Music, humans, and machines: initial reflections for the development of research with collaboration between composers and artificial intelligence in the creative process of Brazilian music[1]

Música, humanos e máquinas: reflexões iniciais para o desenvolvimento de pesquisas com colaboração entre compositores e inteligência artificial no processo criativo da música brasileira

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Resumo

Na década de 1950, os norte-americanos Hiller e Isaacson foram os pioneiros na música gerada por computador: "Suíte Illiac". Apesar dos avanços nos sistemas de inteligência artificial (IA), atualmente a geração de música por meio de máquinas ainda emprega o paradigma estabelecido por Hiller e Isaacson (Steels, 2021). Hoje, os avanços dos processos de cocriação humano-máquina estão transformando a indústria criativa, permitindo que computadores contribuam para a produção de música, arte e cultura de diferentes maneiras que até então eram inimagináveis. Computadores agora "criam" (fazem) música, arte e cultura com potencial de consumo (COMITÊ GESTOR DA INTERNET NO BRASIL, 2022). Estas transformações podem modificar a música em termos epistemológicos e até mesmo ontológicos, reestruturando o papel do compositor. Pesquisadores da ciência da computação e de outras áreas da tecnologia têm buscado fundamentos nas ciências humanas, particularmente em pesquisas baseadas na arte, para fundamentar seus estudos (Caramiaux; Donnarumma, 2021). Neste sentido, há uma necessidade urgente de investigação a partir da área acadêmica da música para estabelecer um diálogo equilibrado com a área da ciência da computação e outras tecnologias. Vale destacar que num contexto no qual a geração de música e os projetos de IA são financiados por empresas profissionais produtoras de software, com o investimento econômico impulsionado pela "usabilidade" (Rutz, 2021), é complicado para o campo da música realizar pesquisas práticas sobre geração colaborativa de música entre humanos e máquinas, uma vez que a maioria dos sistemas atuais não estão disponíveis para experimentação gratuita para pesquisadores da área de música. Portanto, este trabalho tem como objetivo discutir as possibilidades e desafios enfrentados por pesquisadores da área da música para conduzir pesquisas práticas sobre colaboração homem-máquina para a criação musical. Esta discussão surgiu a partir dos desafios encontrados em investigar se colaborações entre compositores e sistemas de geração de música baseados em IA podem manter elementos culturais brasileiros em composições musicais. Esta discussão é vital, pois aborda tanto as barreiras metodológicas quanto às implicações mais amplas da integração da IA com expressões culturais e criativas. A investigação visa não só avaliar a viabilidade de tais colaborações, mas também explorar o seu potencial para expandir as fronteiras criativas e culturais.

Palavras-chave: Criação musical; Colaboração humano-máquina; Inteligência artificial na música; Processo criativo; Música brasileira.

Abstract

In the 1950s, the (North-) Americans Hiller and Isaacson pioneered computer-generated music: 'Illiac Suite'. Despite advancements in artificial intelligence (AI) systems, current music generation through machines still employs the paradigm established by Hiller and Isaacson (Steels, 2021). Concurrently, emergent research on human-machine co-creation is reshaping the creative industries, enabling computers to contribute to music, art, and cultural production in ways that were previously unimaginable. Computers now create (make) music, art, and culture with potential for consumption (COMITÊ GESTOR DA INTERNET NO BRASIL, 2022). These transformations may alter music in epistemological and even ontological terms, restructuring the role of the composer. Computer science researchers and those from other technological fields have sought foundations in the humanities, particularly in art-based research, to underpin their studies (Caramiaux; Donnarumma, 2021). In this regard, there is an urgent need for research stemming from the academic field of music to establish a balanced dialogue with the field of computer science and other technologies. It is worth noting that in a context where music generation and AI projects are funded by professional software-producing companies, with economic investment driven by 'usability' (Rutz, 2021), it is arduous for the music field to conduct practical research on collaborative music generation between humans and machines since most current systems are not available for free experimentation. Therefore, this work aims to discuss the possibilities and challenges faced by researchers in the music field to conduct practical research on human-machine collaboration for music generation. This discussion has proven to be crucial from the challenges found in investigating whether collaborations between composers and AI music generation systems can preserve Brazilian cultural elements in musical outputs. Moreover, it is vital as it addresses both the methodological barriers and the broader implications of integrating AI with cultural and creative expressions. The research aims not only to assess the feasibility of such collaborations but also to explore their potential to expand creative and cultural boundaries.

Keywords: Music generation; Human-machine collaboration; Artificial intelligence in music; Creative process; Brazilian music.

