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ARTICLE

NODE «AI, ARTS & DESIGN: QUESTIONING LEARNING MACHINES»

AI, Arts & Design: Questioning Learning Machines

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Abstract

Explorations of the relationship between Artificial Intelligence (AI), the arts, and design have existed throughout the historical development of AI. We are currently witnessing exponential growth in the application of Machine Learning (ML) and AI in all domains of art (visual, sonic, performing, spatial, transmedia, audiovisual, and narrative) in parallel with activity in the field that is so rapid that publication can not keep pace. In dialogue with our contemplation about this development in the arts, authors in this issue answer with questions of their own. Through questioning authorship and ethics, autonomy and automation, exploring the contribution of art to AI, algorithmic bias, control structures, machine intelligence in public art, formalization of aesthetics, the production of culture, socio-technical dimensions, relationships to games and

aesthetics, and democratization of machine-based creative tools the contributors provide a multifaceted view into crucial dimensions of the present and future of creative AI. In this Artnodes special issue, we pose the question: Does generative and machine creativity in the arts and design represent an evolution of “artistic intelligence,” or is it a metamorphosis of creative practice yielding fundamentally distinct forms and modes of authorship?

Keywords

artificial intelligence, machine learning: AI, ML, arts, design

IA, arte y diseño: Cuestionando el aprendizaje automático

Resumen

La exploración de la relación entre la Inteligencia Artificial (IA), el arte y el diseño han existido a lo largo del desarrollo histórico de la IA. Actualmente estamos presenciando un crecimiento exponencial en la aplicación de Aprendizaje Automático (AA) y la IA en todos los ámbitos artísticos (visual, sonoro, interpretativo, espacial, transmedia, audiovisual y narrativo) en paralelo a la actividad en el campo que sucede tan rápido que la publicación no puede mantener el ritmo. En diálogo con nuestra visión sobre este desarrollo artístico, los autores de este número responden con sus propias preguntas sobre el tema al cuestionar la autoría y la ética, la autonomía y la automatización, y explorar la contribución del arte a la IA, el sesgo algorítmico, las estructuras de control, la inteligencia artificial en el arte público, la formalización de la estética, la producción de cultura, las dimensiones sociotécnicas, las relaciones con los juegos y la estética, y la democratización de las herramientas creativas basadas en máquinas, los ensayistas contribuyentes proporcionan una visión multifacética de las dimensiones del presente y el futuro de la IA creativa. En este número especial de Artnodes, nos planteamos la siguiente pregunta: ¿La creatividad generativa y mecánica en el arte y el diseño representa una evolución de la “inteligencia artística” o es una metamorfosis de la práctica creativa que produce formas y modos de autoría fundamentalmente distintos?

Palabras clave

inteligencia artificial, aprendizaje automático, AI, AA, arte, diseño

Any attempt to write a state-of-the-art review of the development and impact of Artificial Intelligence (AI) in the contemporary world is destined to be fragmentary or perhaps necessarily incomplete. Activity in the field, in all dimensions, is so rapid that publication cannot keep pace. Often researchers self-publish on archive servers, such as <https://arxiv.org/>. Specialized conferences, for example, those organized by (AAAI) the Association for the Advancement of Artificial Intelligence (<https://www.aaai.org/>) and (NeurIPS) Neural Information Processing Systems (<https://neurips.cc/>), not only receive overwhelming amounts of submissions, for which locating reviewers is a challenge, but the conference itself sells out in minutes. 2019 NeurIPS sold out all registrations in eleven minutes and thirty-six seconds (Falcon 2019). This boom in activity also includes work in the arts and design, with dedicated tracks and workshops for creative AI. This situation is a symptom, a manifestation not of a world that is about to change but of a world that has already changed. Development and usage scenarios for artificial neural networks are accelerating, made possible in part by access to large-scale training datasets combined with massive parallel GPU computing (Joshi 2019). From

legal sentencing recommendations to autonomous vehicles, facial recognition and surveillance, personalized medicine and learning, conversational agents embedded in everyday objects and real-time intelligent responsive environments, we are transforming all aspects of human endeavor through the application of machine learning (ML), AI and generative models. We live in times when corporate entities are capable of sensing the world through cascades of applications that use ML, and which have multiscale impacts from the individual on up to entire societies (e.g. surveillance capitalism [Zuboff 2015]). Another instance is the reading, almost in real time of all the billions of “tweets” generated on our planet in many languages (which are automatically translated). Each of the messages is analyzed several times through different kinds of processes, and last, but not least, the resulting data is complemented and correlated, with data from all flights globally, in addition to other data sources. This makes evident an unprecedented reading of the present in its multiple dimensions of data, at scales unimaginable just a few years ago, that are reconfiguring economic and societal domains globally (Sarangi 2018). This gives rise to an urgent need to envision and understand the societal

impact of these innovations, and provide greater interpretability of artificial neural networks with transparency in regard to the underlying biases grounded in the very data that enables their utility.

