



**Conference–Practical Training
FROM ARS COMBINATORIA TO ARTIFICIAL INTELLIGENCE:
MUSIC COMPOSING**

ABSTRACTS

(the language of the abstracts has not been edited)

MUSICKING WITH ALGORITHMS: ARTIFICIAL INTELLIGENCE, CREATIVITY, AND AUTHORSHIP

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The use of artificial intelligence and algorithmic systems in music raises technological questions and fundamental issues about creativity, authorship, and creative agency. Who actually creates when an algorithm participates in the musical process – the composer, performer, programmer, system user, or the system itself? Palle Dahlstedt explores these questions, drawing on his extensive experience in algorithmic composition, interactive sound and music systems, and the development of new electronic instruments.

In this context, algorithms can be understood as tools that assist creative work, automate certain processes or perform particular tasks, as well as active components of the creative process. Their structure, parameter choices, and the degree of control afforded to the human user directly influence how musical ideas develop. In this sense, designing a creative instrument or generative system becomes a form of composition in itself: it establishes a field of possibilities and constraints.

Such practices often complicate traditional notions of authorship. Creative agency may partly reside with the system designer and, in the case of artificial intelligence models, within their architecture, training data, and the musical material of other creators embedded in those data. The relevant question, therefore, is less whether artificial intelligence “creates” and more how different influences and forms of authorship are distributed within a particular process of musicking and creation.

The presentation critically examines notions of autonomy and creativity frequently attributed to artificial intelligence and proposes approaching algorithmic creativity as a dynamic interaction between humans and technology. This dialogue may yield new musical possibilities, as the system provokes the creator’s actions, presents unexpected alternatives, and influences the creative thinking process itself.

ARTIFICIAL INTELLIGENCE AS AN INSTRUMENT: MODELS OF CO-CREATION

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Artificial intelligence can function within the creative process as an instrument, a creative partner, and a participant in shifting creative agency. In this context, the musical outcome emerges from the interaction of the composer’s intention, the generative system’s logic, the decisions of its developers, the training data, and the broader creative context. This interaction helps us understand creativity as a process in which authorship and decision-making are distributed across multiple influences.

The presentation examines several co-creation models. Artificial intelligence can generate material for later selection and transformation, respond to material the composer provides, propose alternative solutions, or introduce intentional randomness and unexpectedness into the creative process. The choice of the system itself, the construction of training material, the definition of parameters and constraints, and the selection, editing, and integration of generated results into the broader structure of a work all become part of the creative process. In this way, a generative system operates within a shared field of creative decision-making and influences the further development of the compositional process.

These principles are discussed through Mantautas Krukauskas's experience across a range of creative projects – from chamber and electroacoustic works to staged works and operas. In these projects, the creative process takes shape through the interaction of the composer's decisions, artificial intelligence systems, and the contributions of other collaborating creators and performers. Depending on the project, AI generates, transforms, and interprets musical material, or explores new creative trajectories, and the composer then selects, modifies, and integrates the results into the broader creative process.

Such co-creative processes make it possible to consider distributed authorship and the interaction of different creative models. The composer's intention intersects with the generative system's structure, its developers' decisions, the musical ideas of other creators encoded in the training data, and the contributions of other active participants in the creative process. Artificial intelligence thus becomes a kind of medium between different aesthetic intentions, historical layers, and creative strategies. This interaction can give rise to new musical ideas and aesthetic outcomes whose trajectories are not fully predetermined, while the creative process itself expands the field of compositional decision-making and musical thought.

DEFINING THE THINKING MACHINE: ON ONE OF ALAN TURING'S VISIONS

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This presentation highlights Alan Turing's theoretical text, which analyzes the concept of an abstract machine, or a hypothetical universal computer. Turing published his reflections on a self-computing machine of the future (then called the "Automatic Machine"), capable of expressing logical statements, 90 years ago (in late 1936) in a publication of the London Mathematical Society. The eccentric mathematician drew an unambiguous analogy between an automaton's states and the mind's states. When the public became somewhat more familiar with the impressively large machines – the most advanced of their time – and their supposed capabilities, they were dubbed "brains." Public attention to this massive, centralized, mechanical, automated mind, and the expectations it carried, raised a crucial question rooted in the theological views of the time: Can machines think? I will show how, until the mid-1950s, computer pioneers and the broader public reacted to hypothetical thinking machines (their reactions were, in many ways, similar to how the public reacts to the real and imaginative AI breakthroughs of recent years). The presentation will also examine the evolution of machine creativity, specifically musical composition, over the last few decades, while exploring the deeply polarized human responses to AI-generated art.

