

ARTIFICIAL INTELLIGENCE

Art and the science of generative AI

Understanding shifts in creative work will help guide AI's impact on the media ecosystem

By **Ziv Epstein¹, Aaron Hertzmann^{2,3}, and the Investigators of Human Creativity***

The capabilities of a new class of tools, colloquially known as generative artificial intelligence (AI), is a topic of much debate. One prominent application thus far is the production of high-quality artistic media for visual arts, concept art, music, and literature, as well as video and animation. For example, diffusion models can synthesize high-quality images (1), and large language models (LLMs) can produce sensible-sounding and impressive prose and verse in a wide range of contexts (2). The generative capabilities of these tools are likely to fundamentally alter the creative processes by which creators formulate ideas and put them into production. As creativity is reimagined, so too may be many sectors of society. Understanding the impact of generative AI—and making policy decisions around it—requires new interdisciplinary scientific inquiry into culture, economics, law, algorithms, and the interaction of technology and creativity.

Generative AI tools, at first glance, seem to fully automate artistic production—an impression that mirrors past instances when traditionalists viewed new technologies as threatening “art itself.” In fact, these moments of technological change did not indicate the “end of art,” but had much more complex effects, recasting the roles and practices of creators and shifting the aesthetics of contemporary media (3). For example, some 19th-century artists saw the advent of photography as a threat to painting. Instead of replacing painting, however, photography eventually liberated it from realism, giving rise to Impressionism and the Modern Art movement. By contrast, portrait photography did largely replace portrait painting. Similarly, the digitization of music production (e.g., digital sampling and sound synthesis) was decied as “the end of music.” Instead, it altered the ways people produce and listen to music, and helped spawn new genres, including hip hop and drum’n’bass. Like these historical analogs, generative AI is not the harbinger

of art’s demise, but rather is a new medium with its own distinct affordances. As a suite of tools used by human creators, generative AI is positioned to upend many sectors of the creative industry and beyond—threatening existing jobs and labor models in the short term, while ultimately enabling new models of creative labor and reconfiguring the media ecosystem.

Unlike past disruptions, however, generative AI relies on training data made by people. The models “learn” to generate art by extracting statistical patterns from existing artistic media. This reliance on training data raises new issues—such as where the data is sourced, how it influences the outputs, and how to determine authorship. By leveraging existing work to automate aspects of the creative process, generative

“...generative AI is not the harbinger of art’s demise, but rather is a new medium with its own distinct affordances.”

AI challenges conventional definitions of authorship, ownership, creative inspiration, sampling, and remixing and thus complicates existing conceptions of media production. It is therefore important to consider generative AI’s impacts on aesthetics and culture, legal questions of ownership and credit, the future of the creative work, and impacts on the contemporary media ecosystem. Across these themes, there are key research questions to inform policy and beneficial uses of this technology (4).

To properly study these themes, it is first necessary to understand how the language used to describe AI affects perceptions of the technology. The very term “artificial intelligence” might misleadingly imply that these systems exhibit human-like intent, agency, or even self-awareness. Natural language-based interfaces now accompany generative AI models, including chat interfaces that use the “I” pronoun, which may give users a sense of human-like interaction and agency. These perceptions can undermine credit to the creators whose labor underlies the system’s outputs (5) and deflect responsibility from developers and decision-makers when these systems cause harm (6). Future work

is needed to understand how perceptions of the generative process affect attitudes toward outputs and authors. This could facilitate the design of systems that disclose the generative process and avoid misleading interpretations.

Generative AI’s specific affordances in turn give rise to new aesthetics that may have a long-term effect on art and culture. As these tools become more widespread, and their use becomes commonplace (as with photography a century ago), it remains an open question how the aesthetics of their outputs will affect artistic outputs. A low barrier to entry for generative AI could increase the overall diversity of artistic outputs by expanding the set of creators who engage with artistic practice. At the same time, aesthetic and cultural norms and biases embedded in the training data might be captured, reflected, and even amplified—thereby decreasing diversity (7). AI-generated content may also feed future models, creating a self-referential aesthetic flywheel that could perpetuate AI-driven cultural norms. Future research should explore ways to quantify and increase output diversity and study how generative AI tools may influence aesthetics and aesthetic diversity.

