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Exploring the Potential of Blockchain Data as Pseudorandom Numbers for Microtonal Algorithmic Composition. A Case Study on *Blockchain Music 2.5*

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EXPLORING THE POTENTIAL OF BLOCKCHAIN DATA AS PSEUDORANDOM NUMBERS FOR MICROTONAL ALGORITHMIC COMPOSITION. A CASE STUDY ON *BLOCKCHAIN MUSIC 2.5*

Abstract: This study explores the utilization of blockchain data as a set of pseudorandom numbers in the context of microtonal algorithmic composition. Conventional methods of generating indiscriminate numbers often lack the desired levels of unpredictability and uniqueness necessary for an intricate musical piece. By harnessing the hash parameter of several blockchains, we propose an innovative approach for obtaining pseudorandom numbers that offer heightened randomness and diversity. Moreover, the ensuing structure ensures the preservation of all composition data on servers, facilitating the re-generation of the piece and enabling listeners to revisit its past fragments. Additionally, leveraging blockchain technology allows the audience to actively interact with the composition, fostering a more engaging and participatory musical experience.
Through a comprehensive case study of a self-written, self-generating piece (*Blockchain Music 2.5*, 2023), we demonstrate the practical implementation of blockchain-generated numbers, showcasing their potential in exploring new post-tonal dimensions and producing unique sonic textures based on the predetermined set of rules. We also discuss the im-

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plications, challenges, and potential future directions of incorporating blockchain-generated numbers in algorithmic music composition. The research expands the landscape of digital music composition techniques and offers new avenues for leveraging blockchain technology in the domain of creative expression.

Keywords: composition, microtonality, polymicrotonality, polysystemism, algorithmic music, self-generative music, xenharmonics, blockchain.

Introduction

In the world of algorithmic composition, music theory, computer science, and mathematics come together in a cross-disciplinary fusion. The application of algorithms is involved in creating music based on a set of predefined rules or inputs. The quality and complexity of such compositions often hinge on the unpredictability and uniqueness of the numbers employed, commonly generated using pseudorandom number generators (PRNGs). However, traditional PRNGs frequently fall short in terms of delivering the variability and diversity necessary for complex musical creations. This inadequacy is particularly evident in the context of microtonal compositions, where musical structures that stray from the twelve-tone equal-tempered system risk becoming overly predictable without a sufficiently complex governing set of rules.

In parallel with these challenges, blockchain technology emerges as a promising alternative for generating pseudorandom numbers. The technology's inherent focus on security necessitates a high degree of randomness within the parameters of each new block to mitigate against hacks and fraudulent activities. This results in a rich stream of data with excellent pseudorandom characteristics, making it a viable alternative to traditional PRNGs. Additionally, the wealth of options available – ranging from various chains and ZK-rollups[2] to smart contracts deployed on EVM-compatible platforms[3] – ensures a steady supply of versatile, pseudorandom data. This abundance aligns well with the computational and creative demands of intricate microtonal compositions, making

2 The ZK (zero knowledge) rollups take many small operations, bundle them together, and then add them to the blockchain as a single transaction. The compressed data generated through this process, influenced by underlying cryptographic techniques, shows potential for use as a PRNG.

3 The EVM (Ethereum Virtual Machine) technology allows running smart contracts on top of an existing blockchain, in a similar manner that one would run custom-made programs with different functions on a computer.

blockchain technology a compelling solution for enhancing the depth and reducing the predictability of algorithmic music. As a result, such an array of data is established as an ideal resource for innovative sonic experimentation.

While examining the potential of blockchain data within its role in providing pseudorandom numbers, one can explore its application in sonification to create algorithmic compositions. Sonification refers here to the process of converting aspects of blockchain data, such as numbers generated through authentication protocols, block sizes, and checksums, into components of musical output. This technique leverages the inherent pseudorandom qualities of blockchain data. The series of compositions examined within this paper, *Blockchain Music*, utilizes this methodology by transforming these blockchain-derived data points into various musical parameters. These are not solely used as sources for randomness; rather, they systematically correspond to distinct musical characteristics like pitch classes, rhythmic structures, and timbral attributes. This method allows the composition to parallel the inherent properties of blockchain data, such as its unpredictability, thereby providing a foundation for an audibly representational form of blockchain's operational dynamics.