For example, in the field of visual aesthetics, it is evident that ML applications are already at the fingertips of each person with a smartphone. Pictures taken with phones are being stored, classified, and ordered according to a digital model of the taste and the user's emotional profile; on cell phones, photo albums are automatically generated, videos are automatically edited, producing visual and audiovisual sets that will gradually become the official memory of individuals. Yet, are they an individual's memories given this automated processing? Authors such as Lev Manovich have pointed out the problem: however, it is evident that what he reflects upon in the book "AI Aesthetics" is just a small portion of the relationship between AI, ML, visual aesthetics, and contemporary computational culture (Manovich 2019). While we are writing this introduction, Arthur I. Miller has published an essay in the *American Scientist* magazine entitled "Can AI Be Truly Creative?" posing a question far from the classic problem of whether machines can think but whether devices can be creative (Miller 2020). The publication of such a text in a periodic scientific publication only means that this topic has been discussed for decades in specialized communities of arts and technology. To mention a few, Ernest Edmonds in his papers from the sixties and seventies already discussed the role of the computer as an assistant in the creative processes (Boden, Edmonds 2019; Franco 2017) or the artist Harold Cohen, who developed work over his entire career, commencing in the eighties, teaching a robot to paint like himself, dismantling the myth that the relationship between computing, algorithms, and art are new (Miller 2019). Clearly, the conversation is expanding as rapidly as the technology and its applications are evolving.

Explorations of the relationship between AI and the arts have existed throughout the historical development of AI, such as Hofstadter's early work at the intersection of computing, AI, the visual arts, music, and poetry (Hofstadter 1999). We are witnessing exponential growth in the application of ML and AI in all the domains of art (visual, sonic, performing, spatial, transmedia, audio-visual, and narrative) with the democratization of software libraries, access to commodity hardware for GPU computing and open access to artificial neural network models, including development of online tools requiring no coding expertise (e.g. Playform <https://www.playform.io/> or RunwayML <https://runwayml.com/>, and integration into digital content creation tools, such as Photoshop). Integration of ML into existing tools or ease-of-use interfaces poses a unique challenge for creative practitioners and culture overall. Will use of ML as easily as a Photoshop filter lead to increased awareness or lack of awareness of potentially encoded bias or decreased artistic agency in accepting whatever aesthetics are "baked" into the ML algorithm by its designers? Will this lead us to unconscious application of a homogenized ML aesthetic as it is sublimated into digital content creation tools? As artists and designers

create never-before-heard sounds and images of ne-ver-before-seen faces, explore new processes for human-machine co-creation and infinitely parameterize the design of objects, are we at the dawn of a new paradigm in creative practice? Or can this explosion of activity be considered part of the continuum of generative art practices spanning the history of human creativity and the evolution of culture?

In this Artnodes special issue, we pose the question: *Does generative and machine creativity in the arts and design represent an evolution of "artistic intelligence", or is it a metamorphosis of creative practice yielding fundamentally distinct forms and modes of authorship?* The journal issue is the companion to a years-long international dialogue on AI in the arts and design initiated via Leonardo Education and Art Forum (LEAF) (<https://www.leonardo.info/leaf>), a program of Leonardo/ISAST. Promoting the advancement of artistic practice, academic scholarship and practice-led re-search, LEAF serves as an international forum for dialogue at the intersection of art, science and technology. To foster community dialogue LEAF coordinates sessions at international conferences like ACM SIGGRAPH (Special Interest Group in Computer Graphics and Interactive Techniques, <https://www.siggraph.org/>) and CAA (College Art Association Annual Conference, <https://www.collegeart.org/>). As guest editors for this issue of Artnodes, and also as the Chair and International Liaison for LEAF, we are delighted to have this opportunity to broaden and deepen the dialogue on this topic through the publication of manuscripts received in response to this Artnodes issue's open call for papers, and amongst these several essays written by participants of LEAF sessions held during ACM SIGGRAPH 2019 and CAA 2020. Panelists in Los Angeles at SIGGRAPH 2019 included Memo Akten, Max Sims, Angus Forbes, Erkki Huhtamo, and at CAA 2020 in Chicago, panelists included Christiane Paul, Elizabeth Demarry, Ahmed Elgammal, Marian Mazzone, Eitan Mendelowitz, Philip Galanter and Meredith Tromble. Examples of contributions by these panelists to the ACM SIGGRAPH 2019 / Leonardo special issue Art Papers include Memo Akten, Rebecca Fiebrink and Mick Grierson's "Learning to see: you are what to see" (Akten et al 2019) and Weili Shi's "Terra Mars: When Earth Shines on Mars through AI's Imagination" (Shi 2019) and other creative practitioners that are deconstructing ML in order to expand its creative and expressive potentials and contribute advances to the arts.