A WORK AS A SYSTEM OF MOBILE MUSICAL STRUCTURES AND *ARS COMBINATORIA*

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Several facts about the cultural layer can introduce the subconscious of modern algorithmic music composition. The path of theorizing probability from *doxa* to *episteme* began in ancient poetry, rhetoric, oratory, and legal disputes, and it took a long time for pre-theoretical actions to be transformed into theoretical scientific knowledge. In the 17th century, mathematicians Blaise Pascal and Pierre de Fermat transformed Cicero's concept of 'probability' (from Latin *probabilitas*) into a formal mathematical theory. Today, the synergy of logic, probability, and modality is emerging as a goal for training AI Large Language Models (LLMs) to understand and generate human language. Apparently, this will also influence the processes involved in generating music.

My presentation's central theme is the concept of a musical work as a system of mobile compositional structures and of music as an *ars combinatoria* that emerged in 17th-18th-century composition. The ontic paradigm and physical nature of sound art (music) were already perceived in the 17th century as a favorable medium for the consequences of the 'probability revolution' (mathematical probability theory) to manifest themselves. This insight appeared in scientific discourse in Marin Mersenne's *Harmonie universelle* (1636-1637), where permutations and combinations of elements were demonstrated through musical examples. The invention of *Arca musarithmica*, presented in Athanasius Kircher's *Musurgia universalis* (1650), is one of the earliest examples of artificial creativity and algorithmic creation. It introduced a new concept of musical composition and technological innovations that are now central to modern algorithmic and AI-generated music.

The paper discusses how the concept of universal language (*Characteristica Universalis*), mathematical combinatorics, and logic proposed in G. W. Leibniz's *Dissertatio de arte combinatoria* (1666) operate in the field of music. Examples from the treatises of Joseph Riepel, *Grundregeln zur Tonordnung* (1755), and Francesco Galeazzi, *Elementi teorico-pratici di musica* (1791;1796), show how combinatorial-based methods of music creation were implemented in pedagogical practice, games, and composers' creative processes in the 18th century. The extremely popular Kircher *Arca musarithmica* boxes, based on controlled randomness and probability, helped spread musical automata. The author of the report seeks to explain the paradox of their operation - why popular music generated by automata could be "composed" even by amateurs with no musical education. From Christoph Reuter's DVD *Musikalische Würfelspiele* (German: *Musical Dice Games*), released by *Schott Multimedia*, I will show the music of musical dice games by J. P. Kirnberger, Joseph Haydn, and W. A. Mozart, generated using combinatorial methods.

FROM VACUUM TO ALGORITHM: THE EVOLUTION OF THE PIANOLA TOWARD REAL-TIME IMPROVISATION

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The automatic piano is among the earliest attempts to mechanically capture and reproduce human musical expression. The idea of self-playing musical instruments goes back even further: music boxes and mechanical organs were early attempts to encode melody onto a physical medium. This principle matured in the pneumatic and vacuum-driven automatic piano systems of the early twentieth century (*Pianola*, *Duo-Art*, *Ampico*, *Welte-Mignon*), in which the performer's dynamics and pedaling were already encoded on perforated paper rolls – each perforation marking a note's onset, duration, and, in more advanced systems, its intensity. This logic is, in essence, the same one the MIDI standard later built on: “note-on” and “note-off” messages carrying a timestamp and a velocity value are direct digital descendants of the perforated roll's data model, only now written not mechanically but in electronic code. It was precisely this shift from a physical medium to a universal, editable digital protocol (established through *Yamaha Disklavier* and similar systems) that paved the way to real-time music generation – notes can now be not only played back from pre-recorded sequences but also created by an algorithm “on the spot”; furthermore, optical key-sensing gives the algorithm the ability to respond instantaneously to live performance.