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Introduction

Artificial Intelligence (AI) is changing the world. Today, globalized societies are dependent on AI in many ways. On the one hand, it can reduce some specific tasks and provide scientific advancements in many fields. On the other hand, AI will, in the near future, cause many to become unemployed, and will increase environmental problems, due to the expenditure on natural resources, such as water, for example. In doing so, the water-intensive requirements of the data centers needed to train large-language AI models demonstrate how AI directly affects water demand. For instance, it was already noted that One MW data center is thought to use up to 25.5 million gallons of water each year to cool its processors[4]. Moreover, training large language models, like GPT-4, require enormous amounts of computational processing resources. According to recent studies, this demand used about 1,287 megawatt-hours (MWh) of electricity and produced 502 metric tons of CO_2, or about the same amount of emissions as 112 gasoline-powered cars over a one-year period.[5] Furthermore, AI is entering areas like art and culture that can transform humanity in other aspects, especially in human-computer interaction. This has been happening very quickly,

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[4] For more details, see: https://www.whitecase.com/insight-our-thinking/ai-water-management-balancing-innovation-and-consumption. Date of access: 2025/05/30

[5] For more details, see: https://knowledge.wharton.upenn.edu/article/the-hidden-cost-of-ai-energy-consumption/. Date of access: 2025/05/2025. Moreover, we are following the discussion from Mitu et al (2024)

and it has had a significant impact on the creative industry. Artists and creators of art are trying to understand this situation and adapt to the new scenario that has emerged in recent years.

In the 1950s, the (North-) Americans Hiller and Isaacson pioneered computer-generated music: 'Illiac Suite'. Despite advancements in AI systems, mainly from Large Language Models (LLMs), current music generation through machines still employs the paradigm established by Hiller and Isaacson, yet in music generation by stylistic rules (Steels, 2021). Accordingly, a compelling analogy about technology and music interplay is found, for example, in the work of Gilberto Gil (1942-), a pioneering Brazilian musician. His song 'O Cérebro Eletrônico' (The Electronic Brain), released in 1969, provides a farsighted commentary on the rise of automation and the increasing influence of machines in society. This song acquires the essence of a conversation that has particularly grown more relevant with the advent of modern AI technologies in music production. Moreover, it addresses the relationship between man and machine, the influence of technology and the possibility of a mind connected to technological devices. In 2016, a machine received, for the first time, the copyright of a song. This was a Sony's project. The music is 'Daddy's Car', generated by the Flow Machines technology, led by French François Pachet (1964-) (Limon, 2016; Steels, 2021). Pachet was responsible for a precursor system to the Flow Machines: the Continuator, which took the symbolic approach to an unprecedented level (Miranda, 2021). From the moment that AI creates songs (popular music) that can be utilized in the music industry, this can change many things in the world. The transformations affect not only creation (how and by whom music is generated), but also matters related to copyright and artistic property. There are still other questions surrounding creations made by AI. For example, Avdeeff (2019) outlines that 'Daddy's Car' was composed in collaboration with the French musician and composer Benoit Carré (1970-), and not just by a machine.

Even though there are AIs capable of creating music on their own, human artistic work is still indispensable. In this sense, human interaction and/or preferences serve like a 'breakeven point' parallels with a 'guidance point' in the music production. It is worth highlighting, as Getschko puts it, that the techniques used in intelligent machines are originally designed by human beings (Getschko, 2022, p. 14). Computational creativity research has increasingly focused on collaborative processes between humans and machines, as seen in several studies (Meehan, 1980; Roads, 1980; Bridget; Blevins; Zahler, 1993; Davis, 2013; Biles, 2003; Lubart, 2005; Hoffman, Weinberg, 2010; Zook et al., 2011; Davis et al., 2014 cited by Davis et al., 2015, p. 109; Moura; Castrucci; Hindley, 2023). Concurrently, emergent research on human-machine co-creation is reshaping the creative

industries, enabling computers to contribute to music, art, and cultural production in ways previously unimaginable. Computers now 'create' (make) music, art, and culture with potential for consumption (COMITÊ GESTOR DA INTERNET NO BRASIL, 2022).

These transformations may alter music in epistemological and even ontological terms, including rediscussing the role of the composer. This place of the composer is an important point to be considered, as different technological developments have reconfigured this role, especially for those involved in the recording industry. As highlighted by Caramiaux and Donnarumma, computer science researchers and those from other technological fields have sought foundations in the humanities, particularly in art-based research (not necessarily in artistic research), to underpin their studies (Caramiaux; Donnarumma, 2021). In this regard, there is an urgent need for research stemming from the academic field of music to establish a balanced dialogue with the field of computer science and other technologies. It is worth noting that in a context where music generation and AI projects are funded by professional software-producing companies, with economic investment driven by 'usability' (Rutz, 2021), it is arduous for the music field to conduct practical research on collaborative music generation between humans and machines with the potential to be utilized later in the phonographic industry, since most current systems with professional potential are not available for experimentation.