The Basics of Blockchain Technology

Blockchain is a decentralized digital ledger technology originally conceived to support cryptocurrencies, as first envisioned by Satoshi Nakamoto (2008). Unlike centralized databases managed by a single entity, a blockchain is maintained by a network of nodes (computers) that validate and store data in a distributed manner. Such an architecture ensures a high level of transparency, security, and immutability, organizing data into distinct blocks for added clarity.

Each block in a blockchain contains a hash of the previous block, a timestamp, and a list of transactions or data. The hash within this context is a complex algorithmic function that converts data into a fixed-size string of characters, acting as a checksum for all the transactions within the block. This function is what provides the high level of unpredictability and randomness essential for secure transactions and, in the context of this study, for generating pseudorandom numbers.

Blockchain technology employs cryptographic techniques to ensure the security of data. Once a block is added to the chain, altering its content would require recalculating the hash of every subsequent block, a computationally infeasible task. The fortified security not only ensures that the blockchain is resistant to hacking and fraudulent activities but also establishes the technology as an ideal platform for safeguarding its historical data on a global scale, where the risks of corruption or loss are mitigated.

Although initially developed for financial transactions, blockchain has found applications across various sectors, including for instance governance, logistics, and healthcare.[4]

Integrating Blockchain in Music

The incursion of blockchain technology into music signifies a fundamental change in engagement with musical works. First of all, the status quo is challenged by enabling a new infrastructure for music streaming and distribution. For instance, a platform named Audius capitalizes on the decentralized nature of blockchain to provide a music streaming service that supports artists through direct transactions and interactions with their audience, effectively eliminating intermediaries and potential points of exploitation (Rumburg, Sethi and Nagaraj 2020).

Moreover, initiatives such as Imogen Heap's MyCelia are pioneering the application of blockchain for equitable remuneration and the management of creative rights. This approach underscores the potential for blockchain to underpin a user-centric payment model and transparent royalty distribution system, thereby advocating for the rights of music creators. The endeavor also exemplifies the potential for smart contracts – self-executing agreements with their terms written directly into the code – to revolutionize the way artists control their intellectual property and revenue streams.

Tokenization might be perceived as another significant advancement, further extending blockchain's utility into the music industry. The first musical artists to make use of the concept were the rock band Kings of Leon: by releasing their 2021 album *When You See Yourself* as a form of Non-Fungible Token (NFT) they have pioneered a novel revenue model for artists by merging music with digital collectibles. Such tokens represent a paradigm shift, endowing digital assets with uniqueness and verifiable ownership – elements that have traditionally been elusive in the digital domain.

Nevertheless, it is prudent to acknowledge the financial volatility inherent in the realm of cryptocurrencies, a sector most essentially linked to these innovative applications. Recent events such as the fall of the FTX platform, the drastic cooling of NFT market fervor, and the speculated introduction of Bitcoin ETFs – which could significantly influence cryptocurrency values – pose risks to the stability of blockchain ventures in music. Therefore, a more steady application of blockchain in music might be pursued within the sphere of sonification.

4 An interesting example of utilizing the blockchain technology in healthcare could have been recently observed in the Indian state of Maharashtra: the local government implemented the Polygon blockchain infrastructure to digitize and safeguard the issuance of COVID-19 test certificates. This strategic deployment of blockchain facilitated the enhancement of record authenticity and verifiability, ensuring a mechanism for health document management.

Sonification stands as a balanced alternative, insulating musical endeavors from the fiscal ebbs and flows that characterize the crypto market. Unlike the financial models vulnerable to cryptocurrency volatility, sonification leverages just the pseudorandom data found *within* the blockchain. This aligns perfectly with the demands of complex algorithmic and microtonal compositions, providing a novel approach to generating unforeseeable and varied numerical inputs.

Sonification of the Blockchain: The Genesis of *Blockchain Music*

In 2014, at the confluence of music, mathematics, and emerging digital technologies, I began composing a piece called *Blockchain Music*. This composition for piano and algorithm was imagined to be a living, evolving artwork, self-updating every few months through the integration of new blockchain data. It is currently projected to finish itself no later than in the 68th century. As far as my research has shown, *Blockchain Music* represents the first sonification of the blockchain data.