The turning point is when the automatic piano shifts from a passive playback device to an interactive partner: Icelandic multi-instrumentalist Olafur Arnalds uses his self-developed custom software system *Stratus* to drive two *Disklavier* pianos so they improvise alongside him on stage. Similar systems are already being used in live performances in Lithuania. The speaker, a pianist and long-time piano restorer, approaches this development from a practical standpoint; his daily work spans both historical mechanical and contemporary digital self-playing pianos, including a “Franklin” (New York) piano fitted with an *Ampico A* reproducing system, currently under restoration. This craft-based mechanical knowledge enriches the broader discussion of artificial intelligence's role in musical creation and performance.

***NOBODY LIKES MAKING MUSIC ANYMORE:* ARTIFICIAL INTELLIGENCE AS THE ANTIPODE OF CREATIVITY AND THE ANTIDOTE TO INTELLECTUAL PROPERTY THEFT**

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“It’s not really enjoyable to make music” has circulated widely within the musician community; Mikey Shulman said it on a podcast while promoting his latest product: a venture-capital investment in an advanced AI-powered music-generation program called *Suno*. It is a free application that can generate a new song in seconds based on text input specifying genre, mood, theme, and lyrics. The program automatically generates or selects vocals, instrumentation, song structure, and audio production elements. It also offers

options to license the generated material and add or remove individual audio tracks. And it requires no prior experience – only to simply press the “create” button.

This technology, which has sparked considerable debate, has also faced legal challenges. Suno and Udio – companies operating on similar principles – are currently defendants in lawsuits brought by major music labels (Universal Music Group, Capitol Records, Sony Music Entertainment, Warner Music Group) and GEMA. It has already been established that both companies misappropriated and used music from the internet and other audiovisual platforms to train their AI models without consent. Beyond the “major players”, creators unaffiliated with large labels, such as Benn Jordan and Jayson Isbell, have also faced serious repercussions, prompting them to take matters into their own hands and protect their intellectual property through their own original approach.

The first part of the presentation will show how generative AI tools “compose” music, reveal the origins of these programs and their creators' philosophy, and address the implications for content ownership. The second part will introduce a technology currently under development that enables control over – and selection of – the availability of original creative material to the algorithm.

TAMING *BUKIMI NO TANI*: THE EXPERIMENT OF *ILLIAC SUITE* (1957), THE THEORY OF ALGORITHMIC MUSIC AND THE PRACTICE OF AI

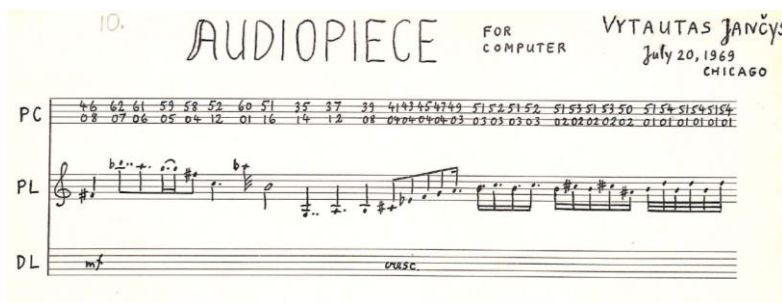
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The concept of an algorithm began to be actively linked to musical creation in the second half of the 20th century, using terms such as “computer-aided”, “computer-assisted”, “computer-generated music”, and so on. According to Kristine Burns (1994), interpreting a medical algorithm to establish a clinical diagnosis most closely resembles a musical algorithm: a step-by-step process in which the answer to one question determines the next. However, Adam Alpern’s view that algorithmic music composition uses formal processes to create music with minimal human involvement encourages a focus on computer-aided composition, which has become increasingly prevalent today. And although Gerhard Nierhaus cites J. S. Bach’s *The Art of Fugue* and Arnold Schoenberg’s dodecaphonic system as examples of algorithmic music, he also discusses innovations in contemporary musical composition related to genetic algorithms, cellular automata, artificial neural networks, and artificial intelligence.