The opaque, engagement-maximizing recommender algorithms of social media platforms could further reinforce aesthetic norms through feedback loops (8) that produce sensational and shareable content. As algorithm and content creators try to maximize engagement, this may further homogenize content. However, some preliminary experiments (9) suggest that incorporating engagement metrics when curating AI-generated content can, in some cases, diversify content. It remains an open question what styles are amplified by recommender algorithms, and how that prioritization affects the types of content creators make and share. Future work must explore the complex, dynamic systems formed by the interplay between generative models, recommender algorithms, and social media platforms, and their resulting impact on aesthetics and conceptual diversity.

Generative AI’s reliance on training data to automate aspects of creation raises legal and ethical challenges regarding authorship and thus should prompt technical research into the nature of these systems. Copyright law must balance the benefits to creators, users of generative AI tools, and society at large. Laws could treat the use of training

¹Massachusetts Institute of Technology, Cambridge, MA, USA. ²Adobe Research, San Francisco, CA, USA. ³University of Washington, Seattle, WA, USA. Corresponding author: zive@mit.edu *The Investigators of Human Creativity coauthors and affiliations are listed at the end of this paper.

data as noninfringing if protected works are not directly copied; fair use if training involves a substantial transformation of the underlying data; allowed only if creators give an explicit license; or subject to statutory compulsory licensing that allows data to be used for training provided that creators are compensated. Much of copyright law relies on judicial interpretations, so it is not yet clear if collecting third-party data for training or mimicking an artist's style would violate copyright. Legal and technical issues are entwined: Do models directly copy elements from the training data, or produce entirely new works? Even when models do not directly copy from existing works, it is not clear whether and how artists' individual styles should be protected. What mechanisms could protect and compensate artists whose work is used for training, or even permit them to opt out, while still allowing new cultural contributions to be made with generative AI models? Answering these questions and determining how copyright law should treat training data require substantial technical research to develop and understand the AI systems, social science research to understand perceptions of similarity, and legal research to apply existing precedents to new technology. Of course, these points represent only an American legal perspective.

A distinct legal question concerns who can claim ownership over model outputs. Answering this requires understanding the creative contributions of a system's users versus other stakeholders, such as the system's developers and creators of the training data. AI developers could claim ownership over outputs through terms of use. By contrast, if users of the system have engaged in a meaningfully creative way (e.g., the process is not fully automated, or does not emulate specific works), then they might be considered as the default copyright holders. But how substantial must users' creative influence be for them to claim ownership? These questions involve studying the creative process of using AI-based tools and may become more complex if users gain more direct control.

Regardless of legal outcomes, generative AI tools are likely to transform creative work and employment. Prevailing economic theory [i.e., skill-biased technological change (SBTC)] assumes that cognitive and creative workers face less labor disruption from automation because creativity is not readily encodable into concrete rules (i.e., Polanyi's paradox) (10). Yet, new tools have sparked employment concerns for creative occupations such as composers, graphic designers, and writers. This conflict arises because SBTC fails to differentiate between cognitive activities such as analytical work and creative ideation. A new framework is needed to

characterize the specific steps of the creative process, which of those steps might be affected by generative AI tools, and the effects on workplace requirements and activities of varying cognitive occupations (11).

Although these tools may threaten some occupations, they could increase the productivity of others and perhaps create new ones. For example, historically, music automation technologies enabled more musicians to create, even as earnings skewed (12). Generative AI systems can create hundreds of outputs per minute, which may accelerate the creative process through rapid ideation. However, this acceleration might also undermine aspects of creativity by removing the initial period of prototyping associated with a tabula rasa. In either case, production time and costs will likely fall. The production of creative goods may become more efficient, leading to the same amount of output with fewer workers. In turn, demand for creative work may increase. However, the production of creative goods may become more efficient, leading to the same amount of output with fewer workers. Furthermore, many work-for-hire occupations using conventional tools, like illustration or stock photography, could be displaced. Several historical examples bear this out. Most notably, the Industrial Revolution enabled mass production of traditionally artisanal crafts (e.g., ceramics, textiles, and steelmaking) with the labor of non-artisans; hand-made goods became specialty items. Similarly, photography replaced portrait painting. Digitization of music removed constraints of learning to physically manipulate instruments and enabled more complex arrangements with more contributors. These tools may change who can work as an artist, in which case artists' employment may rise even as average wages fall.