Therefore, this work aims to discuss the possibilities and challenges faced by researchers in the music field to conduct practical research on human-machine collaboration for music creation. Correspondingly, AI tools are being practiced for automated music composition, sound enhancement, and interactive music experiences, for instance, stirring both independent musicians and the music industry. This discussion has proven to be crucial due to the challenges encountered in conducting this study, which seeks to investigate whether collaborations between composers and AI music generation systems can preserve Brazilian cultural elements in musical outputs.

The intersection of AI and Brazilian music presents a multifaceted scene where technological innovation tries to intersect with cultural traditions. AI is not merely an autonomous composer but, from our perspective as in discussion in this paper, a computational tool that can expand the musical creative possibilities, aiding musicians in composition, production, and performance. However, its growing presence necessitates a critical approach that ensures AI enhances rather than diminishes the authenticity, diversity, and cultural significance of Brazilian music.

This discussion is vital as it addresses both the methodological barriers and the broader implications of integrating AI with cultural and creative expressions in this interdisciplinary study.

The research aims not only to assess the feasibility of such collaborations but also to explore their potential to expand creative and cultural boundaries. The methodology for this discussion is based on bibliographic research and a survey that addresses the main music generation tools available to date.

Brazilian music, society and AI: cultural reflections and implications

Before we begin the reflections we propose here, we must reflect on some aspects involving music and AI. Music is a cultural phenomenon found in all societies, even in those that conceptualize and name it differently (Blacking, 2007). According to Merriam, music must be studied within society (Merriam, 1964) and as society (Merriam, 1977), and this includes the relationship between music and different technologies, because, contrary to what we are often led to believe, technologies implies neither justice nor neutrality, whether in the computational tool selection, in the selection of algorithm, or even in the dataset collection used as the ground. According to Gao and An (2024), technology, and the AI concerns included, not only reflects the value orientations of their designers and consumers but also captures the social structure and human behavior of a given stage. It is also significant to understand that music is always a performance even with the human presence or in acousmatic technologies experiences. Like John Dack's statement: '[...] *a good diffuser will practise and know the limits of the equipment and the effects that the faders will have on the volume and the acoustics of the hall* [...]' (Dack, 2001) . The relationship between music and society is so strong, as explained by Stokes, that it is possible to observe that music can create social situations and manipulate culture. Music is a symbolic space, and its meanings are constructed through individual and collective memories (Stokes, 1997a). Performance has long been a fundamental 'tool' for artists, enabling them to express their creativity and connect with audiences (Stokes, 1997b). However, with the rise of AI, this essential tool is being reshaped. The mastery of performance, once the exclusive domain of artists, is increasingly shifting into the hands of developers and corporations, raising questions about the future of artistic expression and ownership. This directs us to two points: 1) the data used to feed the machines that will generate music and other types of art are cultural and usually public; 2) In a world with great economic and social differences, musical aspects of dominant cultures will become unique.

The *Comitê Gestor da Internet no Brasil* (Brazilian Internet Steering Committee) (2022) highlights, regarding the first point, that attributing copyright to a machine can lead to conceptual and ethical contradictions. When a work of art is created by artificial intelligence based on public

data – such as images, texts, or music available on the internet or in other databases, gathered from the culture itself through performative actions – the machine lacks genuine intentionality, creativity, or autonomy. It relies entirely on data provided by humans and algorithms developed by human programmers. Therefore, granting copyright to an AI would ignore the fact that its 'creation' is, in reality, a recombination or reinterpretation of preexisting works, many of which were produced by artists who have not received credit or, more importantly, compensation for this use. Moreover, the use of public data to train AI systems raises questions about intellectual property and the fair, non-exploitative distribution of benefits. If an AI is fed a vast array of cultural data – such as music, paintings, or texts – who should hold the rights to the generated works? The AI developers? The companies that commercialize it? Or the original creators whose works were used as the basis for training? In this scenario, it makes no sense to attribute copyright to the machine, as it is not a creative entity capable of thinking in the true sense, but rather a tool that reflects and amplifies preexisting human work. It is also important to remember that the machine belongs to someone. So copyrights assigned to a machine are, in fact, copyrights assigned to the machine's owners. However, why do they prefer to assign them to machines and not directly to themselves (humans)?

