*Innovation, Creativity, and Broadening Participation*

# The Arts and the Algorithm: An Amalgamation

## Report on the Algorithmic Arts (AlgoArts) Workshop

**Held January 11-12, 2022**

**Edited by Bill Manaris and Renée McCauley, College of Charleston, USA**

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Cosponsored by the National Science Foundation (NSF) and the National Endowment for the Arts (NEA), and hosted by the College of Charleston.

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## Workshop Organizers

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### Advisory / Program Committee

Fay Cobb Payton, Program Director, Division of Computer and Network Systems, CISE, National Science Foundation / Professor, Information Technology and Business Analytics, North Carolina State University.

Allyson Kennedy, Program Director, Education and Workforce Development, CISE, National Science Foundation.

Jax Deluca, Media Arts Director | Visual Arts, National Endowment for the Arts.

Sunil Iyengar, Director | Office of Research & Analysis, National Endowment for the Arts.

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## Executive Summary

An opportunity exists to alleviate the silos of science, technology, and arts fields through continued sharing of expertise and support across the National Science Foundation and the National Endowment for the Arts.

A diverse and capable workforce is vital to maintaining the nation's standard of excellence in STEM: science, technology, engineering and mathematics, and is a major reason for NSF's commitment to *Broadening Participation*. Research shows that combining computing and engineering with the arts brings **innovation and creativity** into STEM, and **broadens participation**. Studies show that degree programs in the Algorithmic Arts (AlgoArts) **attract, retain, and graduate approximately equal numbers (~50-50%) female and male students** (compared to 17-22% females nationally in CS and engineering). AlgoArts research and pedagogy synthesize technical knowledge and skills in computing and engineering, with design skills from studio art, performance, music and other arts, bringing needed diversity and creativity to STEM fields.

The workshop brought together **422 researchers, educators, and practitioners**, who combine computing, engineering, and the arts. These are literally the Leonardo da Vincis and Ada Lovelaces of our era. They revealed **a major disconnect**... between the needs of faculty who do research, develop, and teach in the Algorithmic Arts, and the available support. This is best captured by the following, surprising statement, which points to a deeper, systemic issue:

"We had to hide our *real* work within the NSF proposal, and our creative backgrounds… **we had to deemphasize the creative aspect of the project – in order to get funded**." [1]

Workshop participants who have been funded by NSF agreed that this is usually the case. [2] **For comparison**, the Creative Europe program – the European Commission's flagship program to support culture, technology, and creativity has a budget of € 3.91 billion (2014-2027). [3]

The ***main recommendation*** from this workshop is to create a special program, and/or add extensions to existing programs to enhance support for the Algorithmic Arts, in both research and education – as the former fosters and always precedes the latter. This way, we can begin to infuse the creative – art and design – in science, technology, engineering and math (STEM + Art

[1] Stated by an AlgoArts professor from a large, research university, in "Looking Forward" – a panel with NEA / NSF program directors and other experts – see http://algoarts.org/videos/
[2] See survey results – in this report.
[3] See "EU Funding Overview – Creative Europe", https://eufundingoverview.be/funding/creative-europe/

= STEAM). These funding opportunities **will directly address NSF's commitment to innovation, creativity, and broadening participation in significant, measurable, and sustainable ways.**

## Contributors

There were 422 registered attendees (while even more watched via LiveStream on YouTube). These are literally the Leonardo da Vincis and Ada Lovelaces of our era… the Thomas Edisons and Tim Berners-Lees. **72 individuals** contributed notably to the workshop. They represent **69 unique institutions and organizations**.

These special workshop participants are listed below (in alphabetical order):

- Fernando Alegre, Louisiana State University
- Refik Anadol, University of California, Los Angeles
- Christopher Andrews, Middlebury College
- Barbara Anthony, Southwestern University
- William Bares, Whitman College
- Nafees Bin Zafar, Apple
- Heidi Boisvert, University of Florida
- Violaine Boutet de Monvel, Université Sorbonne Nouvelle - Paris 3
- Daniel Brown, Intelligent Music Systems
- Erik Brunvand, National Science Foundation, and University of Utah
- Sarah Burford, National Endowment for the Arts
- Mamiko Carroll, Hawaii State Foundation on Culture and the Arts
- Carlos Castellanos, Rochester Institute of Technology
- Haiyan Cheng, Willamette University
- FayCobb Payton, National Science Foundation, and North Carolina State University
- Amber Coppings, Pennsylvania Council on the Arts
- Charles Cusack, Hope College
- Jax Deluca, National Endowment for the Arts
- Alex Doboli, Stony Brook University
- R. Luke DuBois, NYU Tandon School of Engineering
- Roger Eastman, University of Maryland, College Park
- Angela Ferraiolo, Sarah Lawrence College
- Jason Freeman, Georgia Institute of Technology
- Joe Geigel, Rochester Institute of Technology
- Emily Gobeille, Design I/O
- Becky Grasser, Lakeland Community College

- Mark Guzdial, University of Michigan
- W. Michelle Harris, Rochester Institute of Technology
- Shiqing (Licia) He, Texas A&M University
- Raquell Holmes, Improvscience
- Maria Hwang, Fashion Institute of Technology
- Suzanne Ishee, New Jersey Institute of Technology
- Sunil Iyengar, National Endowment for the Arts
- Chipp Jansen, King's College London, and Royal College of Art
- Elena Kauffmann, D2D Art
- Cy Keener, University of Maryland, College Park
- Allyson Kennedy, National Science Foundation
- Youngmoo Kim, Drexel University
- Thomas Kinsman, Rochester Institute of Technology
- Kevin Kwiat, SUNY Polytechnic Institute
- Susan Lakin, Rochester Institute of Technology
- Tracy Lipke-Perry, SUNY Potsdam
- Brian Magerko, Georgia Institute of Technology
- Bill Manaris, College of Charleston
- Stephanie McCaslin, College of Southern Maryland
- Renée McCauley, College of Charleston
- Kyle McDonald, Kyle McDonald Studio
- Alex McLean, Then Try This
- Ann M McNamara, Texas A&M University
- Ruby Mendenhall, University of Illinois at Urbana-Champaign, and Carle Illinois College of Medicine
- Stevens Miller, University of Maryland, College Park
- Dave Musicant, Carleton College
- Carol Parkinson, Harvestworks
- Ellen Pearlman, MIT, and ThoughtWorks Arts
- Elisabeth Pellathy, University of Alabama at Birmingham
- Miller Puckette, University of California San Diego
- Patrick Ravines, Buffalo State College
- Samuel Rebelsky, Grinnell College
- Susan Reiser, UNC Asheville
- Mark Santolucito, Barnard College
- Lori Scarlatos, Stony Brook University
- Christelle Scharff, Pace University
- Stuart Smith, University of Massachusetts Lowell

- Brian Smith, Boston College
- Heather Spence, Department of Energy, and Ocean Memory Project
- Courtney Starrett, Texas A&M University
- Amy (Alice) Sullivan, Stonybrook University
- Darryl Thomas, Western Oregon University
- Shawn Trail, Eastern Washington University
- LeeTusman, Purchase College, Artists and Hackers, and Babycastles
- Michael Tweed, SUNY Delhi
- Jeff Van Hanken, University of Tulsa
- Theo Watson, Design I/O

## Introduction

This project aims to redefine how we think of computer science and engineering research and education, in order to infuse new kinds of innovation and creativity, and to attract new kinds of minds, those who will apply computing theory and practice in different fields in the arts, such as visual art (drawing, painting, photography), music, dance, sculpture, printmaking, art history, theater and performance art, among others; and then bring innovative, out-of-the-box (silos) ideas, theories and technologies back into STEM. We want to allow computing and engineering to expand and mature, beyond its strict mathematical underpinnings, and become a more universal, inclusive, engaging discipline – in both research and practice – a discipline that incorporates and synthesizes other knowledge domains, which may inform and be informed by computational theory and practice.