This edition of Artnodes is unique in two ways. First, it establishes a connection between Artnodes and Leonardo/ISAST. This issue represents the first collaboration in a new partnership between Artnodes open-access academic e-journal for the analysis of the intersections between art, science and technology, and Leonardo/The International Society for the Arts, Sciences and Technology (Leonardo/ISAST), a non-profit organization serving a global network for art, science and technology. Leonardo/ISAST (<https://www.leonardo.info/>) had its beginnings in 1968 as Leonardo journal (<https://www.mitpressjournals.org/loi/leon>), founded in Paris by kinetic artist and astronautical pioneer Frank Malina, focused on the writings of ar-

tists using science and technologies in their work. Next, because of Artnodes' geographical and cultural location in Barcelona; this issue articulates essays from Europe, the United States, Latin America, and Asia, exposing that cultural variety is of crucial importance in the understanding of the field, and addressing the need for inclusiveness as a paradigm for advancing AI equality as opposed to dominance, such as what we often see reflected in contemporary news media about accelerating the competition for AI development (Kanaan 2020). As the reader will see, compelling contributions written by scholars and artists from Latin America and Spain are included in their original language. We have decided to include them in Spanish as an invitation to understand the variety and the complexity of the situation we are addressing and as a reminder of the diverse ways of knowing and creative dynamics of this particular contemporary moment. Authors in this issue represent a spectrum of voices and approaches to the question of AI in the arts and design.

We open our issue with "*Towards Ethical Relationships with Machines That Make Art*" by Philip Galanter. In his essay, Galanter traverses fundamental questions at the heart of AI in the arts and design. Presenting alternative models of authorship in the context of complexism, a theory of generative art grounded in complexity science, Galanter leads us to consider machine ethics in the context of a potential future horizon: the advent of AI capable of autonomous learning, exploration and realization of artworks with no dependency on the human beings that programmed it for its creative direction, technique, content or aesthetics. Confronting us with longstanding anthropomorphizing of both non-human living sentient entities, and non-living technological systems, Galanter guides the reader through defining a notion of machine patiency, in which those with ethical agency act with moral consideration of the recipient of their actions. He argues that as AIs appear more and more to us as peers in their behavior, such as autonomous generative creation of artworks, and notwithstanding the uncertain future regarding the evolution of machine sentience, in order to act as moral agents we collectively face a societal urgency to enact machine patiency.

Continuing on with reflections on autonomy and automation, in the provocative essay "*The Self-Driving Car: A Media Machine for the Posthuman Era?*" Erkki Huhtamo dissects the concepts of autonomy and automation by reflecting on the properties of the self-driving car. Although media archeology methods are present, this is not an exercise on the Fordian car characterized by the automation of mechanical processes; instead, we face the autonomy of machines and the automation of cognition typical of the 21st century. The author's intellectual perspective uncovers the debate about the human and the posthuman by going through the convoluted avenues of the transformation of a contemporary society confronted with these mobile devices that promise to be the quintessential interaction between ML, Internet of Things, Cloud-based mobility services, GPS, sensors, LiDAR, and an almost infinite series of constituent objects as complex

in themselves as articulated to a vast network. Building upon a series of rare studies of the design and technical development of different programs for autonomous cars and the services associated with them, the author paints a vivid portrait of autonomy's marketing tensions and limits beyond machine autonomy and human autonomy.