This discussion also touches on a fundamental aspect of art: authorship is intrinsically tied to human intention and expression. Art is, to a large extent, a reflection of the artist's experiences, emotions, and perspectives. A machine, no matter how advanced, lacks subjectivity or lived experiences, which calls into question the very notion of authorship in the context of AI-generated works. It is worth remembering that, as highlighted by Hafstein (2013), the idea of authorship is deeply connected to colonialism, which, in turn, is intertwined with capitalism. The technological development discussed in this article is also rooted in the capitalist system, and we can observe this connection in attempts to attribute neutrality to machines, as well as in granting them authorship. This maneuver can be seen as yet another strategy of capitalism, which concentrates power in the hands of wealthy companies and individuals, allowing them to control not only material goods but also, now, intellectual property – in this case, that of artists and cultural producers.

Hafstein (2013) further emphasizes that the colonial conception of authorship differs significantly from the views of many peoples and cultures, especially those with oral traditions. What we observe is that, long before the emergence of creative AI for art and music, and the use of public data to feed machines that generate artistic and musical works, there was already a capitalist exploitation of culture. For the author, the public domain can be a colonialist tool used to

appropriate emerging cultural expressions. In this way, technological development merely reproduces this dynamic of exploitation, albeit in new and more sophisticated ways.

Regarding the second point we have highlighted and something which is addressed by the Comitê Gestor da Internet no Brasil (2022), it is evident that in a world marked by significant economic and social inequalities, the musical aspects of dominant cultures tend to become hegemonic, while the cultural expressions of minority or less privileged groups risk being marginalized or even erased. This is something that's already been happening.. With creative AI in the music industry, perhaps this will increase. When the *Comitê Gestor da Internet no Brasil* addresses this point, it expresses concern about cultural diversity. This concern is not unfounded, as in a globalized scenario heavily influenced by capitalism, dominant cultures – often associated with countries or groups with greater economic and political power, such as the Global North – have more resources to disseminate their musical productions on a large scale. This can lead to cultural homogenization, where genres and styles from hegemonic cultures become predominant, while the musical traditions of local or minority cultures are relegated to the background. Moreover, technology and digital platforms, although they have the potential to democratize access to and distribution of music, can also reinforce these disparities. Recommendation algorithms, for example, tend to favor content that is already popular or generates more engagement, which often benefits established artists and genres at the expense of lesser-known cultural expressions. With the development of machines capable of creating art and music, in addition to recommendation algorithms, we will have algorithms that will define the very static creation of music.

This dynamic not only threatens cultural diversity but also impacts the identity and preservation of musical traditions that are fundamental to many communities. The loss of this diversity represents a potential reduction in humanity's cultural heritage at the level of global knowledge, as each musical tradition carries with it unique stories, values, and knowledge. Therefore, this is a concern that goes beyond the formal and aesthetic aspects of music and art in general. We then ask how can we balance technological advancement and globalization with the protection and promotion of cultural diversity? Is it possible to create mechanisms that ensure visibility and fair recognition for all musical expressions, regardless of their origin or cultural context? Within the scope of Brazilian culture and music, which occupy the Global South, will AI reduce the diversity of Brazilian music? Or, at least, will it hinder the dissemination of specific Brazilian music genres and styles? Furthermore, what will happen to the musical roots/origins and

elements so important to Brazilian music that are present in regions like the Northeast, which already suffer negatively from historical, social, and political hierarchies?

Brazil has one of the most diverse music scenes in the world. Its music is a symbol of its identity. Furthermore, according to De Marchi, on the international scene, Brazil is recognized as an important center of music production. De Marchi explains that this fact highlights the Brazilian music industry as one of the greatest in the world (DE MARCHI, 2006, p. 168). In this context, popular music stands out. When we refer to popular music, we are referring both to music directly linked to the recording industry and pop culture, as well as to music of oral tradition. Since at least the late 19th century, as Sandroni affirms, composers of so-called classical music, or concert music, in Brazil have sought to incorporate elements of 'peoples' music' into their compositions (Sandroni, 2008, p. 16).

In the first half of the 20th century, the Brazilian musicologist and writer Mário de Andrade (1893-1945) undertook significant work concerning Brazilian music. This work extended beyond musical recordings and intellectual analyses to actively promoting the preservation of this music. This included encouraging Brazilian music originating 'from the people' to be integrated into music schools, taught by teachers, and utilized by composers.[6] Additionally, he advocated for the establishment of institutions dedicated to preserving Brazilian intangible cultural heritage (SILVA, 2002). In his work on Brazilian music, Mário de Andrade drew attention to the music produced in the Northeastern region of Brazil. The renowned *Missão de Pesquisas Folclóricas* (Folklore Research Mission) – a scientific expedition organized by the Department of Culture of São Paulo – conducted between February and July of 1938, conceived and led by Mário de Andrade, focused on recording music from various states in the Northeastern region of Brazil, as well as one state from the Northern region (Sandroni, 2022). The roots that underpin Brazilian music are especially rooted in its popular culture. In this aspect, African and Afro-Brazilian cultures stand out, as well as the recognition of the musical cultures of Northeast Brazil as the cradle of genuinely Brazilian culture. Still in the first half of the 20th century, while intellectuals like Mário de Andrade influenced the understanding of Brazilian music and, perhaps, the production ofBrazilian classical music, Brazilian