As these tools affect creative labor, they also introduce potential downstream harms to the broader media ecosystem. As the cost and time to produce media at scale decreases, the media ecosystem may become vulnerable to AI-generated misinformation through the creation of synthetic media, particularly media that provides probative evidence for claims (13). These new possibilities for generating photorealistic synthetic media may undermine trust in authentically captured media through the so-called "liar's dividend" (fake content benefits liars by undermining trust in the truth) (14) and also increase threats of fraud and nonconsensual sexual imagery. This raises important research questions: What is the role of platform interventions such as tracking source provenance and detecting synthetic media downstream in governance and building trust (15)? And how does the proliferation of synthetic media affect trust

in real media, such as unedited journalistic photographs? As content production increases, collective attention spans may decrease (16). The explosion of AI-generated content may in turn hamper society's ability to collectively discuss and act in important arenas such as climate and democracy.

Every artistic medium mirrors and comments on the issues of its time, and the debates surrounding contemporary AI-generated art reflect present issues surrounding automation, corporate control, and the attention economy. Ultimately, we express our humanity through art, so understanding and shaping the impact of AI on creative expression is at the center of broader questions about its impact on society. New research into generative AI should inform policy and beneficial uses of the technology while engaging with critical stakeholders, particularly artists and creative laborers themselves, many of whom actively engage with difficult questions at the vanguard of societal change. ■

REFERENCES AND NOTES

1. R. Rombach et al., *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition* (2022), pp. 10684–10695.
2. A. Vaswani et al., "Attention is all you need" in *Advances in Neural Information Processing Systems* 30 (2017).
3. A. Hertzmann, *Arts*, 7 (no. 2) (2018).
4. Z. Epstein et al., "Art and the science of generative AI: A deeper dive," arXiv2306.04141 [cs.CY] (2023).
5. Z. Epstein et al., *iScience* 23, 101515 (2020).
6. M. C. Elish, *Engag. Sci. Technol. Soc.* 5, 40 (2019).
7. S. U. Noble, *Algorithms of Oppression: How Search Engines Reinforce Racism* (New York Univ. Press, 2018).
8. A. J. B. Chaney et al., in *Proceedings of the 12th ACM Conference on Recommender Systems* (2018), pp. 224–232.
9. Z. Epstein, M. Groh, A. Dubey, A. Pentland, *Proc. ACM Hum. Comput. Interact.* 5 (CSCW2), 1 (2021).
10. C. B. Frey, M. A. Osborne, *Technol. Forecast. Soc. Change* 114, 254 (2017).
11. M. R. Frank et al., *Proc. Natl. Acad. Sci. U.S.A.* 116, 6531 (2019).
12. D. Hesmondhalgh et al., "Music creators' earnings in the digital era," Intellectual Property Office Research Paper (2021).
13. J. A. Goldstein et al., arXiv 2301.04246 [cs.CY] (2023).
14. B. Chesney, D. Citron, *Calif. Law Rev.* 107, 1753 (2019).
15. H. Farid, *J. Online Trust Safety* 10, 54501/jots.v1i4.56 (2022).
16. P. Lorenz-Spreen et al., *Nat. Commun.* 10, 1759 (2019).

ACKNOWLEDGMENTS

Z.E. and M.G. helped assess DALL-E 2 and M.R.F. helped assess ChatGPT for OpenAI. A.H. and L.H. work for Adobe, which makes generative AI tools; the ideas expressed here do not represent those of the company.

Investigators of Human Creativity Memo Akten¹, Hany Farid², Jessica Field³, Morgan R. Frank⁴, Matthew Groh⁵, Laura Herrman⁶, Neil Leach⁸, Robert Mahariq^{3,5}, Alex "Sandy" Pentland⁶, Olga Russakovsky⁷, Hope Schroeder⁹, Amy Smith¹⁰

¹University of California, San Diego, San Diego, CA, USA.

²University of California, Berkeley, Berkeley, CA, USA. ³Harvard

Law School, Cambridge, MA, USA. ⁴University of Pittsburgh,

Pittsburgh, PA, USA. ⁵Massachusetts Institute of Technology,

Cambridge, MA, USA. ⁶University of Oxford, Oxford, UK. ⁷Adobe,

Inc., London, UK. ⁸Florida International University, Miami, FL,

USA. ⁹Princeton University, Princeton, NJ, USA. ¹⁰Queen Mary

University of London, London, UK.