The conceptual bedrock of *Blockchain Music* is deeply intertwined with the core principles of blockchain technology. Just as a blockchain is decentralized, immutable, and continually expanding, so too is this musical piece. At each update, the composition incorporates four block parameters from the Litecoin system: nonce (number used only once), size, difficulty, and hash. This offers a form of musical cryptography, where the pseudorandom numbers generated from the blockchain serve as both the musical and computational backbone of the piece.

Nonce serves as the signpost for the algorithm: it instructs the piece about the block number necessary for the next act of musical creation, which is constituted of the pitch and rhythm (both determined by hash), number of notes at the same time (determined by difficulty), and the dynamics (determined by size). Through the series of additional instructions, a piano piece is created.

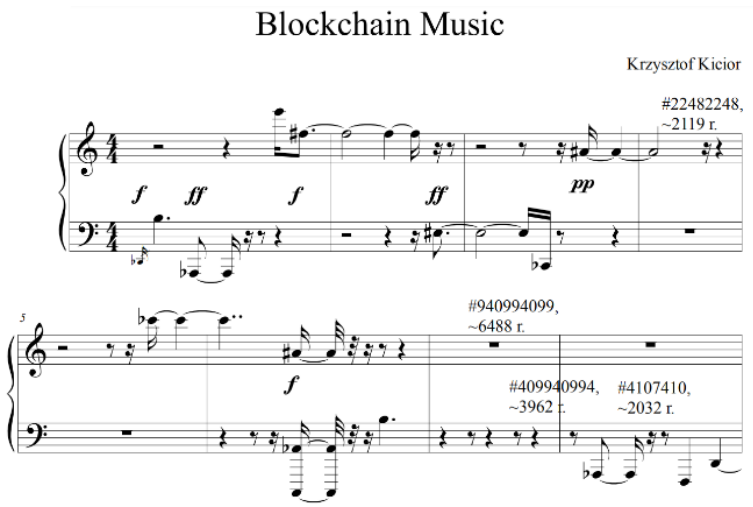

Figure 1. *Blockchain Music*, the beginning of iteration 1 (1.01.2017). The tempo is always equal to ♩ = 60.

What sets *Blockchain Music* apart from other algorithmic compositions is its self-inserting and self-evolving nature. The automatic updating mechanism not only preserves the foundational ideas of the piece but also ensures that it reflects the ongoing growth and transformations within the blockchain itself. However, this feature also comes with inherent limitations. For one, the Litecoin blockchain does not offer a continuous enough data stream for ceaseless musical generation, given its new block creation rate of every few minutes. This logistical constraint justifies the need for live performance: the three-to-five-minute time limit makes it possible for a human being to play the piece. Furthermore, the piano-centric focus inevitably confines the work to just twelve pitch classes, of which eleven are employed in the composition. While it would be completely feasible in a piece for piano solo composed using traditional methods, utilizing such a limited set of data within a seemingly boundless composition leaves the composer, the audience, and the performer unsatisfied.

Thus the need for a new paradigm becomes obvious.

Using the Hash Function as the PRNG

In 2014, Vitalik Buterin, a programmer and co-founder of Bitcoin Magazine, introduced a radical innovation to the blockchain world: Ethereum (Buterin 2014). Unlike Bitcoin, which was primarily designed as a digital currency, Ethereum was conceived as a more versatile platform capable of executing "smart contracts" and hosting decentralized applications (dApps). The introduction of Ethereum marked a pivotal moment in the evolution of blockchain technology, extending its utility far beyond financial transactions. With its more flexible scripting language and the capability to create complex contracts, as well as a block generation time averaging just fifteen seconds, Ethereum opened up new avenues for innovation, including the potential for advanced applications in algorithmic music composition. Its subsequent layer-2 scaling solution,[5] Polygon, has dropped the average block generation time to approximately two seconds, further facilitating the possibilities of continuous pseudorandom data streaming.