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[6] 'People's music' is not folkloric/folk music. In this context, it refers to songs created by the population. A significant portion of this population was composed of Black individuals. It's worth noting that many of these songs had authors. Throughout the 20th century, the understanding of folk music in Brazil changed. Currently, even songs without specific authorship are not called folkloric/folk songs because they belong to a specific community. We could assert that folkloric/folk music in Brazil comprises only those songs without authorship and no longer have any relationship with any group any or community.

music connected to the phonographic industry was increasingly developing. This was through emerging technologies of the time (recording, radio, voice amplifiers, instrument amplifiers, and others).

The current conception of Brazilian music and Brazilian popular music can be attributed to three main pillars: 1) The migration of diverse populations to the territory that is now Brazil, although it is essential to recognize the influences of the Indigenous peoples who already inhabited the region before the European invasion. 2) The development of early recording technologies and, subsequently, technologies related to computers and AI applied in the production and distribution of music. 3) The power relations (social, economic, cultural, and others) established within the national territory. These relations shape regional hierarchies, resulting in a dynamic where the Southeastern region, particularly the Rio-São Paulo axis, stands out as dominant both economically and epistemologically. It is important to highlight that these relationships are based on colonialism, constituted by Eurocentrism. While they develop between Brazil and the world, specifically the West, they are also in conflict within the country itself.

Therefore, in this context where Brazilian music stands out globally in the recording industry, both in production and consumption, where it is currently intertwined with various technological advancements, including systems developed through artificial intelligence, and considering the power dynamics within the national territory, it is crucial to understand the potential impacts of AI-generated music in this scenario.

Related works about the AIs for music production and computer techniques: a short survey

The integration of AI algorithms into music creation and production has introduced various innovative approaches and tools. This is acutely true considering the computer/technological revolution that was witnessed in late 2018 and early 2019, continuing into the 2020s. The synergetic nature of AI in music production is exemplified by research on enhancing human creativity and reducing the gap between a composer's conceptual ideas and their practical implementation (Cai; Cai, 2019). As AI-assisted music creation becomes more genteel, recent trends emerge into a myriad of AI applications emphasizing adaptive, context-aware, and personalized generative techniques amend the role of human-machine intertwining in musical composition (Chen et al., 2024). AI's application in the shared process of composing and producing recorded music reveals the potential for AI to facilitate meaningful human-AI interactions (Nicholls; Cunningham, 2018).

Early AI music composition relied on symbolic AI, where algorithms followed predefined compositional rules (e.g., Markov Chains and Grammar-based systems). Traditional algorithmic composition techniques, such as stochastic processes, rule-based grammar, and revolutionary algorithms, have long been used to generate structured musical sequences. Markov Chains remain a fundamental approach, modeling the probability of note transitions based on learned statistical patterns. Cellular Automata and L-systems, inspired by biological and natural growth patterns, as well as in Genetic Algorithms, continue to be employed to generate evolving musical textures and structures. More recently, *deep learning* architectures have taken precedence, employing transformer-based models, diffusion models, and hybrid intertwined computer techniques to achieve more intricate and stylistically compositions.

The convergent approach to creating AI-based musical systems integrates a myriad of research areas, including information theory, cognitive science, and musicology, underscoring the interdisciplinary nature of this field (Kayak et al., 2020). Machine learning and artificial intelligence are influential in standardizing musical styles and consolidating economic power, as explored in the context of the culture industry (Brook, 2021). AI's potential to transform musical tasks and shape compositional ideas is demonstrated through its ability to extend human capabilities in art music composition (Gioti, 2021). This is further evidenced by the rapid growth of AI applications in music generation, including emotional analysis and cultural exploration, which emphasize the diverse roles AI can play in music creation (Kumar; Kumar, 2023). There are some computational models to be highlighted in the scope of our discussion. One of the most stunning AI-music generation advancements is in real-time interactive AI systems that adapt dynamically to human performers (Dash; Agres, 2024). DeepJam 2.0 and LiveMuse AI integrate machine learning models that analyze an input audio data, allowing AI-generated accompaniments that match the rhythm, harmony, and melody features of live musicians. These systems are used in jazz improvisation, experimental music, and live performances (Chen et al., 2024).

