

Book Review

A critical review of Nikita Braguinski's "Mathematical Music: From Antiquity to Music AI"

Seyhan Canyakan¹

Afyon Kocatepe University State Conservatory, Afyonkarahisar, Türkiye

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Abstract

This review Braguinski's 2022 book which traces mathematical approaches to music from ancient times to modern AI. The book argues that today's AI music systems are not revolutionary but evolutionary developments of mathematical music traditions dating back millennia. Structured in two parts ("Out of Continuities" and "Into Possibilities"), the book first explores historical developments: Pythagoras's numerical ratios, Lull's medieval combinatorial methods, Kircher's and Mersenne's early modern devices, and 19th-century technological innovations. A notable contribution is Braguinski's exploration of 1920s Soviet musical experimentation and its influence on American popular music through Joseph Schillinger. The second part examines modern computational approaches, with Braguinski skeptically analyzing AI's creative capabilities as extensions of earlier mathematical traditions rather than fundamental breaks. The book covers commercial applications including ambient soundscape generation, streaming recommendation systems, and functional music production. Despite its brevity (131 pages) limiting treatment of some topics and non-Western traditions, the book is praised for making complex ideas accessible and providing historical context for evaluating contemporary claims about AI music technology.

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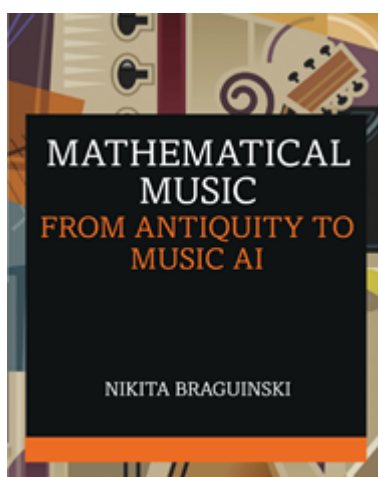
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Title: Mathematical Music: From Antiquity to Music AI

Author: Nikita Braguinski

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Publication Date: 2022

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Nikita Braguinski, a musicologist and historian of technology, in his brief but humanly expansive monograph titled *Mathematical Music: From Antiquity to Music AI*, provides a well-argued genealogy that extends in time towards

¹ Associate Professor, Afyon Kocatepe University State Conservatory, Afyonkarahisar, Türkiye. Email: scanyakan@aku.edu.tr ORCID: 0000-0001-6373-4245

millennia of mathematical thought regarding musical composition and analysis. Routledge (2022) *Praxeology and the Historical Bond of Math and Music: Mathematics as a creative practice as well as a descriptive language* Published by данный Volume has ocument historical relationship between mathematical thinking and music has been framed as a mediated duality both starting to reimagine algorithm composition-oriented practices through modern artificial-layer. By excavating the historical and explicating the theoretical, Braguinski convincingly shows that the computational music systems we have today is not so much a revolutionary rupture as a sequel in an ongoing story, wherein deeply mathematical approaches to musical form, structure, and aesthetics have taken on a new evolutionary step.

Methodological and Historical Scope

A radical swerve from traditional spatial discourse analyses (ns 426), this interdisciplinary framing is possible through Braguinski's multi-faceted scholarly background—studies at the University of Cologne and PhD in media theory at Humboldt University of Berlin. The methodological strategy of the volume itself combines musicological work, historical contextualization, technological exegesis, and cultural interpretation, and indeed, the result is a richly textured narrative that guides us through all of these sometimes complex theoretical eddies with commendable lucidity.

The bipartite structure of the book — *Out of Continuities and Into Possibilities* — is intended to be both historiographical and theoretical. This schema enables Braguinski to trace historical continuities prior to discussing contemporary examples and future speculation, supporting his argument that the computational ways of dealing with music presently in use are the result of intellectual traditions spanning centuries, rather than novel technological trajectories.

Excavating Historical Underpinnings

The first half of the volume painstakingly maps the mathematical foundations of Western musical thought across distinct, delineated historical eras. Against this backdrop, Braguinski starts with the ancient Pythagorean investigation of numerical ratios, showing how these early mathematical explorations laid lasting conceptual frameworks of consonance, dissonance, and musical intervals. Within this, talk about the aesthetic qualities paired with simple ratios (for example 1:2 and 2:3) and his analysis of how these came to be paired reveals just how impactful mathematical thought was on musical perception and theoretical discourse at this early juncture.

This shifts seamlessly into a discussion of medieval combinatorial methodologies, which Braguinski relates through his analysis of the systematic approaches of Ramon Llull. In this way, Braguinski shows how Llull's initially theological application of the combinatorial principle to language and communication heralds mechanical and computational means for musical composition that followed. Grounding these developments in wide-ranging intellectual and cultural spheres, Braguinski shows that imaginative relations between mathematics and music paralleled changing styles of knowing and technology.

