsigned_algorithms/blob/main/unsig_gen.ipynb (19 June 2022)
- wout, ‘Source code of DendroRithms’ <https://github.com/wout/dendro/blob/main/dendro.cr> (26 April 2022)
- ‘IOHK Library’ <https://iohk.io/en/research/library/> (10 June 2022)
- ‘jpg.store’ https://www.jpg.store/collection/unsigned_algorithms?tab=items&sortBy=price-low-to-high&saleType=buy-now (18 June 2022)
- ‘Blockfrost.io ~ API Documentation’ <https://docs.blockfrost.io/> (18 June 2022)
- ‘Creative Conversations: Blockchain Art and NFTs’ https://moca.ca/events/creative-conversations-blockchain-art-and-nfts_panel-01/ (29 May 2022)
- ‘Programmatic NFT. Exploring the medium of blockchain-based art, its potential and impact on art’ https://docs.google.com/presentation/d/1A21A659QM0NdkCi84itPaWpPxq7PDe7moruwJ8N0V0/edit#slide=id.gd9d03af5fa_0_161 (20 May 2022)
- ‘What is Unsigned Algorithms? A chat with #Unsig founder Alex’, YouTube (uploaded 28 August 2021) <https://www.youtube.com/watch?v=tHe2WU7NQYg> (18 June 2022)
- ‘Are NFTs really art?’ <https://www.theguardian.com/technology/2022/mar/14/are-nfts-really-art> (20 May 2022)
- “‘I went from having to borrow money to making \$4m in a “day”: how NFTs are shaking up the art world’ <https://www.theguardian.com/artanddesign/2021/nov/06/how-nfts-non-fungible-tokens-are-shaking-up-the-art-world> (20 May 2022)

Secondary Material

- Barthes, R., *Camera Lucida. Reflections on Photography* (London, 2000)
- Benjamin, W., 'The Work of Art in the Age of Mechanical Reproduction' (1936), in Ch. Harrison and P. Wood (eds), *Art in Theory 1900–2000. An Anthology of Changing Ideas* (Malden/Oxford, 2003), pp. 520–527
- Berger, J., *Ways of Seeing* (London, 1972)
- Boden, M. A. and Edmonds, E. A., 'What Is Generative Art?', *Digital Creativity*, 20/1–2 (2009), pp. 21–46
- Carroll, N., *A Philosophy of Mass Art* (Oxford, 1998)
- Catlow, R., Garrett, M., Jones, N. and Skinner, S. (eds), *Artists Re:Thinking the Blockchain* (Liverpool, 2017)
- Dorin, A., et al., 'A Framework for Understanding Generative Art', *Digital Creativity*, 23/3–4 (2012), pp. 239–259
- Galanter, Ph., 'What is Generative Art? Complexity Theory as a Context for Art Theory' (unpublished paper, 2003), http://www.philipgalanter.com/downloads/ga2003_paper.pdf (4 June 2022)
- Godfrey, T., *Conceptual Art* (London/New York, 1998)
- Greenberg, C., 'Avant-Garde and Kitsch' (1939), in Ch. Harrison and P. Wood (eds), *Art in Theory 1900–2000. An Anthology of Changing Ideas* (Malden/Oxford, 2003), pp. 539–549
- Greenberg, C., 'Towards a Newer Laocoon' (1940), in Ch. Harrison and P. Wood (eds), *Art in Theory 1900–2000. An Anthology of Changing Ideas* (Malden/Oxford, 2003), pp. 562–568
- Lewis, A., *The Basics of Bitcoins and Blockchains. An Introduction to Cryptocurrencies and the Technology that Powers Them* (Coral Gables, 2021)
- LeWitt, S., 'Paragraphs on Conceptual Art' (1967), in Ch. Harrison and P. Wood (eds), *Art in Theory 1900–2000. An Anthology of Changing Ideas* (Malden/Oxford, 2003), pp. 846–849
- MacDonald-Korth, D., et al., *The Art Market 2.0: Blockchain and Financialisation in Visual Arts* (Oxford Internet Institute and The Alan Turing Institute, 2018)
- McIver Lopes, D., *A Philosophy of Computer Art* (Abingdon, 2010)
- McLuhan, M. and Fiore, Q., *The Medium Is the Message*, ed. J. Agel (London, 1967)
- Patrickson, B., 'What Do Blockchain Technologies Imply for Digital Creative Industries?', *Creativity and Innovation Management*, 30/3 (2021), pp. 585–595
- Paul, Ch., *Digital Art*, 3rd edn (London, 2015)
- Pearson, M., *Generative Art. A Practical Guide Using Processing* (Shelter Island, NY, 2011)
- Platt, M., et al., 'The Energy Footprint of Blockchain Consensus Mechanisms Beyond Proof-of-Work' (unpublished paper, 2021, IEEE 21st International Conference on Software Quality, Reliability and Security Companion QRS-C), pp. 1135–1144