Next in "*Ask Not What A.I. Can Do for Art...But What Art Can Do for A.I.*" by Meredith Tromble, the relationship between art and artificial intelligence is reconceptualized beyond the current context of ML approaches to creation. First calling our attention to power structures and ethics in our interactions with the technological and non-human, Tromble then interconnects metaphors in the works of Orphan Drift and Rashaad Newsome to explore artistically-impelled notions of agency for AI. Noting that contemporary questions about AI and the arts are primarily centered on methodologies of ML, which often encode assumptions from 19th-century artistic practice through their reliance upon training data comprised of canonical examples of visual imagery of that era, or on considerations of the societal impacts of AI, she leads us to the unasked question: "what can art do for AI?" Contemplating this proposition Tromble considers the romanticizing and anthropomorphizing of AI, in contrast to the potential of disembodied pure intellect, followed by the possibility that what art can do for AI can be informed by what art can do for human intelligence. Ultimately Tromble proposes a vision of the arts bringing AI into an embrace with the pluripotent multiplicities of meaning that might emerge from new forms of agency in a human-AI co-creative partnership.

Analyzing a specific work, "*Outside in: exile at home an algorithmic discrimination system*" by Annabel Castro, exposes in depth the features, processes, and intentions of a computationally-based media installation, which re-sembles the experience of watching movies in a cinema theater. This apparently familiar scene is the excuse to invite the audience to explore a film that is in the process of making and unmaking itself, at least the edition and composition components have been delegated to an ML algorithm that mixes four fiction films; the audiovisual fragments are separated and reassembled again into a new order. The installation explores two different paths; on the one hand, it serves as a metaphor for what happens in present time with personal data acquired and processed to create a computational representation of the individual, and second, the installation intends to expose the process of detention for extended times of Mexicans of Japanese heritage in the context of the Second World War, something that happened in other Latin American countries as well. This essay focuses on one particular creative project, exploring the different levels of meaning in the artwork, explaining carefully how these levels constitute one ambitious and compelling project.

In "*Identification, classification and control: close links analyzed in reference to artistic practices in the heart of Artificial Intelligence*" Hugo Idárraga explores the historical and mythical roots of automatons, homunculus, cyborgs, and robots to expose some characteristics of their functionalities, establishing a parallel with

experiments on ML, AI, and Deep Learning. Themes that articulate mythical references and contemporary technical implementations are the concepts of identification, classification, and control. Idárraga addresses the history of AI and cybernetics, and with eloquence at the philosophical level, exposes the reasons why automatic identification and classification are not naïf but instead the result of a patriarchal view of society and technology in which surveillance facilitates the control of social processes. The text also exposes an experimental creative project based on the idea of counter identification using visual inputs to trick artificial vision systems, anticipating discussions of the massive implementation of these technologies in contemporary society, positioning art as a way to explore AI's transformation of our technological reality.

Exploring how artists challenge the logics of ML, "*Creative AI: From Expressive Mimicry to Critical Inquiry*" by Angus Forbes calls our attention to fundamental creative gestures articulated within its practice: curation of training data, ultimately defining a space of interpretation, selecting loss functions, and choosing outputs returned when querying neural networks. He goes on to define four dimensions of creative AI practice as: expressive mimicry, interactive mapping, generative art, and critical inquiry. Forbes provides ample evidence for these by analyzing creative AI projects spanning early canonical works by Harold Cohen and David Cope, to contemporary works by Sougwen Chung, Fiebrink, Analema Group, Refik Anadol, Mario Klingemann, Casey Reas, Memo Akten, Chris Rodley, and Pinar Yanardag and Emily Salvador. These works are discussed in the context of the rapid advance of ML techniques, including seminal topics such as feature discovery, style transfer, inceptionism, and generative adversarial networks. This interleaving of creative works and the evolution of ML leads to an articulation of uncharted territory – creative areas which resist ML approaches and those amenable to them as a vision of the future of creative AI.

In his essay "*Intelligent Environments and Public Art*", Eitan Mendelowitz proposes definitions and a taxonomy for public art created with AI / ML as a medium. Proceeding from definitions of public art, AI, and intelligent agents, Mendelowitz articulates a taxonomy based on the characteristics of intelligent agents as an evaluative metric for characterizing AI-enabled public art. The five model dimensions, generative, reactive, interactive, learning and static, arise from four metrics: perception, introspection, actuation and self-mutability. He demonstrates the utility of the schema in analysis of works by contemporary practitioners including Refik Anadol, Sosolimited, Plebian Design, and Hypersonic, Dmitry Sokolov, Rafael Lozano-Hemmer, Local Projects, Legends, NowArchival, The Hetema Group, and Electroland. Reflecting upon the state of the art in this genre, Mendelowitz comments upon the preponderance of AI-based public art as being instantiated as generative or interactive rather than *learning* and points us towards creation of work in this dimension as a horizon for potential growth.