Braguinski provides careful attention to the early modern period, including Kircher's devices for composition and Mersenne's mathematics of musical property. His treatment of Kircher's 1650 "*Musurgia Universalis*," with its suggestion of a wooden box with movable slats for mechanical composition—a distant ancestor of algorithmic 'composition' methods—is particularly illuminating. And more significantly, Braguinski's exposition on how Mersenne's *Harmonie universelle* (1636) used combinatorial computations to calculate the number of possible compositions reveals a high level of mathematical interaction with musical options at that time.

Throughout the 19th century developments, the author illustrates the way industrial technologies and nascent scientific disciplines altered musical-mathematical relationships. In looking at Dietrich Winkel's *Componium*, a mechanical randomizer that produced musical variations, he shows the ways automation was starting to change how music composition worked. Likewise, his reading of Hermann von Helmholtz's studies of acoustics shows that new scientific models fundamentally reshaped the understanding of the interrelationship of listening experience with musical mathematics.

From Soviet Experimentalism to Transcultural Transmission

Perhaps the most original and significant element of the volume comes in Braguinski's investigation of early Soviet musical-mathematical experimentation in the 1920s and its remarkable transfer to American popular music settings. In

Opening Notes, this section opens up a largely unexplored historical path, revealing unexpected counterpoints between avant-garde musical theory and commercial music production.

Spanning the years from 1918 through 1935, much of Braguinski's narrative traces the ways in which musical research was conducted at Soviet centers like the State Institute for Musical Science (GIMN) and the State Academy of Artistic Sciences (GAKhN), and how a scientifically informed method of musical analysis and composition took shape in the wake of the relative artistic openness surrounding the Russian Revolution. Sen shows how Soviet researchers understood the Western musical canon as a way to extract universal mathematical principles, and his analysis of the theories of musical proportionality of Georgij Konjus and the statistical analyses of musical masterworks of Leonid Sabaneev illustrates this point.

Braguinski incisively excavates how those Soviet experimental strategies beached on American pop shores through emigré theorist Joseph Schillinger, whose methods for mathematical composition were adopted by such leading American figures as George Gershwin, Glenn Miller, and Benny Goodman. This historical link, of Soviet avant-garde research and mid-century American music, creates a challenge for established historical narratives while also showing the complex model of transcultural carrying of the principles of mathematical music.

This road has become all but nonexistent, buried under the remains of musical trends that once were. (Braguinski) But certainly it is worth digging to more fully excavate the intellectual history of popular music; especially as the importance of the computerization of much music technology has pushed mathematical approaches to centre stage" (49). The ability of the author to synchronise both developments from the past with happenings of the present, all the while indicating the archaeological nature of his text is illustrated in this very observation.

Engineering Tools, New Applications.

The later part of the volume moves into modern computational methods, but even for the machine learning methods, the explanations are intuitive and without losing historical context. Without falling into the trap of over-simplifying, Braguinski gives a sound explanation of neural nets and deep learning, framing these tech developments as part of the larger historical arc laid out earlier.

It demystifies the technological "black box" that characterizes many modern AI systems and explains how deep learning systems work well. According to Braguinski, "In deep learning, incoming information is fed to a vast ensemble of very elemental calculating units (the so-called neural network); the results of these calculations are used to either segment this information sensibly or to produce some new information that resembles the original somehow" (63). With such precise but reader-friendly definitions, Braguinski enables non-specialist readers to grasp complicated technical processes.

Especially valuable is Braguinski's skepticism in the face of present day assertions of AI having the ability to create autonomously. Even where these systems are impressively complex and computationally intensive, he persuasively argues, they are still deeply rooted (ontogenetically, to use a term from biology) with earlier, mathematical approaches to music — they differ in scale and efficiency but in essence are no ontological break from their precursors (201).

Cultural Implications and Real-World Applications

Braguinski outlines modern commercial uses of the principles of mathematical music, so the volume contributes to more than abstract theorization. Mackenzie roots his theoretical discussions in concrete commercial and cultural practices, examining case studies of real-world implementations of music AI — from ambient soundscape generation, to streaming recommendation systems, to automated mastering services.

Braguinski's examination of the use of musical mathematics by startup companies that harness algorithmic definition for functional purposes (e.g., as an aid for relaxation or work productivity) exposes the enduring link between current techno-discourses and pre-modern mathematical-mystical traditions. His characterization of the founders of one Berlin-based company as "speak[ing] of 'ultradian rhythm' and 'sleep onset period' [...] stress[ing] that their product uses 'the latest research on how specific frequencies, musical scales and phrases affect the cognitive state of the person' [...] and referring to 'scientific principles and research implemented in the platform'" (87) identifies the ways in which contemporary tech rhetoric recirculates earlier claims about the special efficacy of mathematical music.

Finally, his exploration of the use of machine learning algorithms by streaming platforms to create tailored suggestions reveals a new level of computational mediation of musical consumption (p. As Braguinski explains, "The listener can search for a particular group, song, or podcast and discover an audio recording that he or she already knew about... yet, having invested heavily into the licensing of all sorts of music and spoken content, the streaming company also wants to introduce the user to its catalogue. (braguinski 88) This reflection lays bare the alignment between user agency and commercial necessity latent in contemporary mathematical models of preference and similarity that structure experiential music encounter through algorithmic systems.