Building on the conceptual and technological framework of my initial *Blockchain Music* piece, I ventured into a more ambitious project: a series of pieces named *Blockchain Music 2.x*. Unlike its predecessor, which was written for

5 The so-called Layer-2 solutions (L2) are additional systems that operate on top of the main blockchain (L1). Their main function is helping manage the blockchain congestion by taking many transactions and handling them separately, but in a manner that is still anchored to the main system. This way, the main blockchain does not get too crowded, and things can keep moving quickly and efficiently.

piano, this new series is designed for algorithms and virtual synthesizers, and was programmed entirely in Max MSP. The modifications do not stop there; the *Blockchain Music 2.x* series can play continuously, offering an ever-changing musical landscape seemingly without end. In this paper I will focus on *Blockchain Music 2.5*: the latest version in the series.

Leveraging the architecture of the EVM-compatible blockchain, I have simplified the framework for endless musical creation by focusing solely on the hash function: a checksum for every consecutive block. The function consistently presents as a 64-digit hexadecimal number, prefaced by the "0x" indicator. To illustrate, let us consider the hash of Polygon block number 41923415, generated on April 25, 2023:

$$0x82a659720d22ccd7464e32fecd6c4d2a61290485b87c9e9bbe3a56ce716c75a4$$

Given that a comparable 64-digit number is produced roughly every two seconds, it can be readily harnessed to generate an almost ceaseless flow of musical content. To achieve this, I have chosen to slice the hash function into 32 separate two-digit hexadecimal values, omitting the leading "0x" indicator. Even though generating 32 data points every two seconds does not match the human capacity to recognize 30 stimuli per second (Isnard et al., 2019, 1–2), it is more than enough for crafting a musically complex and engaging piece.

Upon dividing the hash function, we obtain a sequence of hexadecimal numbers as follows:

$$\cancel{0x}\ 82\ a6\ 59\ 72\ 0d\ \ldots$$

When these hexadecimal numbers are converted to their decimal equivalents, we get:

$$130\ 166\ 89\ 114\ 13\ \ldots$$

The resulting set of decimal numbers, which fall within the range of 0 to 255, can be effectively employed to guide the structure of the composition. To accomplish this, I have chosen to use the numerical range extending from 0 to 200 to dictate the pitch. These newly-acquired numbers are converted through the *scale* object of Max MSP to the range of 0 to 127[6] so that they can be easily parsed as pitch within the MIDI messages and sent to an external virtual synthesizer.

6 In text-based programming, the equivalent of the operation would be multiplying the number by a factor of approximately 0.637 and then rounding it to the nearest integer.

The numbers within the range of 201 to 240 are allocated for governing the musical layers within the composition, while the remaining numbers, spanning from 241 to 255, pertain to broader structural alterations in the composition, such as modifications in tempo or the equilibrium between its layers.

While the tempo of the piece varies – so that the composition makes an impression of a self-regulating organism – its limitations forbid it from exceeding ten notes per second. Therefore, with an average block creation time set at two seconds a maximum of twenty numbers can be used before the next block is generated – and, with the remaining data points discarded, the cycle can start again.

The Algorithms Versus the Premise of Polysystemism

The usage of computers in music has led to the point where the constraints of traditional instrument tunings are no longer a performative boundary. Within the digital realm, where software dictates the pitch of played-back sound, the application of microtonal tuning systems becomes a pathway for new musical exploration. This action signifies a turning point, one that challenges the customs of classical harmony and propels music into a realm of virtually limitless potential. Paradoxically, it might appear that justifying *not* using microtonal systems in pitch-determined computer-generated music might be much more difficult than the other way around.

Polysystemism, a concept first articulated by Ivor Darreg (1988), further expanded by Alessio Elia (2017, 185–188), and independently explored in my own work, involves the simultaneous use of multiple tuning systems within a single piece. In my compositional practice, this approach has proven highly effective in generating novel musical landscapes and augmenting existing harmonic systems. Through a sequence of self-directed experiments, I have ascertained that for a "polysystem" to be most effective, the included systems should maintain as many common attributes as possible.

The idea constitutes a significant compositional strategy within *Blockchain Music 2.5*. I have selected two tuning systems for the piece: the Bohlen-Pierce equal temperament, which divides the 3/1 frequency ratio into thirteen equal steps (yielding an interval of approximately 146.3 cents), and the Carlos Alpha equal temperament, which divides the 3/2 frequency ratio into nine equal steps (yielding an interval of approximately 78 cents). According to the aforementioned self-directed experiments, these two systems seem particularly compatible when used in conjunction: both are synthetic tuning systems that reject the traditional octave in favor of another string division, and both provide a satisfactory approximation of other natural intervals.

