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Harmonizing Innovation and Ethics: Navigating the AI Revolution in Music Creation and Production

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Abstract. This article explores the multifaceted implications of artificial intelligence (AI) in the music industry, primarily focusing on its application in music creation, production, and the evolving legal and ethical landscapes. With AI becoming increasingly central in businesses and technology, its role in music has expanded, ranging from AI-driven music generation services to virtual vocalists and AI-assisted music production tools. I delve into these practical applications of AI in music, such as royalty-free background music for content creators and audio mastering, and the more public-facing research-oriented pursuits of industry leaders like Google and OpenAI. I also present examples of how AI has been used in recent commercial music releases, particularly by electronic producers such as Holly Herndon. The emergence of AI-driven virtual vocalists is highlighted as well, as it brings unique challenges in identity and legal rights. I discuss the need for frameworks to empower vocalists, ensuring equitable compensation and control over training models. Similarly, I critically examine the legal and ethical implications of deep learning in music, especially in the context of copyright issues and the economic impact on musicians. I also underscore the importance of transparency in AI applications and the commercial use of the term "AI." Finally, I emphasize the responsibility of AI researchers and developers in understanding the impacts of their creations, advocating for a critical examination of AI's socio-cultural impacts. There is vast potential of AI in music, and I advocate for collaborative efforts among artists, developers, legislators, and other stakeholders to navigate the complexities of AI in music creation and production.

Keywords. copyright-AI, ethics-AI, music-AI, responsible AI

1 Introduction

Since the debut of OpenAI's ChatGPT, artificial intelligence has become a focal point, with businesses eagerly capitalizing on the heightened interest in AI technologies. The fluid nature of our conception of AI is evident, as encapsulated in axioms such as Tesler's theorem asserting that "artificial intelligence is whatever has not been done yet" [1]. This evolving understanding is further reflected in phenomena such as the "AI

effect," the notion that "when an allegedly uniquely human ability or skill is being automated by means of computer technology, we refer to it as 'AI.' Yet, as soon as this automation is seamlessly and fully successful, we tend to stop referring to it as an 'AI case'" [2].

2 Emerging Applications for AI in Music

In the contemporary landscape, AI utilization spans various domains. Digital culture theorist Lev Manovich outlines a taxonomy of AI applications: "1) *Selecting* content from larger collections," "2) *Targeting* content," "3) *Assistance* in creation/editing of new content," and "4) *Fully autonomous* creation" ([3], emphasis in original). To illustrate a taxonomy for AI-driven music products and services, Table I contains examples of such products and services categorized into music generation, plug-ins, mixing and mastering, source separation, voice models, music-driven productivity or wellness apps, and audio enhancement.

TABLE 1. AI MUSIC PRODUCTS AND SERVICES.

Company	Service/Product	Use
Google	MusicLM	Music generation
Mubert	Mubert	Music generation
Audialab	Emergent Drums 2	Drum machine
Sonic Charge	Synplant 2	Synthesizer
LANDR	Mastering (online/plug-in)	Mastering
RoEx	Mixing and mastering (online)	Mixing/mastering
AudioShake	Instrument Stem Separation	Source separation
LALA.AI	Stem Splitter	Source separation
Holly+	Holly+	Voice model
Voice-Swap	Voice-Swap	Voice models
Brain.fm	Brain.fm	Productivity/wellness
Endel	Endel	Productivity/wellness
insoundz	Revive	Audio enhancement

Many commercial music generation services predominantly market to content creators seeking royalty-free background music. This preference may arise from the simplicity of the music itself, making it likely easier to generate using current models. Conversely, major tech companies like Google, Meta, and OpenAI have introduced music generation models as demos rather than fully realized products: MusicLM is available through Google's AI Test Kitchen, Meta's MusicGen is available as a demo on Hugging Face, while OpenAI's Jukebox is less accessible to novices as users can run

it on Google Colab. These demos serve as showcases for the cutting-edge research conducted by these companies, illustrating their commitment to staying abreast of AI developments. This dual perspective highlights both the practical applications of AI in music creation, primarily serving content creators in need of more commonplace background music, and the currently research-oriented pursuits of industry leaders.