In this context, "the Algorithm is the Medium" and, as such, researchers, practitioners, and educators need to engage algorithmically and interweave algorithmic thinking and development of technological solutions into their art theory and creative practice. Algorithms have existed for at least 2,000 years (e.g., Euclid's algorithm). In music and art, algorithms appear as early as Guido d'Arezzo (ca. 1000 A.D.), and in compositions by Bach, Mozart, John Cage, Iannis Xenakis, among others. Modern examples include data visualization and sonification for scientific or aesthetic purposes, such as visualizing / sonifying biosignals, images, orbits of planets, and human movement (e.g., dance), among others. This project focuses on Algorithmic Arts (AlgoArts) research and development; it also focuses on Computing in the Arts (CITA), an NSF-funded model curriculum, which is part of the new movement to combine art and design with science, technology, engineering and math (STEM + Art = STEAM).

To combine STEM and Art successfully and sustainably, we need to ensure that researchers and educators in this STEM field have adequate support for their research and careers, as well as their teaching. These are literally the Leonardo da Vincis and Ada Lovelaces of our era. The Thomas Edisons and Tim Berners-Lees. Universalists / generalists who are well grounded in computing and engineering theory and practice, and who are also venturing into the arts, and feel comfortable expressing themselves artistically and creatively. These are the innovators who will come up with new ideas – ideas that are only possible by transcending the traditional silos of science, into other fields of creativity and innovation, and then bring them back to create new theories, technological solutions, and artifacts (e.g., HTML, smartphones, YouTube, etc.) that enrich our lives, our technology, the economy, and society at large.

The goal of this project is to build a strong, yet diversified community of CS+Art researchers, educators and practitioners who – through their practice, research, and mutual support – can develop new theories and technologies, and pursue the ultimate goal of developing curricular material to synthesize the creativity and design of art with the mathematical rigor and formality of computer science, technology, and engineering.

A six-year longitudinal study shows that the CITA curriculum model attracts and retains almost twice as many female students, compared to traditional CS degree programs, and graduates 45.6% women compared to the 17-22% national average in CS.

This project consists of two workshops, one held in Spring 2022, and one being planned for Spring 2023. The project goal is to produce a report that will lay the foundation to develop research support, and eventually curricular guidelines for building effective CITA degree programs in US universities and abroad.

This is the report of the first workshop, held on Jan. 11-12, 2022, via Zoom – due to the COVID-19 pandemic.

The second workshop is being planned for Spring 2023, and is expected to be held face-to-face, at a major research university.

## What

This two-day workshop, as part of an envisioned series, assembled a diverse group of **Algorithmic Arts (AlgoArts)** researchers, educators and practitioners to *explore, discuss, and propagate successes in broadening public participation in computing in the arts*.

Workshop attendees worked to:

- *identify promising strategies* for integrating the arts with computer science education, by fostering a robust dialogue among educators, practitioners, and researchers working in this shared space; and

- *create a community of experts* who can develop recommendations for curricular guidelines and pedagogical practices, public policy and funder actions, and for research to advance this growing field of inter- and trans-disciplinary practice.

## Why

A diverse and capable workforce is vital to maintaining the nation's standard of excellence in STEM: science, technology, engineering and mathematics.

Algorithms have existed for at least 2,000 years (e.g., Euclid's algorithm). In music and art, algorithms appear as early as Guido d'Arezzo (ca. 1000 A.D.), and in compositions of Bach, Mozart, John Cage, and Iannis Xenakis, as well as in the visual algorithmic works of MC Escher, Roman Verostko, Vera Molnár, and Ernest Edmonds, among many others. [4] Leonardo da Vinci and Ada Lovelace are two notable intellectuals who changed the world, by combining the arts with sciences and engineering. So are Thomas Edison and Tim Berners-Lee, to name a few.

Creative innovation is fueled by artists and scientists working together. Artists have always sought out emergent tools and technologies. Customization is also a trait of a creative practice. Algorithmic arts allow for complete customization of tools and media. The infusion of algorithms in the arts has greatly expanded since the broad availability of computers in the 1960s. Every practice of art and entertainment, from graphics design to animation, sculpture, dance, theater, music, film, and games, has seen impact, if not dramatic and revolutionary change. We believe and advocate that the reciprocal infusion of artistic creativity, design, and innovation should also be allowed and supported to expand into computing, engineering, and other STEM fields. For instance, see "Artists-in-Labs: Process of Inquiry" [24]. Also, see the AlgoArts videos included (via embedded links) in this report.

As stated in [22], hosting artists in scientific labs creates a creative tension that leads to new ideas, and is likely to produce new discoveries:

- "Art and science are in a tension that is most fruitful when these disciplines observe and penetrate each other and experience how much of the other they themselves still contain."

The U.S. National Science Foundation is committed to innovation, creativity, and broadening participation. In particular, it is committed to expanding the opportunities in STEM to people

[4] A thorough history of the Algorithmic Arts, including many of its pioneers in the 1960's and 70's is available at Roman Verostko's website – see http://verostko.com/

of all racial, ethnic, geographic and socioeconomic backgrounds, sexual orientations, gender identities and to persons with disabilities.

AlgoArts research and pedagogy demonstrably bring innovation and creativity, and broaden participation. In particular, research shows that combining the creative – art and design with science, technology, engineering and math (STEM + Art = STEAM) has a significant impact in increasing participation to computing by underrepresented groups. In the context of CS education, this blending, or amalgamation, **attracts, retains, and graduates approximately equal numbers (~50-50%) female and male students** (compared to 17-22% females nationally in CS and engineering) [4–8, 10, 13, 16–20].

Building on this historical momentum, **this Algorithmic Arts (AlgoArts) workshop** examined the potential for bringing greater amalgamation – or synthesis – between

- the aesthetic sophistication, creativity, and design of the arts; and
- the technological mastery, mathematical rigor, and theory of computer science, and engineering.

There is significant evidence and bibliography on how Algorithmic Arts research and pedagogy introduce innovation and creativity, and broaden participation – see [1-25].

## How

The workshop was held on Jan. 11 and 12, 2022, via Zoom, lasting three-and-a-half hours on each day. It included:

- **two keynote speakers** — one from Computer Science & Engineering, and one from the Arts;

- **eight prominent AlgoArts practitioners and educators** who discussed their work and observations;

- **a community town-hall meeting**, where audience members talked about challenges and opportunities in the synthesis of the arts and algorithms, and

- **a panel featuring NSF and NEA staff and other experts**, discussing the past & present, interacting, and offering a broad perspective on the future of funding and public policy in the field of Algorithmic Arts.

## Goals

**Algorithmic Arts** (AlgoArts) encompasses all people and programs involved in the integration of computing and arts – creation of art through computing, and creation of algorithms for artistic practice.

The main goal of this workshop was to bring together a diverse group of Algorithmic Arts researchers, educators and practitioners. These are the Leonardo da Vincis, and Ada Lovelaces of our time.

They were asked to explore, discuss, and propagate successes, and to identify funding, policy, and curricular needs for integrating the arts with computer science research and education, for the purpose of broadening and deepening engagement with innovative learning practices.

Related subgoals included:

- *identify promising strategies* for integrating the arts with computer science education by fostering a robust dialogue among educators, practitioners, and researchers working in this shared space.

- *create a community of experts* who can develop recommendations for curricular guidelines and pedagogical practices, public policy and funder actions, and for research to advance this growing field of inter- and trans-disciplinary practice.