The virtual synthesizer used to perform the piece, Omnisphere, can be retuned with .tun files corresponding to both systems. Therefore, there is no need to further modify the MIDI messages received from Max MSP.[7] The timbre of both layers differs drastically: while the Bohlen-Pierce layer uses a sharp sound with its timbral attributes similar to a plucked string, the Carlos Alpha layer employs more mellow sonic qualities, creating a soft pad sound — often euphonic due to the tuning system's characteristics.

Upon initial inspection, deterministic algorithms may seem to conflict with the fluid, multi-layered principles immanent in polysystemism. Yet, after a more rigorous analysis, a subtle harmony emerges. The idea of employing multiple systems simultaneously need not be confined merely to musical elements; it can permeate deeper layers of the composition. In *Blockchain Music 2.5*, this approach is extended to include data from not just one, but two different blockchains, thus embodying the notion of polysystemism on multiple dimensions. The chosen blockchains must provide unrestricted access to their hash data to facilitate continuous music generation. Accordingly, the blockchains employed in *Blockchain Music 2.5* are Polygon, which offers open API access to all, and PooChain, where I act as a validator.[8]

In addition, the decentralization that characterizes blockchain technology finds a conceptual parallel in the multi-centric orientation of polysystemism. Within a blockchain, each block operates as an autonomous entity, contributing its unique set of data to the overall system. This mirrors how individual pitch systems contribute to the formation of a complex yet cohesive polysystemic musical composition. The integration of multiple blockchains in *Blockchain Music 2.5* further amplifies this parallel.

Preservation of the Data on Servers and Re-Generation of the Algorithmic Piece

Many conventional algorithmic compositions confront a similar issue: their existence is limited to the immediate moment. Generated in real-time, these compositions often cannot be revisited in their previous states or evaluated to

7 The reference point for both systems is MIDI note 60 with a frequency of 261.625 Hz. In other words, the middle C sounds just as it would on a non-retuned synthesizer — and all the other pitches are kept relative to it.

8 It is worth noting that practically every EVM-compatible blockchain allows accessing the needed data through a remote procedure call (RPC), a request-response protocol. However, due to the Max MSP constraints — namely the automatic conversion of Boolean values to corresponding integers within the dictionaries — it is impossible to correctly parse a *maxurl* POST request without resorting to other programming languages.

discern how they would have sounded at an earlier point in time. Works like Brian Eno's *Reflection*, released in 2017, and Jean Michel Jarre's *Eon*, released in 2019, encapsulate this concept: each listening experience is unique, as the algorithms driving these pieces yield a distinct auditory event at each execution. Unless these experiences are recorded in some way and played back, their inclusion within an overarching musical concept is rather questionable, at least in the ontological sense of the existence of musical work (Ingarden 1986, 116–119).

One of the most interesting and innovative aspects of *Blockchain Music 2.5* is its ability to be regenerated. In the digital age, where data can be both ephemeral and permanent, the preservation of algorithmically generated compositions introduces a series of considerations — both ethical and aesthetic. In traditional musical compositions, a score serves as the primary method of preservation.[9] However, *Blockchain Music 2.5* challenges this convention by existing in a state of constant evolution, determined by real-time blockchain data, thus exploring a new method of conserving the piece.

To address this, data from the utilized blockchains – Polygon and PooChain in the case of *Blockchain Music 2.5* – are obviously preserved on servers, through the structural characteristic of the technology. This yields a dual consequence: firstly, it allows for the real-time composition to continue evolving without the need for continuous human intervention. Secondly, the stored data can be employed to regenerate the composition at any given point in time, thereby preserving each unique moment of the work.

The concept of re-generating a musical work from archived blockchain data adds a new dimension of complexity to the understanding of what a composition can be. In the traditional sense, compositions are regarded as fixed entities, completed once the composer has set down their pen or, in today's context, saved their digital file. Conversely, typical algorithmic compositions are often fleeting, existing solely in the present moment. *Blockchain Music 2.5*, however, challenges both these notions. It exists as a mutable entity in a constant state of evolution, with each moment being both a unique emergence and an integral part of the larger, continuously developing yet determinate composition.