AI-driven plugins are primarily oriented toward mixing and mastering tasks, exemplified by tools from iZotope and Sonible. This inclination may stem from the fact that these tools rely on analyzing incoming audio, which has been extensively researched in the field of music information retrieval. However, there are also notable AI-driven instruments, such as Emergent Drums 2, a drum machine, and VOCALOID6, a singing synthesizer. Additionally, effects such as TAIP, a tape saturator, and Neutone, which runs various AI audio processing models, contribute to the expanding repertoire of AI-enhanced music production tools. An increased demand for AI-driven music-making tools is likely to spur the creation of a more diverse range of plugins. However, a potential obstacle lies in the computational overhead associated with running these models, whether locally or remotely. Balancing the need for advanced capabilities with the practical constraints of computational resources will be crucial for the seamless integration and widespread adoption of AI-driven plugins in music production.

3 Examples of AI-Assisted Music Creation

Limited published research has focused on the intersection of artificial intelligence and music creation (see [4] and [5] for examples of existing research). However, insights gleaned from interviews with artists who integrate AI into their work shed light on the role of AI in their music-making process. Vocalist and producer Holly Herndon's 2019 album *PROTO* stands as an early example of AI incorporation, employing a machine learning program, Spawn. Trained on Herndon's voice, Spawn acts as a collaborator throughout the album [6].

The year 2023 witnessed a surge in music integrating AI technologies, potentially reflecting increased accessibility for the average user. Electronic producer Lee Gamble utilized voice models in his album *Models* to explore the potential humanization of AI technologies [7]. Similar to Herndon, Gamble trained one model on his voice and considered the voice models as collaborators in the music-making process. Another electronic producer, patten, asserts to have created the "first LP made entirely from AI-generated sound sources," *Mirage FM*, which, similar to Herndon, he hopes demonstrates the possibilities of AI-assisted creativity [8]. *Mirage FM* is composed of samples taken from Riffusion, a text-to-audio model. Riffusion is based on a fine-tuning of Stable Diffusion, a text-to-image model, on spectrograms [9]. It produces low-

fidelity output, however, patten embraces this limitation, considering it an integral part of the aesthetic of the tool. In contrast to the other artists' motivations, electronic producer Oneohtrix Point Never's album *Again* features some tracks composed with the assistance of various AI tools, including Riffusion and OpenAI's Jukebox, to explore the limits and failings of current AI technologies [10].

4 Virtual Vocalists

"Virtual vocalists" deserve special attention because they present a unique set of challenges surrounding the concepts of identity and the legal rights vocalists have to their own voices. Before the sophistication of AI, virtual vocalists were created using either vocal synthesis or samples. Now producers can use AI to create virtual singers using models trained on recordings of real singers. The identity of a virtual vocalist is inherently flexible, offering opportunities for creative expression but also raising concerns about the potential for bias. When delving into these complexities, it becomes evident that frameworks are essential to empower vocalists, granting them control over the use of their voices in AI training models and ensuring equitable compensation for their contributions.

One pivotal event that underscores the intricate challenges in the domain of AI-powered virtual vocalists occurred in August 2022 when FN Meka, a virtual rapper partially powered by AI, was signed, and then subsequently dropped by Capitol Records [11]. The project faced sharp criticism and was accused of perpetuating stereotypes about Black culture and sidelining Black creators during the character and music development process. In a study examining racialized Vocaloids and their reception, Nina Sun Eidsheim asserts that "connections between race and timbre are cultural constructs and practices" that are formed through a "process by which timbre, visual imagery, text, and listening are tied together into a narrative about race" [12]. Consequently, developers of virtual vocalists and artists who utilize their tools must remain acutely aware of their biases to ensure that these products are created and used with respect and sensitivity. This incident also illustrates the ethical questions surrounding developers' ability to configure and profit from identities that differ from their own, particularly those belonging to marginalized groups.

In addition to issues surrounding identity, vocalists' rights to their own voices becomes a paramount concern. Organizations like the American Society of Composers and Publishers (ASCAP) are actively lobbying for "six guiding principles for AI" with the aspiration that Congress will adopt them as legislation to safeguard the rights of musicians and songwriters [13]. Without federal protections, state laws governing the use of another's likeness seem to be the best option for artists whose voices are digitally replicated [14]. The future may also witness legislative developments governing how

artists are compensated when their voices are used to train AI models. Notably, YouTube is collaborating with record labels to monetize music that incorporates AI, while companies specializing in licensing AI voices trained on human singers are emerging. Artists like Grimes and Holly Herndon are adopting alternative approaches by making models of their voices available for other musicians to use, albeit with certain stipulations [15], [16]. Additionally, Herndon's involvement with Spawning, a company focused on tools that permit artists to opt out of public training datasets, underscores the importance of giving creators agency in this evolving landscape [17].