## Program

The workshop was held on Jan. 11 and 12, 2022, via Zoom, lasting three-and-a-half hours on each day. It included **two keynote speakers** — one from Computer Science & Engineering, and one from the Arts; **eight prominent AlgoArts researchers, educators, and practitioners** who discussed their work and observations; **a community town-hall meeting**, where audience members talked about challenges and opportunities in the synthesis of the arts and algorithms, and **a panel featuring NSF and NEA staff and other experts**, which discussed the past & present, interacted, and offered a broad perspective on the future of funding and public policy in the field of Algorithmic Arts.

| **TUESDAY, January 11** | **WEDNESDAY, January 12** |
|---|---|
| *Doors open*<br>12:45 PM (EST) | *Doors open*<br>12:45 PM (EST) |
| Welcome & Opening Session<br>1:00 PM-1:10 PM (EST) | Welcome & Opening Session<br>1:00 PM-1:10 PM (EST) |
| Keynote 1 – **Youngmoo Kim**<br>1:10 PM-1:50 PM (EST) | Keynote 2 – **Heidi Boisvert**<br>1:10 PM-1:50 PM (EST) |
| Speaker 1 – **Maria Hwang**<br>2:00 PM – 2:20 PM (EST) | Speaker 5 – **Refik Anadol**<br>2:00 PM – 2:20 PM (EST) |
| Speaker 2 – **Brian Smith**<br>2:30 PM – 2:50 PM (EST) | Speaker 6 – **Theo Watson & Emily Gobeille**<br>2:30 PM – 2:50 PM (EST) |
| Speaker 3 – **Mark Guzdial**<br>3:00 PM – 3:20 PM (EST) | Speaker 7 – **Cy Keener**<br>3:00 PM – 3:20 PM (EST) |
| Speaker 4 – **Susan Reiser**<br>3:30 PM – 3:50 PM (EST) | Speaker 8 – **Courtney Starrett**<br>3:30 PM – 3:50 PM (EST) |
| **"Challenges & Opportunities"** – a community town hall with participants offering thoughts, comments, ideas<br>4:00 PM – 4:30 PM (EST) | **"Looking Forward"** – a panel with NEA / NSF program directors, and other experts<br>4:00 PM – 4:30 PM (EST) |

## Statistics on Broadening Participation

### Registration

We received **386 registrations**. Registration remained open until Saturday, Jan. 8, 2022, at 11:30PM (EST). Additionally, there were 10 invited speakers, and another 26 direct registrations (advisory committee, invited participants, and organizers) – bringing the total to **422 registered participants**.

The breakdown was **46% female, 2% non-binary, and 52% male**, which is typical for Computing in the Arts degree programs (vs. 17-22% female participation in CS and Engineering) [5, 7]. This supports NSF's commitment to *Broadening Participation*.

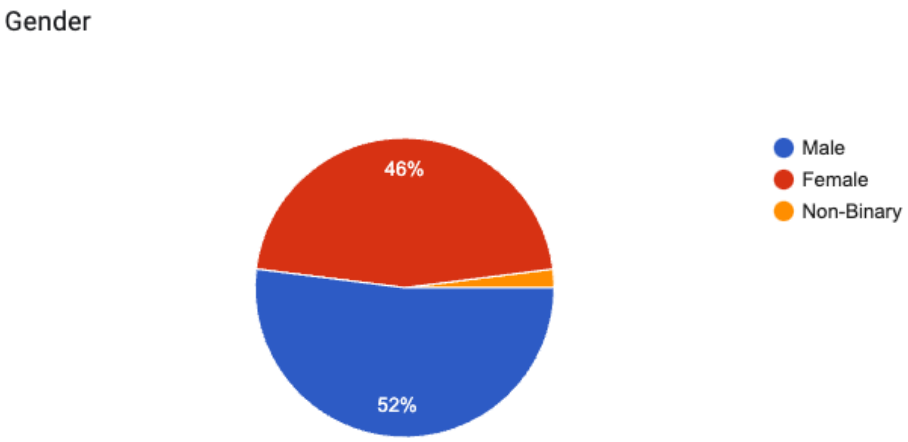



**Fig. 3.** Breakdown of workshop participants based on gender.

Due to the large number, registrants were separated into participants and attendees, for a more intimate / manageable Zoom experience.

**Additional attendees** watched via LiveStream on YouTube.

## Attendance

The following are attendance statistics separated by day, and overall:

*Day 1*

- **101** unique individuals participated via Zoom.
- **318** unique individuals watched via LiveStream on YouTube (see Fig. 1).

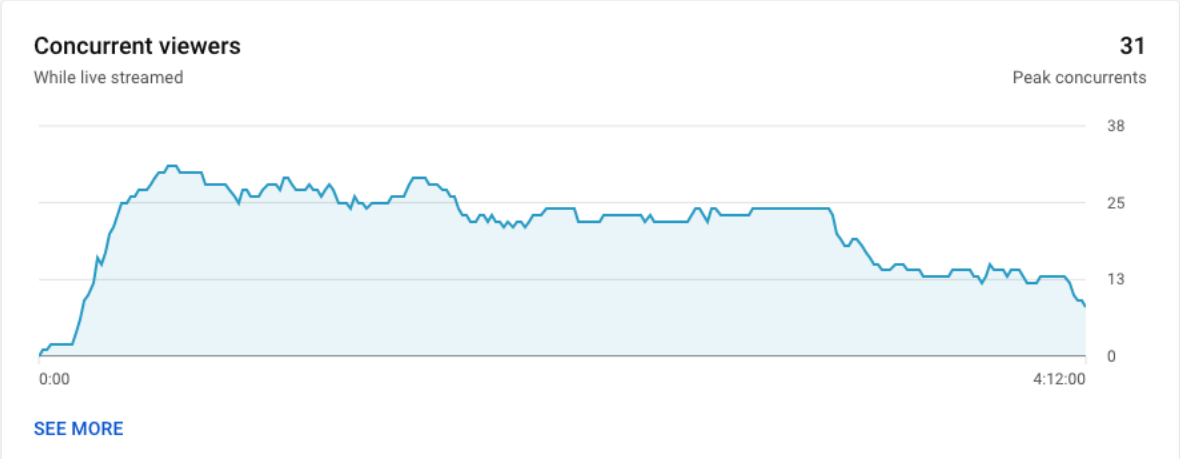



**Fig. 1**. Graph of YouTube attendance ONLY during Day 1 – Zoom attendance not included. A total of 318 unique individuals (31 max concurrent) watched on YouTube alone.

*Day 2*

- **75** unique individuals participated via Zoom.
- **113** unique individuals watched via LiveStream on YouTube (see Fig. 2).

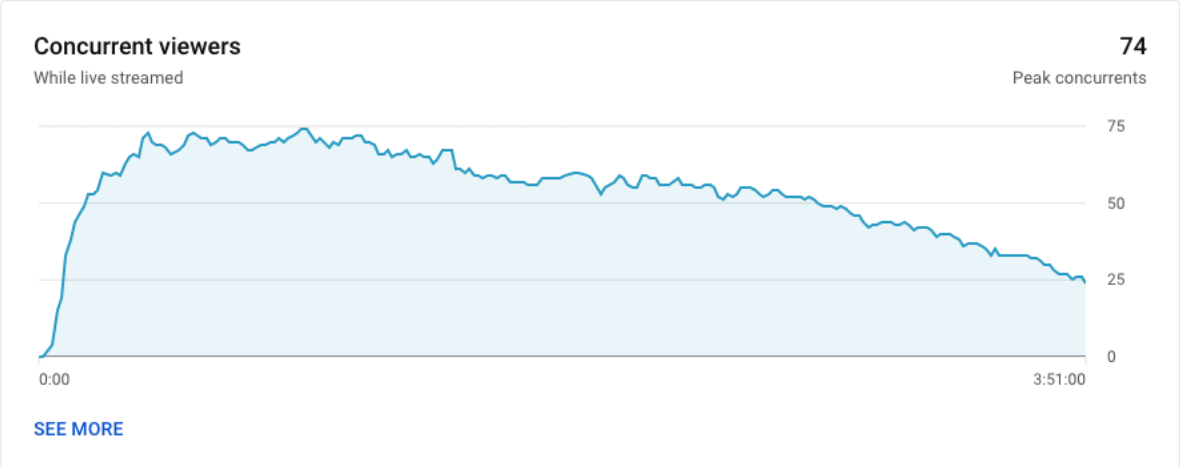



**Fig. 2.** Graph of YouTube attendance ONLY during Day 2 – Zoom attendance not included. A total of 113 unique individuals (74 max concurrent) watched on YouTube alone.