What is now considered the first attempt at algorithmic computer composition was an experiment conducted at the University of Chicago in 1957 – Lejaren Hiller and Leonard Isaacson created the *Illiac Suite* for string quartet, whose sequence of intervals was programmed by a Markov chain algorithm. However, at that time, Vytautas Jančys – a composer, violist, violinist, and pianist who had emigrated from Lithuania – had already been living in Chicago for several years; incidentally, he had studied mathematics in the United States and was engaged in computer programming.



In 1969, he would compose “Audiopiece for Computer” – more than twenty years before the Lithuanian computer music movement gained momentum (as seen, for example, in the works of composers Gintas Kraptavičius and Vytautas V. Jurgutis).

A *PRESET* INSTEAD OF A PROBLEM: AI ARRANGEMENT AND ORCHESTRATION TOOLS AS AN OBSTACLE TO THE FORMATION OF MUSICAL SKILLS

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Arrangement and orchestration tools currently marketed to musicians – chord progression generators, MIDI packs, orchestral libraries with pre-recorded phrases, prompt-driven solutions – are presented as accelerators of creative work. This paper hypothesizes that, from a music education perspective, they remove precisely those tasks that develop inner hearing: the ability to hear a score before it sounds. The specific focus is notational audiation (Edwin Gordon) – the ability to hear music while reading and writing notation – which these tools render unnecessary by making the result audible at once.

It is proposed to classify such tools not by whether they are based on artificial intelligence, but by the type of interface they offer. An interface whose structure mirrors the discipline's structure, requiring the user to choose instrument and register, determine doublings, chord position and inversion, and lead each voice, carries a pedagogical residue: by operating the tool, one learns the subject. Figured bass notation teaches harmony in this way, and writing a part for French horn teaches transposition. A natural-language prompt or a MIDI chord pack carries no such residue. “An epic string sound” is not a description of an orchestration: it specifies neither register, texture, divisi, nor voice leading. This distinction explains why deskilling began before generative models, and why AI represents a continuation rather than a beginning.

The paper also addresses a common counterargument: that an experienced professional may legitimately use any tool available. It argues that this is not a matter of entitlement but of oversight capacity: the professional has an internal model that lets them verify the tool's output and depart from it. This argument, however, does not explain how such a model is formed when the automated option is the default starting point. The paper concludes with a question about learning sequence: under what regime of deferral can inner hearing still be acquired if the tool is available from day one?

CREATIVITY AND TECHNOLOGY

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Creativity has always been tied to technology. When we listen to music, we do not notice its role in the creative process. This is natural, as emotion, content, and the performer's relationship to the work come to the foreground. However, no work of art is possible without technology. The painter needs pencils and paints, the writer ink and paper, and the filmmaker film stock. Granted, these tools have now shifted significantly to electronic, virtual, and software-based solutions. Today, artificial intelligence (AI) has joined their ranks.

The latter fundamentally alters not only technology, but also the ethical and moral aspects of creative work. The philosophy and practice of creative processes are shifting. First, we will clarify how creators and consumers understand AI. The former view it merely as an auxiliary tool, an expanded source of information, and a means to resolve certain creative questions. Self-respecting artists will never commission AI services to create in their stead. Moreover, doing so is absurd: at best, AI will present a relatively new sonata or symphony based on existing canons and rules, drawn from the vast expanse of musical information accessible to it on the internet – from what is stored on millions of servers. It cannot use what doesn't exist online.

Artificial intelligence cannot create a fundamentally new, unheard-of, and original work of music. It will merely be a medley of hastily assembled musical phrases and styles based on a client-written prompt. In pop music, the practice of using predefined musical presets and semi-finished components – so-called “loops” – has long existed. These are freely accessible to anyone, even those without music literacy. The internet is full of this kind of “creativity”. With these new possibilities, the creator’s stance, position, and principles become crucial. Ultimately, they determine the work’s value and originality.

Overestimating artificial intelligence is just as dangerous as underestimating it. It offers extraordinary help in solving the technological challenges of composing electronic music, and when integrated into traditional music software, it not only accelerates creative processes but also suggests optimal options for timbre synthesis or instrumentation and answers software-integration questions that arise during the creative process. AI excels at restoring and arranging musical works, as well as archiving one's own heritage and that of epochal composers. Thus, we must prudently accept the pros and cons of new technologies – without overemphasizing their autonomy and while preserving the creator's individuality.