Pivoting on the exhibition "Infinite Skulls", in which Robbie Barrat utilized a generative adversarial network (GAN) trained on 500 images of skulls painted by Ronan Barrot to generate countless images of similar yet unique skulls, Bruno Caldas Vianna asks "How and why did we end up wanting machines to do the work of painters?" In his essay, "*Generative Art: Between the Nodes of Neuron Networks*" the journey in search of an answer starts with the origins of deep convolutional generative adversarial networks (DCGANs) in cybernetics and traces their development through Rosenblatt's perceptrons, Minsky and Papert's critique, connectionism's development of distributed representation and backpropagation, on through Hinton's greedy layer-wise pretraining of deep networks, to emerge as Goodfellow's formulation of generative adversarial networks combining generators and discriminators. It takes us through this trajectory of emergence to its intersection with generative art, and the distinctions between rules-based and models-based formalization of aesthetics. It continues beyond, to questioning the nature of authorship of a work when the formalization is the result of an indirect process: the training of a network, rather than the direct process of defining and encoding the formalization as rules/algorithms. Ultimately Vianna takes us into uncharted territory and asks us to contemplate the gaps between the nodes in the net as the locus of perfect imperfections that hold the potential to reveal the capability inherent in machine learning as a new frontier in visual art.

In "*Panoramic views of the collective visual heritage through convolutional neural networks. The exhibitions Revolutionary Arkive and Mnemosyne 2.0*", Ferran Comes Reverter presents and discusses two installations by Pilar Rosado presented in 2019: *Revolutionary Arkive* and *Mnemosyne 2.0*. These photographic installations explore the possibilities of large image datasets stored and tagged in specialized and controversial databases, like ImageNet, through Convolutional Neural Networks (CNNs). The artistic work developed by Pilar Rosado can be understood as a comment to the intellectual work and methods of the art and culture researcher Aby Warburg, and in particular, to his *Bilderatlas Mnemosyne*. These references point to the intimate interrelation between the production of images, iconicity, and culture. In this sense Rosado's installations can be seen as an exercise of repositioning Warburg's ideas with 21st-century tools including CNN, ResNet-50, and algorithms such as t-SNE to expand the debate on the notions of visual social heritage and its role in contemporary culture.

Sharath Chandra Ramakrishnan investigates the configuration of AI listening devices and the technosocial domains that give shape to them in his paper "*Unlocking the Black Box of AI Listening Machines: Assemblages for Art, Technology and Innovation*." In this text, sound processing, speech recognition, natural language processes, AI, and ML, are contextualized as widely available industrial devices. The need to explore and explain the many layers of socio-technical complexity embedded in the so-called smart speakers reminds

us of the importance of object semiotics because screens do not mediate the interaction with these listening platforms. Therefore, opening the black box is a necessary action proven to be challenging because it requires focusing on the corporeality of speakers and voice assistants, which are icons of our digital material culture. The author engages with the discussion of specific artworks that operate as discursive tools to disassemble the constitutive components of the interconnected listening systems. Additionally, the many references to historical and media archaeological sources enrich the perspective of the paper.

Marian Mazzone and Ahmed Elgammal articulate a vision for their online creative studio platform for artists in the essay “*Artists, AI and Machine-based Creativity in Playform*.” They present the design for a web-based system with ease of use similar to contemporary digital imaging applications allowing for machine learning to be used as easily as filters or digital compositing for voluminous image generation. Interviews with several artists, using the system while it is in beta, provide insight into ways of working with *Playform* and the unresolved questions inherent in the recent emergence of machine learning as generative engines for creative content in visual arts, texts/narratives and musical composition: Is machine learning a medium, tool or creative partner? Can there be truly serendipitous results in generative arts systems? As *Playform* and similar systems arrive on the contemporary creative landscape, only time will tell how their emphasis on curation of inputs and outputs will impact the role of the artist.

In “*The aesthetic factor in the automation of logical tasks: The case of chess*”, Santiago Rementeria-Sanz examines the relationship between AI, ML, and ludic practices, in particular chess. This game, which is deeply rooted in Western culture and has been called in Spanish “el juego ciencia” (“game of science”), is analyzed in the context of expert systems development such as the IBM Deep Blue, which was able to defeat world champion Garry Kasparov in 1996. More recently, the advance of AI applied to games had another landmark with the introduction of the *AlphaZero* platform created by DeepMind to master games like chess, shogi, and Go. However, the account presented by Rementeria-Sanz does not deal exclusively with technical development; instead, it is occupied with aesthetic problems associated with the practice of playing chess. It is here that Rementeria-Sanz establishes a connection with art and shows us how games share many features with art including decision-making and elegance of execution. This text should be contextualized and considered along with other advances in this field, in particular the progress in the game of Go and AI, which has been portrayed even in documentaries such as *AlphaGo* directed by Greg Kohs.