*Total*

**419 (101 + 318)** unique individuals attended the event, at least (based on Day 1, above). The number may be larger, because individuals who missed Day 1, but attended **only** Day 2 are not included in this count. **This is at least four times as many participants** as originally expected.

## Presenters and Talks

The workshop included **two keynote speakers –** one from Computer Science & Engineering, and one from the Arts; and **eight prominent AlgoArts researchers, educators, and practitioners,** who discussed their work and observations.

### Youngmoo Kim – Keynote

Youngmoo Kim is Director of the ExCITe Center at Drexel University, an institute at for transdisciplinary collaboration, and Professor of Electrical & Computer Engineering. His research group, the Music & Entertainment Technology Laboratory (MET-lab), pursues AI for music, human-machine interfaces and robotics for expressive interaction, and STEAM education. He has also served as Resident Technologist for Opera Philadelphia and is an advisor for the Philadelphia Museum of Art. He was a member of the National Academies committee for "Branches from the Same Tree", a 2018 report on the integration of the Humanities & Arts with Sciences, Engineering, and Medicine in Higher Education.

Kim also has extensive experience in vocal music performance, including performances with the Tanglewood Festival Chorus and SpeakEasy Stage Company (Boston) and currently sings with The Tonics, an a cappella ensemble in Philadelphia. In response to the coronavirus pandemic, he developed Virtual Chorister, a smartphone app for remote music collaboration, and launched "Creating at a Distance", a newsletter highlighting creative & collaborative work in the era of social distancing.


Click on image above to watch.

## Heidi Boisvert – Keynote

Heidi Boisvert is an interdisciplinary artist, experience designer, creative technologist and academic researcher who interrogates the neurobiological and socio-cultural effects of media and technology. Simply put, she studies the role of the body, the senses and emotion in human perception and social change. Boisvert is currently mapping the world's first media genome, while taking great care with its far-reaching ethical implications. She founded futurePerfect lab, a creative agency and think-tank that works with social justice organizations to design playful emerging media campaigns to transform the public imagination. She also co-founded XTH, a company creating novel modes of expression through biotechnology and the human body. Presently, she is working with David Byrne on Theater of the Mind, a new immersive theater piece and co-curating EdgeCut, a live performance series.

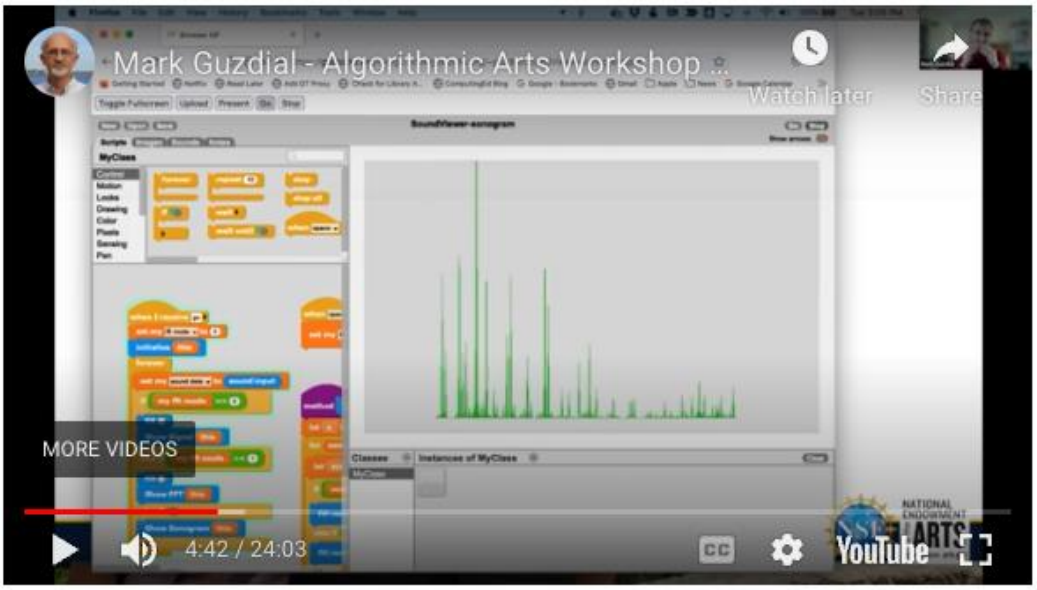
Boisvert, who holds a Ph.D. in Electronic Arts from Rensselaer Polytechnic Institute, is an Assistant Professor of AI and the Arts within the School of Theatre + Dance at the University of Florida. She is also a Senior Research Fellow at the Norman Lear Center (based at the University of Southern California's Annenberg School for Communication), a research affiliate in the Open Documentary Lab at the Massachusetts Institute of Technology and a member of NEW INC, the cultural incubator at The New Museum of Contemporary Art. She serves on the advisory board of American Documentary POV Spark and was selected by ZERO1 and the U.S. Department of State's Bureau of Educational and Cultural Affairs to represent the United States in Turkey.


Click on image above to watch.

## Mark Guzdial

Mark Guzdial is a Professor in Computer Science & Engineering and Engineering Education Research at the University of Michigan. He studies how people come to understand computing and how to make that more effective. He is one of the founders of the International Computing Education Research (ICER) conference. He was one of the leads on the NSF alliance "*Expanding Computing Education Pathways*" which helped US states improve and broaden their computing education. He invented and has written several books on the "Media Computation" contextualized approach to computing education. With his wife and colleague, Barbara Ericson, he received the 2010 ACM Karl V. Karlstrom Outstanding Educator award.

Guzdial is an ACM Distinguished Educator and a Fellow of the ACM. His most recent book is *Learner-Centered Design of Computing Education: Research on Computing for Everyone* (Morgan & Claypool, 2015). He received the 2019 ACM SIGCSE Outstanding Contributions to Education award.




Click on image above to watch.

## Refik Anadol

Refik Anadol is a media artist, director and designer based in Los Angeles, California. He works in live audio/visual performance, site-specific immersive installation and parametric sculpture, particularly creating a hybrid relationship between architecture and media arts. He holds an MFA from University of California, Los Angeles in Media Arts, an MFA from Istanbul Bilgi University in Visual Communication Design, and BA in Photography and Video.

Anandol is the recipient of a number of awards, including Microsoft Research's Best Vision Award, German Design Award, UCLA Art+Architecture Moss Award, University of California Institute for Research in the Arts Award, SEGD Global Design Awards and Google's Art and Machine Intelligence Artist Residency Award. His site-specific audio/visual performances have been seen in Walt Disney Concert Hall (USA), Hammer Museum (USA), International Digital Arts Biennial Montreal (Canada), Ars Electronica Festival (Austria), l'Usine | Genève (Switzerland), Arc De Triomf (Spain), Zollverein | SANAA's School of Design Building (Germany), santralistanbul Contemporary Art Center (Turkey), Outdoor Vision Festival SantaFe New Mexico (USA), Istanbul Design Biennial (Turkey), Sydney City Art (Australia), Lichtrouten (Germany).


Click on image above to watch.

## Maria Hwang

Maria Hwang is a professor of Computer Science at the Fashion Institute of Technology (FIT) in the Math and Science department. Her research focuses on delivering fashion, health, and wellness content through persuasive, personalized, and playful human-centered interfaces. Courses she teaches include "Statistics, Machine Learning, and Data Mining," "Programming and Mobile Apps," "Statistical Analysis," and "Basic Mathematics."