There are computational models related to machine learning frameworks approaching generative artificial intelligence and probabilistic or score-based generative models. They are included in the context of the Generative Adversarial Networks, a.k.a. GAN, and Diffusion Models. GAN-based models such as MuseGAN and diffusion models like MelodyDiffusion are enabling highly detailed and stylistically coherent compositions (Ma et al, 2024). Unlike traditional sequence-based approaches, these models iteratively refine musical structures, contributing to the controller over musical attributes such as timbre, rhythms, and harmonic development. These approaches are

found in music restoration processes, music style emulation, and hybrid genre synthesis (Briot et al., 2020). Furthermore, AI models are increasingly assortmenting multi-modal capabilities, allowing computer systems to generate music material based on visual, textual, and mood inputs (Chen et al., 2024). For instance, Google's MusicLM 2.0 expanded text-to-music system translates descriptive prompts into musical pieces, as well as the fixed media output from text prompts such as SUNO, UDIO, Diffusion, among others. In doing so, generally, there are AI-music generated systems focused on the end-user consumers about online streaming services centered on customizable AI music generation playlist, where systems generate adaptive compositions that evolve in response to user engagement and contextual cues (Kalideen; Yağli, 2025). For instance, Spotify's AI-powered generative playlists curate music tailored to a listener's activity, emphasizing how AI initiatives are operating from static music recommendation toward context-sensitive and personalized experiences (Briot et al., 2020).

Transformer models, initially designed for natural language processing, have been highly effective in music generation as well (Dharival et al, 2020). These systems leverage extensive datasets, enabling them to generate fair sound result compositions that might mimic human music production, including stylistic nuances, complex harmonic progressions, expressive melodic and rhythmic patterns (Briot et al, 2020). Recent interactions of these models such as already seen in OpenAI's Jukebox V3, Google's MusicLM 2.0, Meta's Audiogen, and NVIDIA's Fugatto, just to cite a few, have truly improved long-term structural coherence in AI generated music and sounds (Ma et al, 2024).

Moreover, there is an interesting trend in AI music composition which is the emergence of collaborative AI tools designed to work alongside human composers rather than replace them (Dash; Agres, 2024). Platforms like MelodyStudio offer AI-assisted harmonic and melodic suggestions that enhance creativity while preserving the unique artistic voice of human musicians. These systems are being integrated into Digital Audio Workstations (DAWs), allowing seamless AI-assisted composition within professional music production workflows (Briot et al., 2020).

AI's impact on music creation and evaluation is profound, as it enables the generation and assessment of music by analyzing various musical elements, thereby influencing the music industry (Zhou, 2023). The so-called 'smart music applications' leverage AI to create emotionally expressive compositions and facilitate real-time collaborative production, highlighting the intersection of technology and creative expression (Tabak, 2023). AI-models are also targeted to play a role in live performances, with real-time generative accompaniment and AI-driven improvisation tools being

explored in experimental music circles. AI-assisted live looping and interactive sound processing are enabling artists to push the boundaries of traditional performance. While AI offers possibilities for expanding sonic exploration, there is still a need to ensure that human creativity remains at the forefront.

Recent advancements in AI/Machine Learning-based music generation, including deep learning models, demonstrate significant progress in creating original musical compositions across different musical genres and styles (Patil et al., 2023). Research on AI in composition, performance, music theory, and digital sound processing provides a comprehensive overview of AI's potential applications in various musical domains. LANDR, for example, an automated music mastering platform, utilizes AI to shape music mastering processes and cultural production, highlighting the critical relationship between machine learning and media cultures (Sterne, Razlogova, 2021). The AIVA project is an AI-powered music composer that creates original compositions using deep learning algorithms.[7] Open-source platforms like Magenta by Google offer some advanced tools for music composition, performance, and analysis, promoting accessibility and innovation in music technology.[8] Similarly, OpenAI Jukebox generates music in various musical genres using deep learning algorithms.[9] Jukedeck allows users to create custom music tracks by analyzing user input to match desired styles, tone, and tempo, for example.[10] Amper Music enables users to create and customize music tracks using machine learning algorithms, emphasizing the user-centric approach of AI in music production.[11] Synthesizer V provides realistic vocal synthesis and music production capabilities, illustrating the advancements in AI-driven vocal technologies.[12] Voicemod offers real-time voice modification and enhancement, demonstrating the practical applications of AI in live performances and music production. [13] Table 1 below presents the primary AI applications discussed, which we believe effectively illustrate the advancements in music technologies achieved through the utilization of these technologies.

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[7] https://www.aiva.ai. Accessed on 2025/20/02

[8] https://magenta.tensorflow.org/blog. Accessed on 2025/20/02

[9] https://openai.com/research/jukebox. Accessed on 2025/20/02

[10] https://openai.com/research/musenet. Accessed on 2025/20/02

[11] https://ampermusic.zendesk.com/hc/en-us/articles/360023435213-Making-Music. Accessed on 2025/20/02

[12] https://dreamtonics.com/synthesizerv/. Accessed on 2025/20/02

[13] https://www.voicemod.net/pt/. Accessed on 2025/20/02

Music, humans, and machines: initial reflections for the development of research with collaboration between composers and artificial intelligence in the creative process of Brazilian music

Tab 1. Some AI apps for music production and composition.