The server-based access strategy also raises questions about ownership. Since the data is stored on servers, who, in theory, has the right to access it and regenerate the composition? While these questions may venture into legal and philosophical territories, they nonetheless underline the nature of employing blockchain technology in music composition.

9 This notion is challenged by *Musikalisches Würfelspielen*, popular in 18th-century Europe, which might be considered the first algorithmic compositions. As they are the stored sets of instructions rather than concrete scores, they can be regarded as an early guideline for data storage.

Blockchain-Driven Composer-Listener Interaction in Context

In traditional music composition, the audience typically exists as passive recipients, consuming the experience as it is presented to them. The performer-audience barrier has been present for most of the Western history of music – and even though some aspects of the creative process have been historically expedited to the listeners, as in the already mentioned *Musikalisches Würfelspielen*, it was not a part of the overall tendency. Even the 20th-century pieces exemplifying early algorithmic approaches in leveraging mathematical models and computational processes to generate musical structures, such as Xenakis's stochastic compositions and Cage's chance operations, are devoid of any interaction with their listeners. In this traditional paradigm, the composer-audience relation was predominantly unidirectional, where the composer's intent was communicated through the performance of their work, leaving little room for direct engagement with the listener.

Nonetheless, the interactive practices of the 20th and 21st centuries have seen the line between the composers, performers, and audience beginning to blur. To name a few concepts, Max Mathews' *Radio Baton* and George Lewis' *Voyager* were some of the first attempts at electronic interactivity in music, laying the groundwork for later development. As consumer electronics became more advanced, so did the possibility of redefining the relationship between art creators and recipients. For instance, Björk's *Biophilia* album, released in 2011, was accompanied by an application that allowed users to engage with the music and visuals, essentially altering the listening experience through user interaction. This model sees the radical transformation of digital technology through the democratization of the creative process and expansion of how composers and audiences can interact.

Contemporary composers frequently employ a variety of interactive platforms to engage the listeners. For example, custom applications designed by composers themselves offer audiences the ability to alter musical elements in real-time. Tools like Unity and game audio engines such as FMOD and Wwise have been utilized to create interactive musical experiences where the listeners' actions directly influence the auditory output. An illustrative case is the work of American composer Ellen Reid, whose site-specific pieces involve interactive elements that change with the listener's location. In the concert setting, composers such as Tod Machover have experimented with crowd-sourced symphonies and inviting public contributions to the final composition through mobile applications. These innovations not only bridge the gap between composer and audience but also redefine the traditional roles of each.

The aforementioned methods prelude the emergent blockchain-based models of interaction, hinting at a future where the boundaries of composer, performer, and listener may become increasingly fluid and interconnected. Yet, a piece that simultaneously utilizes interactions that are real-time, readily accessible, and not bound by location might still be an area ripe for exploration. The advent of blockchain technology further expands on such a possibility. Such a feature is incorporated into *Blockchain Music 2.5*, where audience members are encouraged to shape the evolution of the composition in real-time through blockchain transactions on the piece's address:

$$0x22d2035eefd0464ee13ee222925dad6f6ee32e91$$

By engaging in transactions with the composition, audience members effectively introduce new variables into the algorithm that guide the music's unfolding. Each transaction, complete with its unique time stamp and hash function, serves as a data point that the algorithm incorporates, thereby influencing the composition's subsequent development. In essence, every transaction becomes a small but meaningful element in the evolving musical piece. The algorithm has been programmed to audibly reflect these changes: when a transaction is inbound, the composition will detect it and randomly choose one of five temporary musical transformations.

This audience-driven dynamism is not just ephemeral; it becomes part of the composition's legacy. Since the parameters of each transaction – time, hash, and so forth – are recorded on the blockchain, these crowd-contributed elements can also be re-incorporated during the re-generation of the piece at any later date.

Thus, *Blockchain Music 2.5* achieves a form of "interactive permanence". The composition not only evolves in real time but also retains the ability to recreate its own history, embodying both every set of received data and every choice made by the audience. It establishes a novel paradigm for composition-audience interaction, one rooted in both the instancy of the moment and the enduring quality of blockchain technology.