Traditionally, we think of artists as unique individuals who create distinct works. But the immensely popular Vocaloid character Hatsune Miku challenges this preconception. While certain aspects of her identity are defined (young, female, Japanese), she "does not exist as a set personality with a specific narrative back story… [so] she can become… emergent, dynamic, and malleable in the hands of musicians and fans alike" [18]. Virtual vocalists with fluid identities will certainly be possible with AI-generated vocalists as well. But because AI represents a blend of the material it was trained on and the patterns it discerns within its training data, developers must confront the complex ethical questions associated with AI-generated work and take responsibility for the tools they create.

The world of virtual vocalists stands at the intersection of identity, rights, and artistic responsibility. As the boundaries of creativity and technology continue to blur, it becomes imperative that we navigate these challenges with sensitivity, ethics, and a commitment to preserving the integrity of artistic expression.

5 Legal and Ethical Implications of Deep Learning

Deep learning is accompanied by a plethora of legal and ethical implications, further complicated by the novelty of the technology. A primary concern is copyright issues, as delineated in a report prepared by the Congressional Research Service [19]. Presently, the U.S. Copyright Office restricts copyright to works authored by a human being, even if the work is generated based on a text prompt. However, if the AI-generated material undergoes arrangement, modification, or combination with human-authored materials, it may be eligible for copyright protection.

The attribution of authorship in AI-generated work also raises significant questions. Determining whether the author is the human who supplied the prompt, the AI program itself, or the developer of the program is an ongoing challenge. At present, there is no clear rule governing this aspect. Some services, such as OpenAI, address this ambiguity by assigning copyright to the user, thereby circumventing the complexities surrounding authorship and copyright ownership.

Generative AI introduces the potential for copyright infringement during both the

training and output phases. Notably, organizations like the Authors Guild, The New York Times, and Getty Images contend that training AI programs on copyrighted materials constitutes a violation of copyright law. In contrast, tech companies and their advocates argue that such activities fall within the realm of fair use [20]. As of now, multiple lawsuits on this matter are still pending, leaving both perspectives untested in a legal context. While some AI services decline prompts involving copyrighted characters or the imitation of a particular artist's style, others may permit users to generate such works, potentially exposing both the AI services and their users to legal action.

Training datasets pose a significant challenge, with potential economic ramifications for musicians already contending with existing economic models, such as streaming services, and now facing competition from AI-generated music for business opportunities. The complex nature of training on copyrighted works is exemplified by Ed Newton-Rex, a researcher in AI audio, who resigned from his role as VP of Audio at Stability AI due to concerns about the company's stance that training on copyrighted materials falls under fair use [21]. Acknowledging that "much of the efficacy – and hence much of the value – of machine learners depends on the datasets on which they are trained," it becomes imperative for compensation models to adapt in tandem with technological advancements for artists to sustain their livelihoods [22]. Without legislative changes, the risk persists that the "cultural capital of individual musicians and communities" will continue to be "exploited by capitalist firms for private interests" [23].

Transparency surrounding the datasets used to train AI models and the role of AI in commercial products and services is another concern. While companies may justify the secrecy around datasets as necessary to safeguard proprietary models, it is plausible that the reluctance to disclose stems from models being trained on copyrighted works, exposing companies to potential legal challenges, as discussed earlier. Stability AI is one example of a company that discloses its dataset; their Stable Audio model was trained using audio files supplied through an agreement with AudioSparx, a stock music company [24].