App initiatives	Takeaway
LANDR	An automated music mastering platform
AIVA - Artificial Intelligence Virtual Artist	AI-powered music composer that creates original compositions using deep learning algorithms
Magenta	With a wide range of open-source tools for music composition, performance, and analysis
OpenAI Jukebox	Generates music in various genres using deep learning algorithms
Jukedeck	Creates custom music tracks for content using AI algorithms to match the desired style
Amper Music	Allows users to create and customize music tracks using machine learning algorithms
Synthesizer V	A platform for realistic vocal synthesis and music production using AI technology
Voicemod	Real-time voice-changing software that uses AI to modify and enhance the user's voice

Source: Made by the authors.

These developments in AI and music technology feature the transformative potential of AI in (re)working music creation, production, and consumption. The integration of AI into music not only enhances creative possibilities but also raises important questions about music in perspective, the role of human creativity, and the socio-economic implications of technological advancements in this field. In summary, the integration of Artificial Intelligence into music production and composition has led to novel creativity and technological advancements in how humans interact with machines, gadgets, and computer resources. Through various AI applications, from automated music mastering to intelligent tutoring systems, the interaction between human creativity and machine learning has expanded the boundaries of what is possible in music creation. AI tools such as those presented, among others, have demonstrated remarkable capabilities in generating, customizing, and enhancing musical compositions across diverse genres and musical styles. These technologies not only ease the (musical) creative process but also offer custom-made learning

experiences, synchronous and/or asynchronous interactive tools, and skillful workflows. As AI continues to evolve, its impact on the music industry will likely grow, fostering alternatives of artistic expression, and rediscussing and/or reassessing the roles of composers, producers, and performers. The advancements highlighted in this review underscore the transformative potential of AI in shaping the future of music production and composition. These trends highlight that AI-generated music is transitioning from a myriad of AI-generated music systems, broadening the scope of human-machine collaboration in musical creativity. Classical algorithmic techniques still continue to inform these developments, ensuring a balance between structured compositional logic and the dynamic learning capabilities of modern AI systems.

While AI has introduced groundbreaking possibilities in music creation, its adoption within academic and independent artistic research presents challenging hurdles. Currently, the majority of state-of-the art AI music generation tools are developed by big techs and private companies, despite the masking discourse on the 'free for use with limitation' fashion mode ads, restricting access to researchers due to proprietary licensing and high costs. For instance, AI-based mastering services such as LANDR, AIVA, and Amper Music require paid subscriptions to access professional-grade features, limiting their usability for independent academic research, experimental, and autonomous music projects. Accordingly, one of the main concerns for music researchers is the lack of open-source AI tools with professional prospects. While platforms such as Google's Magenta provide some degree of accessibility, they do not always match the fair-enough quality and flexibility of commercial alternatives. This is a critical challenge for musicologists and composers looking to study AI's impact on composition as they often lack the financial support to access industry-standard AI models.

Given these constraints, how can researchers, scholars, and enthusiasts collaborate with professional musicians to explore AI's role in creative practices? This is particularly demanding in regions where funding for artistic research is scarce. Since professional artists require compensation for their work, many collaborations are limited to academia/universities, excluding industry professionals who might otherwise contribute valuable insights.

A possible path to these challenges would be the development of publicly funded AI music platforms that prioritize accessibility and transparency. Academic institutions, emerging startups, and independent research organizations could collaborate to create AI tool initiatives that do not impose restrictive licensing fees or claim ownership over user-generated content. By addressing these debates, the music research community can move towards a more inclusive and equitable

integration of AI in composition, production, and performance. However, for now, the question still remains: how can institutions and funding bodies facilitate access to AI tools in a way that ensures fair use and respects the autonomy and the privacy of both researchers and professional artists?

Human-machine collaborative musical creation for Brazilian music: some considerations

The impact of AI initiatives on music composition, production, and cultural preservation is multifaceted. The potential for AI tools and applications to both enhance and challenge traditional music creation processes is thought-provoking and significant. While AI may provide innovative tools that augment or boost human creativity, there are also concerns about the potential homogenization of musical styles, especially within the musically rich Northeastern Brazil region. Our primary inquiry may be as follows: Can AI-generated music be curated to respect and preserve specific cultural elements, ensuring that the music evolves while maintaining its cultural roots? Indeed, collaborative creativity between humans and AI has shown promising results, enhancing human creativity by providing new tools and perspectives within hybrid dynamics. Human-AI collaborations demonstrate the potential of these hybrid approaches, leveraging the strengths of both AI's computational power and human creativity and autonomy.