Prior to joining FIT, Hwang was a post-doctoral researcher at the Columbia University Medical Center's (CUMC) Biomedical Informatics Department working with Lena Mamykina. Maria received her doctorate of education (Ed.D.) at Teachers College, Columbia University in Instructional Technology and Media under the supervision of Charles Kinzer, focusing on persuasive messages for behavior change in a digital game environment. She continues her research on different persuasive and motivational strategies in gaming environments for healthful behavior and chronic disease management. She is also developing courses and modules that are geared towards non-computer science (CS) major students that can aid them in their career with the basic CS literacy and skills. She is hoping to create a CS minor at FIT through writing and developing more courses that are rigorous but also flexible for those coming in with no prior CS knowledge.


Click on image above to watch.

## Brian Smith

Brian Smith is the Honorable David S. Nelson Professional Chair and Associate Dean for Research at the Lynch School of Education and Human Development, Boston College, and a Professor of Information Science and Education. His research interests include the design of computer-based learning environments, human-computer interaction, design sciences, out-of-school learning, creativity and innovation, and computer science education. Earlier, he served as senior associate dean of academic affairs at Drexel University's College of Computing & Informatics, and as program director in the Division of Research on Learning at the National Science Foundation (NSF).

Brian co-directs Boston College's M.A. in Learning Engineering, a new program on applying the principles and methods that guide student learning to design engaging and effective learning experiences. A 1991 graduate of the University of California at Los Angeles in computer science and engineering, Smith earned a Ph.D. in learning sciences from Northwestern University. He began his academic career at the Massachusetts Institute of Technology's Media Lab, followed by appointments at Pennsylvania State University as associate professor of information sciences and technology, and the Rhode Island School of Design as dean of continuing education, where he oversaw the development of art and design programs for youth and adults, and was a co-investigator in RISD's "STEM to STEAM" initiative.


Click on image above to watch.

## Cy Keener

Cy Keener is an interdisciplinary artist who uses environmental sensing and kinetic sculpture to record and represent environmental phenomena. He is an Assistant Professor of Sculpture and Emerging Technology at the University of Maryland's Department of Art. Recent work includes installations that visualize rain, wind and ocean waves. He received a Master of Fine Arts from Stanford University, and a Master of Architecture from the University of California, Berkeley.

Cy has completed commissioned installations at Stanford University, the Scottsdale Museum of Contemporary Art and the Rubin Center for the Visual Arts at the University of Texas. Over the past year, he has presented his work at ISEA in Durban South Africa, the National Academy of Sciences in Washington D.C., as well as The Nature Conservancy and The National Arts Club in New York.


Click on image above to watch.

## Susan Reiser

Susan Reiser works at the intersection of computer science and art, developing software and creating tangible forms. One large and exciting project she worked on is an animatronic sculpture fabricated at UNC Asheville's STEAM Studio and installed at Times Square. The figurehead design was the student project in a Mechatronics capstone class co-taught with Professor Emeritus Rebecca Bruce. The students were also mentored by Sara Sanders, Linnea Linton, and Brent Skidmore. The entire sculpture was designed and constructed by students, faculty, and staff, under the art direction of Mel Chin. Susan teaches STEAM (STEM + Art) courses at UNC Asheville in the Departments of Computer Science, New Media, and Mechatronics; collaborates and teaches workshops and an introductory computer science course at Cherokee High School using culturally-relevant projects, and creates data materializations with Texas A&M's Courtney Starrett.

Susan's interests and publications are in 3D computer graphics, tangible computing, and computing in the arts. She thoroughly enjoys the creativity inherent in human-centered design and fabrication, and tries to convey that to her students. Before teaching at UNC Asheville, she worked in industry as a software developer and principal engineer. In addition to corporate work, she developed visualization applications for Duke's Electrophysiology Lab.


Click on image above to watch.

## Theo Watson & Emily Gobeille

Theo Watson is Partner & Creative Director at Design I/O. He is an artist, designer and experimenter whose work is born out of the curiosity and excitement of designing experiences that come alive and invite people to play. Theodore's work ranges from creating new tools for artistic expression, experimental musical systems, to immersive, interactive environments with full-body interaction. His recent work includes The Eyewriter, an eye-controlled drawing tool, Graffiti Research Lab's Laser Tag, laser graffiti system and Funky Forest, an immersive interactive ecosystem for young children. Theodore works together with Zachary Lieberman and Arturo Castro on openFrameworks, which is an open-source library for writing creative code in C++.

Emily Gobeille is is Partner & Creative Director at Design I/O. She is an artist and award-winning designer who specializes in merging technology and design to create rich immersive design experiences. Working in concept development, visual design, interaction design and creative direction, her experience over the past eighteen years spans many disciplines, including web, print, motion graphics, games and installations. Emily's unbound energy and affinity for telling stories lends to her playful approach to projects. With an emphasis on meaningful interaction and systems built to support open play and discovery, her work creates a sense of wonder and delight.


Click on image above to watch.

## Courtney Starrett

Courtney Starrett is associate professor at Texas A&M University in the Department of Visualization and holds the Harold L. Adams '61 Interdisciplinary endowed Professorship in Visualization. Her work has been exhibited nationally and internationally, is included in permanent collections at the Mint Museum Uptown in Charlotte, NC, and Center for Contemporary Art & Culture at Pacific Northwest College of Art in Portland, OR, and has been published in print in periodicals and books *such as Metalsmith Magazine*, *How Design Magazine, Taiwan Craft Magazine*, *Art Jewelry Magazine*, *Cast: Art and Objects*, *500 Necklaces*, and *500 Plastic Jewelry Objects*.

Courtney's innovative design workflow utilizing data as a raw material as a base for the design of 3-dimensional objects, *data materialization*, has been published in a leading journal on the application of science and technology to arts and music: *Leonardo (MIT Press)* and cited in forthcoming the *Handbook on Human Computer Interaction* (Springer; 1st ed.2023) chapter on Data Physicalization (Dragicevic, Jansen, and Vande Moere, 2019). She has served as an ACM SIGGRAPH volunteer on conference planning committees and subcommittees for more than a decade in roles such as the 2014 Studio chair, the 2019 Emerging Technologies chair, and the 2022 Community Engagement chair.


Click on image above to watch.

## “Challenges & Opportunities” – A Community Town-Hall

The first day of the workshop ended with **a community town-hall meeting**, where workshop participants – presenters, and audience members discussed challenges and opportunities in the synthesis of arts and algorithms.


Click on image above to watch.

## “Looking Forward” – A Panel with NEA / NSF staff and other experts

The second day ended with **a panel featuring NSF and NEA program directors, and other experts**, discussing the past & present, interacting, and offering a broad perspective on the future of funding and public policy in the field of Algorithmic Arts. The rest of the report captures and analyzes contributions from these two events.


Click on image above to watch.

## Workshop Questions

The participants were asked to contribute answers to the following four questions prepared by the NSF / NEA Advisory Committee.

### Questions

- **Q1:** What are the main challenges and bright spots in your work to integrate arts and computing?
- **Q2:** What can funders, higher education, and other discipline-specific orgs do to advance the field of AlgoArts?
- **Q3:** What partnerships and resources are needed for the future of AlgoArts?
- **Q4:** What are your "go-to" AlgoArts resources?

The following sections provide an overview and highlights of the responses.

## Participant Responses

72 participants contributed answers to these questions either during the workshop or afterwards (via a post-workshop survey).

The following sections provide a summary from aggregating various comments / answers, for each of the questions (Q1 – Q4 above). These answers were provided by the workshop participants during the community town hall, the NSF/NEA expert panel, and the on-line comment mechanism (chat), during the workshop; and afterwards, via the follow-up online survey. In the interest of space / brevity, only some (but not all) of the comments have been included, as specific exemplars. Also, the essence of what was contributed collectively by all participants has been preserved – to the greatest extend possible.

### Q1. Main Challenges and Bright Spots in Integrating Arts and Computing

Speaking about combining science with the arts, Iannis Xenakis said in 1975:

- "From here nothing prevents us from foreseeing a new relationship between the arts and the sciences, especially between the arts and mathematics: where the arts would consciously "set" problems which mathematics would then be obliged to solve through the invention of new theories." [5]

There is **significant research indicating that combining computing and engineering with the arts effectively broadens participation, as well as innovation and creativity**, e.g., see [1-25].