The commercial value of the term "AI" has led to it being "often used interchangeably with, or instead of, the specific kind of machine learning that companies and labs are doing" and obfuscates the part AI plays in a product or service [25]. This ambiguity is exemplified in a study on the AI-powered mastering service LANDR, where researchers posit that the platform likely "uses ML for part of the process, for instance in analyzing the sound of an uploaded audio track, and then select[s] from a matrix of preset possibilities for processing" [26]. This suggests that the machine learning component may not be tailored to each track, but the exact process remains undisclosed, as LANDR does not provide insights into the inner workings of its mastering program. In contrast, Yamaha, although somewhat concealed within the research and

development section of their website, offers an article dedicated to explaining how AI is incorporated into their Vocaloid product, providing a more transparent approach to showcasing the integration of AI in their offerings [27].

6 Researcher Accountability

It is imperative for AI researchers and developers to embrace accountability for the technology they create, taking the lead in critically examining its impacts and working towards mitigating negative consequences through research, supporting regulation, and other measures. Researchers have themselves critiqued their respective fields, such as human-computer interaction ("while the field [of human-computer interaction] examines and generates… systems… its political dimension—that is, the varying balances of power between who produces the technology, who designs it, who uses it, and what socio-cultural impact it may have—is rarely addressed" [28]) and music information retrieval ("MIR [music information retrieval] is not yet engaging in the 'ethical turn' that other technology research fields are undergoing" [23]).

An important recommendation is for researchers to collaborate more closely with artists, not only to enhance the development of better models and services but also to understand and address artists' concerns. In an article focusing on "research applying machine learning to music modelling and generation," the researchers emphasize that "rarely does such work explicitly question and analyse its usefulness for and impact on real-world practitioners, and then build on those outcomes to inform the development and application of machine learning" [4]. Another researcher supports this assessment while also challenging the fatalistic assumption surrounding AI deployment: "Also problematic and unchallenged is the axiomatic assumption that 'AI will help musicians make music'. To the best of my knowledge, no investigations have been conducted to pinpoint what specific help musicians need, prove that such help is actually beneficial, or ensure that these tools will contribute to a more just music industry" [23].

A noteworthy project in this realm is Google's DeepMind laboratory's tool, SynthID, designed for watermarking and identifying AI-generated images and audio [29]. This technology holds promise for addressing challenges related to misinformation and enhancing the transparency of AI-generated media. Hopefully, researchers will persist in developing tools to combat the complex issues that accompany AI. A scrutiny of research papers on AI-generated music from major entities like Meta, OpenAI, and Google, reveals a shared acknowledgment among researchers regarding various risks associated with AI deployment. These risks include built-in bias or a lack of diversity [30], [31], [32], [33], [34], the potential for use in misinformation or scams (such as "creating remarkably realistic deep fakes and voice phishing" [32]), misappropriation of training data [33], and ethical concerns surrounding the sourcing of training data and

competition for the work of musical artists [34]. Nevertheless, the extent of ongoing efforts to address these challenges remains unclear, and the willingness of researchers to be vocal about the issues, especially when their ideals may conflict with the economic models of their employers, poses an open question.

7 Conclusions

"AI" is an ambiguous term that encompasses a range of meanings. Existing AI-driven tools for music and audio typically engage in selecting content, targeting content, aiding in the creation or editing of content, or generating entirely new content. While there is currently a limited variety of AI-driven products for music production, the sustained global interest in AI technologies is likely to continue fueling their development. Commercial music releases are already incorporating AI into the music-making process. However, more published research on AI-assisted music creation would be beneficial for both developers and musicians. Virtual vocalists are particularly complex, as they can embody the musical identity of an existing artist but can also be given a completely fabricated identity chosen by the creator.

Despite the proliferation of startups and established companies actively engaged in developing AI-driven music products and services, the ethical, legal, and economic implications of this technology remain unsolved. Pressing issues include the copyright status of AI-generated media, whether training models on copyrighted work constitutes a violation of copyright laws, the potential for AI-generated media to infringe upon copyright laws, and how to fairly compensate artists whose music is included in datasets. Transparency from companies is crucial, particularly regarding the sources of datasets and the role of AI within their products or services.

Developers also bear the responsibility to address difficult ethical questions surrounding the systems they develop and to engage with musicians, producers, audio engineers, and others who will be most impacted by advances in machine learning in music. I firmly believe that addressing the challenges posed by AI will require collaboration and mutual understanding among artists, developers, legislators, and other stakeholders. By fostering cooperation, these diverse perspectives can contribute to the development of equitable solutions that navigate the complexities surrounding AI in the domain of music creation and production.

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