However, challenges in research and practical implementation remain. The accessibility of advanced AI systems for experimentation is limited, as most are developed and funded by professional software companies. This creates a barrier for independent researchers and smaller academic institutions. In Brazil, these difficulties extend to the academic field of music in general, even when the research is conducted at renowned universities by researchers affiliated with these universities. It is worth noting that in Brazil, research on music takes place primarily within the scope of public universities. Research related to emerging technologies, as well as the training of its researchers, also occurs primarily within public universities. A notable point is that the academic field of music is still based on musicology and music theory grounded in the 19th century, systematically focused on European classical music. Since the companies that fund music production projects have economic objectives, it is difficult to secure such partnerships when the academic field of music does not emphatically engage with elements related to the recording industry and popular music. This is particularly ironic because it is precisely popular music and the cultural roots of the people, along with technological development and the recording industry, that underpin the development of Brazilian music.

Furthermore, due to social and economic inequalities and unequal access to new and emerging technologies, the integration between music and computer science in dialogue with the music market and the creative industry is crucial. Without this collaboration in research, hierarchical boundaries may expand, and musical genres like those from Brazil risk losing even more space, both on the national scene and a potential global music scene. When music loses space, the individuals who create it and those who identify with it also lose social and cultural spaces. Additionally, evaluating AI-generated music involves both technical analysis and subjective assessment of creativity and cultural authenticity, requiring a balanced dialogue between science, art and culture.

The issue about the authorship in AI-generated music continues to be a contentious concern, particularly as AI models become more 'autonomous' in their creative capabilities. Legal frameworks worldwide remain inconsistent, with some jurisdictions attributing ownership to the AI developers, while others recognize the human user guiding their own AI perspective. There are emerging legal discussions regarding whether AI systems should be recognized as 'co-creators', prompting the need for revised intellectual property frameworks that ensure fair attribution and compensation.

A major ethical concern is whether AI-generated music contributes to cultural diffusion and homogenization. Since AI models are trained on existing musical datasets, they tend to replicate dominant music styles while underrepresenting niche or regional musical traditions. The algorithmic biases may favor certain musical styles over others, sidelining less commercially viable but culturally significant genres. The menace of this bias further complicates the major ethical and authorship questions, as AI-generated compositions often do not reflect the predominance from other non-European and non-North American cultures, such the Brazilian music.

Ongoing research centers on ensuring AI-generated compositions maintain artistic integrity while preserving the diverse traditions (is it really true?) of global music cultures (Kofler et al, 2024). We are expecting for the future developments in AI music composition initiatives a more genuine and transparent AI decision-making processes and data collection and retrieval, designing musicians to retain the creative control while leveraging AI's expansive generative capabilities (Chen et al., 2024). These important debates illustrate that AI in music composition is not merely about automation but, conversely, is about expanding the creative possibilities from the own human musicians, offering novel technologies and computer implementations to enhance (if it is

possible) human expressivity, adaptability, and artistic innovation in music creation (Briot et al., 2020).

Moreover, one of the most pressing considerations is how AI is shaping the music industry, from the influence of algorithmic curation in streaming online services to the evolving role of AI-assisted music composition either in popular music and experimental music. While AI-generated music systems open the door for hybrid applications and innovative production techniques, there is an inherent risk of cultural homogenization pastiche. To try mitigating this perspective, a commitment to 'culturally-aware' AI models that esteem and fit to local and the particular musical context is essential, not disregarding ethical concerns, copyright and privacy protection if virtual data collection.

The rise of AI-generated music raises some other questions, such as those followed by the philosophical issues regarding the nature of creativity and artistic expression. While AI technologies can generate melodies, harmonies, rhythmic patterns, specific and odd timbre results, and even entire compositions, it lacks the intentional and cultural consciousness that truly defines a human artistry fashion. From our current perspective, AI models are viewed as a tool for augmenting, rather than replacing, the potential creative prospects. These perspectives emphasize the need for ongoing interdisciplinary dialogue between technologists, musicians, legal experts, and cultural scholars. In doing so, AI-generated music is not just a technical innovation: it is a particular handing force that needs to be handled with care and awareness, ensuring that technological progress aligns with artistic integrity and cultural diversity.

In conclusion, while AI presents exciting opportunities for innovation in music production and composition, it also poses significant threats, creative, and ethical considerations. Ongoing research and continuous interaction between music and computational technologies are crucial for the broader aspects of music, harnessing the full potential of AI in music, particularly where music is an integral part of cultural identity. Beyond the importance of human artistic work are the roles of composers, musicians, and music researchers who are familiar with the musical cultures they research and create.

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