This section includes representative answers contributed to question Q1: "What are the main challenges and bright spots in your work to integrate arts and computing?". Some comments have been combined to increase cohesion, and to communicate similar ideas. Also, some comments have been edited for brevity, clarity, and anonymity, while preserving the essence of the contribution.

**Our biggest surprise** was the main barrier identified and reiterated by various workshop participants, namely **the disconnect between NSF's commitment to innovation, creativity, and broadening participation**, and how proposals that include an AlgoArts component are reviewed.

[5] Iannis Xenakis, Doctoral Thesis, "Arts/Sciences: Alloys, Aesthetics in Music", vol. 2, p. 3, 1975.

The first group of answers is from **researchers in academic STEM departments and universities, who would like to pursue AlgoArts research, but feel it is unsafe to do so, in terms of tenure and promotion** (and in extension, in terms of educating and/or attracting research students to pursue this creative line of inquiry). They state that having a sustainable, recognizable source of funding for this type of research, will make university administrations (and, in extension, tenure & promotion committees) recognize AlgoArts research as a bonafide research field, and thus make it "safe" to pursue, in terms of tenure and promotion.

They state that creating particular AlgoArts works, as well as new theories and technologies (e.g., think HTML) to create such works through computational, engineering, and mathematical means… should count as valid STEM or STEAM research.

The following comments emerged in the Community Town Hall and NSF/NEA panel discussions. They relate to the above issue, and provide more detail. Comments have been edited for brevity, clarity, and anonymity:

- "We had to hide our real [AlgoArts] work within the proposal, and our creative backgrounds… we had to deemphasize the creative aspect of the project – in order to get funded."
- "I've been on many NSF review panels, and one comment I have about the infrastructure… or culture is this: Whenever I advocate for a proposal that has an arts or design element in it… that proposal always gets sidelined against other proposals that focus mainly on the discipline… it never gets funded."
- "We just did a large collaborative grant proposal [with another large STEM institution], and the BPC component was 100% STEAM. The reviews came back and effectively said: 'What is this thing?' "
- "This might not be true in the education directorate… but in the core research areas, we need to reset the conversation… to understand that AlgoArts research (or research that includes AlgoArts elements) is, in fact, research."
- "We have been passively-aggressively putting (hiding) art into our NSF proposals."
- "In other solicitations, such as the IUCRC, someone has to tell people that either (a) AlgoArts research counts, or (b) carve out an area where AlgoArts researchers are in competition with one another – and not in competition with, say, a robotics initiative, or medical surgical research, or environmental flood sensing… otherwise AlgoArts proposals will never get foregrounded."
- "The EU has a similar problem with silos. It has addressed it with the Creative Europe program. In its first phase, it had a budget of € 1.47 billion (2014–2020). Currently in its second phase, it has a budget of € 2.44 billion (2021-2027)."

- "NSF has a lot of academics, so a lot of these silos – [the ones] we have been talking about during the past two days – carry over into the agency; also it is a government agency, where there are various institutional things happening. The goal of this workshop has been to begin looking into ways to deconstruct these silos, and to begin moving forward."
- "There have been specific solicitations like CreativeIT… that have spurred interesting AlgoArts work… and that has also elevated these kinds of collaborations in the eyes of my institution."
- "Having a specific solicitation that invites AlgoArts collaborations makes this a real thing – people are willing to contribute their energy and time. "
- "We got great results from the Computing Innovation Fellows program. Have NSF create a pool of Algorithmic Arts fellows. This will highlight and elevate the field, and bring some distinction to these practitioners."

The following is a representative subset of comments contributed on-line via the survey, or during the meeting. They paint a similar picture (again, modified for brevity, clarity, and anonymity):

- "A main challenge is in balancing the need to produce work that my tenure committee will recognize as "worthy" of a CS department, and in pursing more experimental and risky avenues of research."
- "The challenge always remains establishing recognition of arts/technology/innovation integration. We are constantly pushing for recognition of the value of the arts in our STEM-centric university, and the benefits of arts-integration for cross-campus coordination in pedagogical planning and research development."
- "The evolution of our understanding of what is [the synthesis of] art and computing. Exciting as they evolve [together]. Challenging in that they continue to be viewed and funded as separate activities, brought together only in unique or elite contexts."
- "Challenge - Established software engineering culture - lacks diversity in many ways, and acts as gatekeeper to creative technology. Bright spot - live coding culture, where communities and technologies develop together, and people dance to algorithms."
- "Main challenge is access to tech, research/artistic creation funding, and also space."
- "Teaching large-scale classes involving arts seems much harder than teaching large-scale pure-computing classes. Bright spot: getting CS students enthusiastic about arts, or vice-versa."
- "Since AlgoArts is inherently interdisciplinary and collaborative, it is challenging to bring together the right experts and create that synergistic environment, without the work overwhelming you, and taking even more time than just doing a project (or class) alone. [Specific funding would help alleviate that.]"

- “Bright spot = seeing young people get inspired by the convergence of art and computer science. Challenge = getting the adults (parents, counselors, administrators, politicians, etc.) to see the arts as being just as important, and even integral to STEM.”
- “Main challenges - limitations of my own understanding and lack of available opportunities. Bright spots - this [AlgoArts workshop] grabs the attention and interest of people who can be extremely influential in securing more funding for state and city government projects.”
- “Challenge - Finding opportunities for recognition for arts-focused work that will count towards tenure. Bright spot - wonderful collaborations!”
- “I work with students who are deeply invested in intersectional work around engineering and creative practice. The primary challenge, to my mind, is convincing folks that arts practice can be research a priori, rather than an add-on for, e.g. pedagogical purposes (e.g. most STEM -> STEAM).”
- “The main challenges have to do with existing between the two worlds [science and art]. While my CS department is very supportive, there is a lot of gray area in what an [AlgoArts] “research agenda” [should] look like, and how to evaluate different kinds of scholarly activities. (I am post tenure decision, but I made this transition in the middle of that process which added a fair amount of stress.)”
- “Another challenge is finding interesting collaborators. Very few members of our faculty across the arts have interest in computational methods, and the few times I managed to get a collaboration started, retirements, or moves have brought them to an end prematurely. [Specific funding would help alleviate that.]”
- "Beyond a few exceptions, there are relatively few venues or institutions that are actively interested in presenting algorithmic and computational art. Or when they do, it's often part of a specific niche overview (see: The Whitney's ‘Programmed: Rules, Codes, and Choreographies in Art, 1965–2018’).”
- In our work with [system X], we've seen incredible power of [the arts] to drive engagement and intention to persist in computing amongst diverse K-12 student populations and learning contexts, and we've been able to reach over [a significant number] students… A persistent challenge is designing creative computing environments that privilege open-ended expressivity for students, while still motivating them to develop their computing knowledge (and not just settle for coding practices that are not particularly algorithmic).”
- “Bright spots: growing interest in the nascent field. Opportunity for artists and presenters working in this field to create new platforms of presentation (online, museum, apps, AR/VR, etc.). Another bright spot is the growing community (see Processing Foundation, Processing Community Day, as examples), and increased related education programs within higher education."
- “Main challenge: silos. Bright spot: the first integrated workshop on NEA/NSF :-) ”