Future trajectories and cultural implications

The closing chapters of the volume engage with possible futures for algorithmic music, addressing topics from mass personalization to the changing nature of experimental vs popular music spaces. In this way, these providential analyses circumvent techno-utopianism and dystopian pessimism, to provide a tempered contemplation of potential technological pathways and their cultural ramifications.

Braguinski adds, "Mass-produced and individualized is a particularly gripping theme which his discourse examines: Isn't that a contradiction in terms? At least not when it comes to digital products"(93) This commentary highlights a paradigm shift made possible by computational approaches to music—the ability to synthesize novel musical experiences at scale—which may overturn traditional models of music making and listening.

Braguinski proceeds to discuss how the mathematical mediation between avant-garde musical experimentation and commercial music production has only deepened in the latest turn. For example, his study of experimental mathematical methods from early Soviet research and their transition via someone like Schillinger into American popular music shows "the tools and the language of the avant-garde have become the working instruments of popular and functional music" (105). This historical arc complicates familiar accounts of the tension between experimental and commercial musical settings.

He ends with a cautious outlook for the future, including possible ethical issues around using music AI to profile and manipulate listeners' mental states. His recommendation that "that live data on the mental health of individual audiences is harvested and deployed in the form of advertising and propaganda campaigns" (114) recognises genuine problems without falling into scare-mongering.

Stylistic and Presentation-Related Aspects

From beginning to end, though, Braguinski is careful to match with academic rigor a mode of expression that does not alienate a readership of mixed expertise. He uses technical terms judiciously and always provides sufficient explanations, making complex mathematical and musical ideas accessible to lay persons. The illustrations in the volume—historical diagrams, musical notation, and schematic representations—lend further support to understanding but never distract from the text.

Especially powerful is Braguinski using examples to explain complex analytical concepts. By showing what machine learning can do, such as running his own experiments with GPT-3 to generate chord progressions and guitar tab (71-73), Stein makes what can be a rather abstract theoretical discussion into something concrete that readers can more easily visualize in their minds.

Critical Review and Limitations

Although "Mathematical Music" is an important work of scholarship, it does have some limitations. Some of the historical developments and technical processes are treated necessarily briefly given the book's concise form (its 131 pages of text). As another example, the short treatment of Chinese mathematical methods for music (14) points to areas for fuller, cross-cultural exploration that the constraints of the volume leave only partially developed.

Similarly, although Braguinski does a good job of outlining Western mathematical music traditions, more thorough engagement with non-Western mathematical approaches to music—perhaps from Indian, Persian, or East Asian traditions—could have provided additional historical depth and questioned some of the Eurocentrically-influenced ideas about what the interplay between mathematics and musical systems is.

This also translates into less emphasis on the analytical applications of the mathematical principles, since the volume is mostly geared towards compositional applications. A broader treatment of the ways in which mathematical tools have revolutionized the analysis of music—from the systematic work of Heinrich Schenker, through the pitch-class set theory of Allen Forte, to the computational musicology of today—could have offered a more thorough picture of the impact of mathematics on musical thought.

But these limitations are mainly limitations of scope, not an issue of concept. In the parameters he sets up for it, Braguinski's narrative is impressively vivid and concrete without being too far out of reach for non-specialist readers.

Academic Contribution and Importance

Despite these limitations, which he acknowledges, "Mathematical Music" is an important piece of research in the larger puzzle of how mathematicians and musicians have historically interacted individually and culturally. In doing so, Braguinski disrupts simplistic narratives around technological revolution by tracing the continuity between ancient Pythagorean theories and contemporary neural networks, and between cultural values, mathematical concepts, and musical practices over centuries.

As the volume mentions, its value goes beyond its use as history: we value the implications for contemporary discussions about algorithmic composition and AI music generation, too. Braguinski places these developments in the context of musical history, offering the perspective needed to assess contemporary music technology novelty and importance claims. As he authoritatively proves, "of course, what happened can't be described only as a linear narrative. The investigation of mathematical music "is the work in progress" (116).

For mathematicians, musicians, technologists, and math-music enthusiasts and newcomers alike, Braguinski's volume is a boon, offering a goldmine—a goldmine that details not just what mathematical music is but, more importantly, how it came to be, and where it might be headed. Its cross-disciplinary aspect effectively connects historiographical rigor with technological insight, providing perspectives that deepen our understanding of the historical evolution and present forms of mathematical music.

At a time of rapid technological change with promises of technological transformation of a level rarely seen in history, often over-hyped in our time, Braguinski's historical perspective helps frame what is about to be revealed, and what will be the future. Having recounted the history of computational technology at least implicitly most of us should infer this and in fact, his scholarly intervention reminds us that the sophistication of contemporary approaches to music through computation, does not remove these approaches from several centuries of mathematical traditions regarding musical form, structure, and aesthetics – traditions that established their connective tissue with the present through current algorithmic practices, albeit some (hopefully) more instrumental than others.

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