The Additional Consequences of Using Blockchain Technology in Music

The utilization of blockchain technology in *Blockchain Music 2.5* has ramifications that extend beyond the domains of composition and audience interaction. One particularly interesting consequence is the transformation of the musical piece into a functional cryptocurrency wallet. As audience members

interact with the blockchain to influence the composition, they can also send cryptocurrencies to the wallet associated with the piece. This creates a distinctive economic dimension, merging the musical and financial ecosystems in an unprecedented manner.

Each transaction not only influences the musical texture but also contributes to the financial value stored within the piece itself. This amalgamation of artistic and economic realms opens up new possibilities for how we understand the value of a musical composition. Traditionally, the worth of a piece of music has been assessed in terms of its aesthetic qualities or its cultural impact. However, in the context of *Blockchain Music 2.5*, the composition acquires a tangible, quantifiable financial value alongside its artistic and interactive dimensions.

Furthermore, this economic aspect does not exist in isolation; it interacts interdependently with the piece's artistic elements. The act of sending cryptocurrencies can be seen as another form of audience participation, another way to interact with and influence the musical composition. And just like the musical contributions, these economic transactions are permanently recorded on the blockchain, becoming a lasting part of the piece's identity.

In summary, the incorporation of blockchain technology into the realm of music composition offers a multitude of transformative possibilities. *Blockchain Music 2.5* illustrates how this technology can not only redefine the boundaries of artistic expression and audience engagement but also introduce a groundbreaking economic dimension to the musical experience. The composition serves as a pioneering example of how blockchain can blur the lines between art and commerce, between creator and consumer, and between the ephemeral and the enduring.

Note

A 10-minute demo fragment of *Blockchain Music 2.5* may be accessed via the following link: https://www.youtube.com/watch?v=XieNzePwk7o

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EXPLORING THE POTENTIAL OF BLOCKCHAIN DATA AS PSEUDORANDOM NUMBERS FOR MICROTONAL ALGORITHMIC COMPOSITION. A CASE STUDY ON *BLOCKCHAIN MUSIC 2.5*

(summary)

This article presents a novel approach to music composition that leverages blockchain technology. The central idea is to utilize the inherent randomness of blockchain data, specifically hash parameters, to generate pseudorandom numbers. The method addresses the limitations faced by traditional pseudorandom number generators (PRNGs) in creating intricate and varied musical compositions.

The paper begins by discussing the challenges in microtonal algorithmic music composition, highlighting the need for more effective randomness in generating musical elements. It also explains how blockchain's decentralized nature makes it a rich source of random data. The emphasis is put on the uniqueness of each block's hash,

which can be used to produce unpredictable patterns. The article also explores how blockchain works and what kind of musical developments are already happening in that area.

I introduce *Blockchain Music* (2014), a short piece for piano composed by an algorithm sonificating the Litecoin blockchain. The most pressing limitations of the piece include the non-continuous stream of data and the economic unfeasibility of the project. The main part of the research revolves around the successor to Blockchain Music, a composition titled *Blockchain Music 2.5* (2023), where blockchain data is used to create a microtonal music piece. This case study demonstrates the practicality and effectiveness of the proposed method. The process involves extracting numerical values from blockchain hashes and translating them into musical parameters such as pitch, tempo, and dynamics.

Polysystemism, as discussed in the article, refers to the simultaneous use of multiple tuning systems within a single musical piece. The concept, initially articulated by Ivor Darreg, and later expanded by Alessio Elia and myself, is integral to *Blockchain Music 2.5*. In this work, I employ two tuning systems, the Bohlen-Pierce ET and Carlos Alpha, to create a complex, multi-layered sound. These systems, both rejecting traditional octaves in favor of other natural intervals, offer a novel exploration of pitch and harmony. The idea of polysystemism is also visible in the simultaneous usage of two blockchains: Polygon and PooChain.

The paper concludes by exploring the broader implications of integrating blockchain technology in music composition. I suggest that this approach not only enhances the randomness in music but also opens new avenues for creativity in the digital music landscape. For instance, the sonification of the blockchain allows for coupling a composition with a cryptocurrency wallet. The article proposes that blockchain technology could revolutionize how composers approach algorithmic music, providing them with a vast and ever-changing source of data for inspiration.

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