- “I am fortunate to be in an academic environment that not only values, but also encourages interdisciplinary collaboration for these types of projects. That said, gaining funding to achieve this work has been challenging.”
- "Main challenge is to find enough funding, so that these creative and interdisciplinary works could be tested and researched in the collaborative domains within the fields of movement and dance... Bright spots are the creative processes, and the actual impact of this work on the lives of a multitude of people, in my 50+ years of teaching and creating.”
- “[Our institution] has an administration that actively encourages collaboration between disciplines, and has provided [a lot of infrastructure and space] – these are my bright shining spots. Challenges are and have always been [related to] operational funding.”
- “The lack of resources for teaching & [research]. We have the computing power at [our large institution through an industry partnership], but it seems like a parasitic relationship due to being cost prohibitive for running research studies & incorporating [findings] into the class. We're building an open educational resource to generate shared modules for teaching, but often the materials are not friendly to artists, and require translation to be useful to teach art students.”
- “One aspect of the silo problem, or the lack of respect on different “sides” of campus relates to the notion of “research”. This means something specific in sciences and engineering, and is also critical in arts and humanities, but they can sometimes use such different language and seem so different that that might be one place where the communication and mutual respect might be challenging. One specific example - in engineering, publications are sometimes a proxy for research success, but artists don’t “publish” in the same way as engineers. And engineers don’t show their work in public settings the way artists do.”
- “Bright spots involve fertile opportunities for interdisciplinary collaboration, and for exploring conceptual material outside of the scope of other art fields. Challenges include educating some collaborators/faculty/artists in other fields, on the status of media technologies as art materials in their own right, and with their own relevant social, cultural, political and other conceptual concerns – rather than as purely technical support for other traditional art forms.”
- “[Main challenge is funding] for developing a [particular art-specific tool] that I utilize to engage youth in coding.”
- “The main challenge is finding collaborators in the arts who have the time, the space, and the support to engage in interdisciplinary collaboration. The main bright spot is the increased creative energy and novel suggestions and ideas that come from having interdisciplinary collaborators.”

## Q2. Things that funders, higher education, and other discipline-specific orgs should do to advance the field of AlgoArts

This section includes representative answers contributed to question Q2: "What can funders, higher education, and other discipline-specific orgs do to advance the field of AlgoArts?". The majority of the ideas was covered in the previous section, under main challenges. Additional ideas are presented below.

Some comments were combined to increase cohesion, and to communicate similar ideas. Also, comments have been edited for brevity, clarity, and anonymity, while preserving the essence of the contribution:

- "Introduce the AlgoArts field to the broader scientific, technical, and higher education community. Things as simple as plugging interesting work on the NSF Instagram page, or a 'feature piece' in Science or Nature journal would be of great benefit."
- "Normalize mainline federal research funding in STEM to allow for application areas in arts & design. This should include not only education funders (STEM+C, ITEST, etc.) but funding in doctoral fellowships (S-STEM, NRT), integrative NSF programs such as CPS and Expeditions, and entrepreneurial programs such as ICORPS/SBIR/STTR/TTP. It's frustrating in the extreme to have proposal after proposal effectively sidelined because the arts aren't considered to be research-worthy areas of investment, given that New York City alone has an $11B media economy."
- "Offering many small grant opportunities would provide recognition to researchers in this space that would be valued by external committees. Also, for many in the AlgoArts space, small / seed grants can go a long way. Younger faculty who have been through degree programs in AlgoArts need to aggressively seek funding sources in other than the usual places. I got an NSF grant for visualization research that drew heavily on the work of composer Iannis Xenakis. Some of the important work in computer music was funded by DOD grants for work in helicopter noise reduction. At [large, research university], the challenge seems to be the silo-ing of arts fields within the College of Creative Arts. Arts funders can encourage interdisciplinarity and consolidation/sharing of technological resources by tying funding opportunities to values of cross disciplinary collaboration."
- "The collaborative, co-creative and generative workshops described by the keynote speakers are so central to new work, and meaningful collaborations. Yet, they seem difficult to fund. There's much to learn in how we fund and develop interdisciplinary communities."
- "There needs to be clear and explicit support for arts-based approaches for NSF programs like AISL, ITEST, STEM+C, etc. and the BPC initiative overall that see the

support of arts professionals working in technology as valid, relevant, and necessary STEM career pathways."

- "Connect artists with each other, and bring awareness to the ways in which artists are utilizing CS to advance the field of AlgoArts."
- "Funding needs to be made available for trans-, inter-, cross disciplinary groups to further investigate this area. Funders can help us with equipment grants. Higher education can help offer flexibility for team-teaching, but that also comes down to $, so it also comes back to the funders."
- "Create funding sources and opportunities to support transdisciplinary approaches that fall between areas with standard metrics. Recognize 'generalists' that may not have traditional accomplishments in one area, but who can serve as interdisciplinary translators and leaders."
- "I'm nearing the end of my career, so what's right for me is probably not right for others. In higher ed, there probably has to be more understanding of algorithmic arts in terms of tenure and promotion: For computer scientists, is building an artwork counted as a publication? If so, how? For artists, who are often used to having a primary artist, what does collaborative art mean?"
- "Funders: Residencies are nice (computer scientists in art departments, artists in computer science departments). Summer retreats or stipends, perhaps? More workshops like this one. (Thanks for hosting it!)"
- "Bit of money would help."
- "Explicit funding support for practice-based research/research-creation in art and technology (e.g. support for PhD and MFA students). We need more research beyond tool-making and other engineering-centric research for the arts."
- "Create contexts in which artists, educators, and computer scientists can come together to brainstorm ideas. Celebrate work in both academic and broader cultural contexts. Create funding streams that explicitly create space for this kind of work, to avoid the disciplinary bias that can sometimes otherwise creep in."
- "NSF – please include more interdisciplinary reviewers."
- "Keep offering grant opportunities! Finding funding for the arts is hard… finding funding for the AlgoArts, even harder, and finding funding for CS folks doing AlgoArts from traditional funding outlets like the NSF is as difficult. Years ago, the NSF had a CreativeIT solicitation. It would be nice to see something like that again."
- "Look to K-12 educators and teaching artists for more creative and integrative approaches to teaching. Fund arts integration training for professors. Support the arts and STEAM programs in the local communities where colleges and universities are located. Require cross discipline collaboration every so many years in higher ed institutions."

- “Fund work that is a balance of the technology and science and the art. Work that sits at this balance but doesn't tip the scale heavily to either side doesn't have a home yet, it seems to be of interest, but not fitting funding criteria clearly.”
- “Currently, I think this field has a lot of potential to grow. Of course, more funding opportunities, workshops, grants, and conferences geared to this theme always help. These are not only networking opportunities but also ways to continue to validate the field and attract newcomers to the field.”
- “At [major research institution], we're lucky, because the institution (through [industry] investments) has made a commitment to hire a large number new faculty in AI (several of whom have gone to the arts) & to prioritize socializing AI across the curriculum. In the College of the Arts, we're designing a new program, building a Center for student-faculty research, an artist-in-residence program, an annual convening, journal & more. We also want to spearhead a nation-wide coalition of other institutions doing the same. Funders could support curricular & research initiatives, but also facilitate cross institution dialogue. Funding an infrastructure for open-source resource sharing is key.”
- “In terms of students of color, funders could offer paid internships to learn AlgoArts concepts and techniques.”
- “I’d like to see funders and discipline-specific orgs supporting mentorship and internship type opportunities outside of academia (think “Google Summer of Code” but for the arts). Higher education could invite outsiders in more often, and provide better funding. Guest lectures/workshops and adjunct positions pay notoriously poorly. There is also a big missed opportunity in connecting people in “tech” to the arts. Thinking of Youngmoo Kim, there are tons of MIR-type researchers who are just working at places like Spotify, but they could be a great resource in education if there was a bridge.”
- “Assist in the development curricular materials to develop cohesive degree programs - that's our greatest need as we organize our degree programs. One faculty member [at my large, research university] has said, what's different from simply art? Algorithms are just another tool, like paint and glazes. Our campus is starting up related programs and activities in CS, art, theater, English, info science, journalism, art history, architecture - creative coding is becoming background, like writing. Defining CITA sharply will assist us in distinguishing our program.”
- “Higher education administrators need to support faculty in computing / arts who want to learn cross disciplinary skills and recognize publications and performances that may be in the complementary discipline's venues. For example, a faculty development grant should support an artist who wants to take programming classes, or vice versa.”
- “Have funding to support faculty training, course development, to support student learning, research, and presentations, and to turn created arts into real products so more people will appreciate the power of algorithmic arts.”