Tapscott, D. and Tapscott, A., *Blockchain Revolution. How the Technology behind Bitcoin and other Cryptocurrencies Is Changing the World* (London, 2019)

Whitaker, A., 'Art and Blockchain: A Primer, History, and Taxonomy of Blockchain Use Cases in the Arts', *Artivate*, 8/2 (2019), pp. 21–46

NFTs

MICK + WOUT, *DendroRithms*, *Dendro0000*, input parameters and algorithm, minted as NFT on Cardano, 2022. Owner: Mick van Meelen and Wout Fierens. <https://cardanoscan.io/transaction/4b784e7339c29f4ef1212bcc5ca56078a1e46f672587a99bcca2628df1e14d47?tab=metadata> (20 June 2022)

MICK + WOUT, *DendroRithms*, wallet with various pieces, minted as NFT on Cardano, 2022. Owner: the author. <https://pool.pm/stake1uyzgn9c54694qxr8dxhfxm5fz3k5s3qc8z6rfkunuhmu7k0qxy83g9/%402e9b243d> (20 June 2022)

MICK + WOUT, *DendroRithms*, *Dendro0777*, input parameters and algorithm, minted as NFT on Cardano, 2022. Owner: the author. <https://bit.ly/3N4TnrN> (20 June 2022)

Alexander Watanabe, *unsigned_algorithms*, *unsig00000*, sensory outcome, minted as NFT on Cardano, 2021. Owner: @adaboy98669717. <https://pool.pm/0e14267a8020229adc0184dd25fa3174c3f7d6caadcb4425c70e7c04.unsig00000> (20 June 2022)

Alexander Watanabe, *unsigned_algorithms*, *unsig00000*, input parameters and algorithm, minted as NFT on Cardano, 2021. Owner: @adaboy98669717. <https://cardanoscan.io/transaction/e4a90da18935e73f7fd6ffaa688b35b011a1a8a710b47bdb5d7103a05afc0197?tab=metadata> (20 June 2022)

Alexander Watanabe, *unsigned_algorithms*, wallet with various pieces, minted as NFT on Cardano, 2021. Owner: Grancho. <https://pool.pm/addr1qx62yzsp66tjxy7yeqkqfdkfwtk56f7trqrdeu88u049vzmxzkmcc5c3q6pa6tgt3ddpr8rnyda2j258cwtqm30pqgq3kswm9/%400e14267a> (20 June 2022)

programmable.art guild with Patrick Rivenbark and Ben Shippee, *TX_scope*, *NFVTXSI*, sensory outcome, minted as NFT on Cardano, 2022. Owner: the author. <https://www.programmable.art/txscope> (20 June 2022)

NyteLyte, *Going out West*, mixed media collage, minted as NFT on Cardano, 2021. Owner: the author. <https://pool.pm/asset1035tma7jt9ve47j90vfv5z7s2a3ne5he4lwyuj> (20 June 2022)

Acknowledgements

Firstly, I wish to thank my supervisor, Geoffrey Batchen, who guided me through the writing process of this dissertation. It has been an extremely interesting, exciting, and, at times, intimidating experience to do this research during the very early blocks of blockchain art. Many people from the Cardano community, who are equally excited, curious, and critical, gave me some answers when there were none elsewhere. Jim Sanders, your passion for *unsigs* and blockchain (art) inspired me to go this way—it was a change of direction that went far beyond the change of a thesis topic. I am so grateful, pawa. There are countless other people I want to mention: Joshua S. (!) Bamford, you introduced me to the scientifically proven power of synchronicity; NyteLyte, you showed me the intensity of light and darkness, the beauty of the unsettling, and the subtlety of a frying pan; and you, Daniel Rodríguez, provided technical guidance and lit a candle whenever needed. Jelani Sasso, Solaire, MarchCat, Ibis, Redegg, Grancho, CryptoMatt, Per van der Horst, and many members from the *unsig* and *Dendro* communities, thank you for sharing your insights, questioning my beliefs, and always having an answer to why it all matters. The compassion and dedication of Holger Hartstock, Quasar, and the always happy Felix Weber to build a more just system is exceptional. Fellow OxBATs, thank you for spreading the wings of encounter. Noodz and Rod.G., you were the heroes five minutes before midnight. And you, Marcel Niessner, made me go home and eat an apple. A special thanks to all the creative people who are exploring blockchain art: the programmable.art guild, especially Ben Shippee, for questioning and blurring the lines between beauty and utility; Mick and Wout for thinking and creating so holistically (and choosing Naples Yellow, a colour that deserves immutability); and Alex Watanabe for always pushing the boundaries and having an (in)appropriate opinion about primates. But mainly thank you for making art that makes us think and feel. Lastly, I deeply want to thank you, Patrick Rivenbark, my friend and partner in crime whose heart is always on fire, for being the human being you are. Y'all, and many more, who endured and supported the stubborn, and meticulous person I can be; this is for you. It has been the craziest and most fun experience I had—so far.

[The medium is the message, too!](#)