This introduction to Artnodes issue No. 26, “*AI, Arts & Design: Questioning Learning Machines*” serves as a modest contribution to a much larger dialogue. It comes from a year-long research process

organizing panels in conferences, in which we have had the opportunity to listen to several of the artists, scientists, and curators most active in the field of arts and design exploring and discussing AI and ML. Their perspective and practice, through historical analysis, software development, creative work and artistic research, and in conceiving and curating exhibitions, offers insight in the midst of the rapidly evolving fields of machine learning, artificial intelligence and creative AI. Their work spans many of the topics reflected in the writing of the authors in this issue and which pose questions necessary for deconstructing the existence of machine learning and artificial neural networks, and the promise of AI. Changes driven by these technologies are happening worldwide, but they are not happening everywhere, or in the same ways. Our contribution, through this special issue, is just one of many that exist at the moment. Of note are the contributions of the AIArtists portal (<https://aiartists.org>) led by Marnie Benney and Pete Kistler, that has done a remarkable job in the exposition and discussion of the creative and critical uses of AI and Machine Learning. Among other important issues, they highlight the work of African American artists in the field such as Stephanie Dinkins, Joy Buolamwini, and Mimi Onuoha (Benney 2020). Another notable example is the collaborative work by Kate Crawford and Trevor Paglen in the project *ImageNet Roulette*, which reveals problems behind data acquisition, classification methods, and bias in training data for neural networks (Crawford, Paglen 2019). Their work stands out for both its far-reaching technical development and deep cultural understanding.

We are grateful and humbled by the art, science and technology community and their responsiveness during this time of unprecedented change and challenges brought upon us by the COVID-19 global health crisis. The community came together in support of communicating artists’ and scholars’ work and writing in this area of AI in the arts and design. We wish to extend a heartfelt thank you to the authors for sharing their work on this important topic, to all of the peer reviewers who so generously served to review manuscripts for this issue, to the exceptionally talented Artnodes Editorial Team, without whom this publication would not be possible, to the Leonardo/ISAST Team for their tremendous support, to Artnodes journal editor Pau Alsina for his open-ness in taking this journey with us and his generosity in offering us the opportunity to serve as guest editors, to all of the attendees at the ACM SIGGRAPH 2019 and CAA 2020 panel sessions for the lively conversation and inspiration, and to all of the readers, for your willingness to engage with all of us in exploring the critical and timely issues at the heart of the present and future of AI in the arts & design.

We feel this is just the beginning and look forward to continuing the conversation with all of you!

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CV



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Working with emerging technologies Ruth creates resonant connections between art and science. Her work envisions a future in which art-science integration opens new portals of imagination, invention, knowledge, and communication across cultures to create solutions for our most pressing global problems. Bridging high-dimensional data and metadata, information visualization and sonification, immersive environments, and social and mobile participatory media with domains such as urban ecology, neuroscience, genomics, astronomy, and digital remix culture, she explores avenues for achieving works with multiple entry points that can exist concurrently as aesthetic experiences, artistic practice or cultural interventions and serve as the basis for artistically-impelled scientific inquiry and tools. Her work has been presented or featured in SIGGRAPH, WIRED Magazine's NextFest, UCLA Fowler Museum, CAA, Ingenuity Festival Cleveland, Los Angeles Municipal Art Gallery, FILE 09 Sao Paulo, IEEE VR, MobiSys, SPIE, IEEE ICIP, the American Journal of Human Genetics, Genomics, Leonardo, LEA, Proceedings of the National Academy of Sciences, NPR's The Connection, NY Times, Genome News Network, AMINIMA and ArtWeek.

CV



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”Burbano, originally from Colombia, explores the interactions of science, art and technology in various capacities: as a researcher, as an individual artist and in collaborations with other artists and designers. Burbano’s work ranges from documentary video (in both science and art), sound and telecommunication art to the exploration of algorithmic cinematic narratives. The broad spectrum of his work illustrates the importance- indeed, the prevalence- of interdisciplinary collaborative work in the field of digital art.”