## Q3. Partnerships and resources needed for the future of AlgoArts

This section includes representative answers contributed to question Q3: "What partnerships and resources are needed for the future of AlgoArts?". Some comments have been combined to increase cohesion, and to communicate similar ideas. Also, some comments have been edited for brevity, clarity, and anonymity, while preserving the essence of the contribution:

- "Training workshops for artists. NSF+NEA small grant program (~ $10k) available to researchers outside CS (even though I am in CS myself) would have high impact in the community. Lots of open-minded artists, humanities, imaging specialists, meteorologists, and scientists to work together to uncover new dimensions of trans-, inter-, cross-disciplinarity in arts, humanities, sciences and technology."
- "Since different experts need to come together with classes in the cross sections of CS and Arts, making it easier for two or more faculty to collaborate and teach (in our case let the faculty have a co-taught class count as one of their classes) and receive the full credit for it."
- "Resources that are needed include access to equipment, education and presentation opportunities for independent and emerging artists. Partnerships that are needed include high-quality, accessible presentation venues that are open to experimentation."
- "Access and funding to bring AlgoArts into more public school classrooms."
- "There needs to be better engagement around leveling up research practices in the discipline to embrace not only the tools and toolkits per se, but exhibition and engagement strategies, the use of AlgoArts technologies in second-order research areas, such as rehabilitation, citizen science, art / music therapy, etc."
- "Partnerships with game and game audio engine companies (Wwise, FMOD, Unreal Engine, Unity). Partnerships with community organizers so as to bring interactive music and arts out of the concert hall and into public spaces."
- "True and honest recognition that corporate sponsorships or philanthropy usually comes with very visible and invisible strings attached. Can there be some middle-ground between the NEA and NSF, funding-wise that aims to truly support independent artists at ALL stages of their career – beginning, emerging, mid-life and the well-established?"
- "Something that would be lovely for people getting started and/or rebuilding a [degree] program would be a single location with pointers to books, curriculum, syllabi, lessons, labs, etc. for multiple (programming) languages, parts of the arts (music, photo, movements, etc.), people interested in collaborating (and in what), etc. Lots of amazing things out there, but it can be a challenge to curate the overwhelming body of knowledge."
- "I would like to see more of a deliberate community (which I hope this is the start of). It would also be nice to establish a regular conference / meetup dedicated specifically to

the AlgoArts. There are a number of conferences that acknowledge the arts with a separate arts show (like Vis, SIGGraph, ICCC, DIS, CHI, etc...), but I would love to attend one a conference that was just dedicated to it. ISEA is nice, but the algorithmic element is not as emphasized. The EYEO festival has some of that vibe, but, to return to one of the challenges for an academic working in this area, EYEO provides few opportunities for displaying/presenting/participating."

- "NFTs have made it clear that many artists working with tech/code/digital art are in need of basic financial support and better communities. We must build these resources without relying on financialization and assetization of art."
- "More support for conferences that combine communities of computer science, creative computation, visualization, performance, etc."
- "Help establish interdisciplinary and intra-disciplinary partnerships, inclusive of the many, small-, mid-, and big-level creative tech companies. I know several creative tech business individuals – the amount of stunning research they are doing in industry is amazing, and should absolutely be integrated into a comprehensive plan. I was really impressed with the partnerships presented during the workshop. It seems there are some important collaborations going on, and funding opportunities being utilized."
- "Provide support for Museums to include AlgoArts exhibits and installations, especially (online and face-to-face)."
- "Provide support to organize networking events, but also even some short-term projects where people with tech and art background can apply, and have organizations (such as museums or galleries) gather them, evaluate them, and display them. Need for more venue support: both new institutions such as galleries/project spaces, as well as support for 'traditional' institutions like museums to present this work."
- "Partnerships with mainstream and grassroots arts and cultural organizations across the widest possible definitions of art; deliberate work to make these approaches accessible; partnerships with university and K-12 leaders."
- "Provide opportunities for more industry engagement with academia in the algorithmic arts."
- "The workshop was a good start...it's nice to get the 2 sides (art and tech) talking. Targeted conferences in AlgoArts would be nice. More visible, reputable spaces for exhibitions, performances, and (post-pandemic) conferencing (hats off to the Eyeo/InstInt Festivals). More related conferences and journals, to get more visibility and interaction."
- "Produce a taxonomy of resources to create computer art. That would be a guide for would-be participants. It should cover tools from the basic ones for computer-aided illustration to the advanced tools like those exhibited in the Algorithmic Arts workshop. Offering a set of free tools would be an incentive for would-be participants to join the AlgoArt community."

- "NEA and NSF to come together to find ways to support these projects. Museums to understand their significance (as some already are) and help to archive and sustain exhibitions (more digital arts conservationists)."
- "Time is the key element. And in order to get time, money is necessary – either in the form of course release, or for advanced/grad student support. In order to bridge with the non-university community, money needs to be made available to bring in outside partners, as opposed to relying upon donations/volunteers [as many AlgoArtists do now]. As with any partnership; mutual respect, consideration and flexibility are imperative. At an institutional level, interdisciplinary collaboration must be encouraged."
- "Grants and funded opportunities where the collaboration between the arts and sciences is based on seing both sides as equal partners."
- "Strategic (non-parasitic) partnerships with industry (i.e. all the usual bedfellows) to underwrite the prohibitive costs for computing power, as well as providing residencies for faculty & internship for students. Shared open-source resources & data sets; something akin to Neil Gershenfeld's database of 3D printing models."
- "We can build shared repositories of teaching materials and textbooks and online tutorials. We need more resources like those from Daniel Shiffman at NYU. A shared list of conferences and performance venues and grant opportunities would be helpful too."

## Q4. Existing AlgoArts resources

This section includes representative answers contributed to question Q4: "What are your 'go-to' AlgoArts resources?". Some comments have been combined to increase cohesion, and to communicate similar ideas. Also, some comments have been edited for brevity, clarity, and anonymity, while preserving the essence of the contribution:

- "A great book recently supported by NEA – 'Code as Creative Medium: A Handbook for Computational Art and Design', by Golan Levin and Tega Brain: https://mitpress.mit.edu/books/code-creative-medium"
- "Lots of great arts + science examples in this 2018 report 'The Integration of the Humanities and Arts with Sciences, Engineering, and Medicine in Higher Education: Branches from the Same Tree', https://nas.edu/branches"
- "John Maeda's How to Speak Machine is also a helpful resource – https://howtospeakmachine.com/"
- "Matlab and the Matlab community, Dyalog APL and that community, GIMP, MS Paint, and my background in Music and Computer Science."
- "This excellent list of software and resources for live coding https://github.com/toplap/awesome-livecoding"
- "ACM, IEEE, ISEA conferences, collaborative rapid prototyping workshops, Slack channels, forums and user groups, and various co-labs (i.e., collaborative professional learning opportunities that bring educators together to learn, innovate, and lead)."
- "We work in the non-profit arts community. The best 'go-to' resource that we have is the community of artists who are creating works in this genre. They are the best resource to bring in new information and they also are willing to share their information. As a follow-up, [our AlgoArts organization] needs resources such as equipment and funds to hire expert programmers and instructors to support those artists who want to expand on the shared knowledge and take it in their own new direction. This activity is time-consuming and takes place over extended periods of intense development."
- "We've succeeded in Cultivating Ensembles to have a balance of performance/art inform STEM – http://CultivatingEnsembles.org"
- "All my attention has pivoted to curators, artists, educators, and journalists on Twitter, which works as a kind of locus of activity that points to other resources—latest IDEs, art + code tools and tech, critical writing, etc. Also the many people who have been through the Eyeo festival."
- https://openframeworks.cc, http://www.isea-web.org
- "SIGGRAPH and occasionally SIGCSE libraries / video resources. Web searches."

- “SIGGRAPH, Leonardo, Computer Music Journal. “Pure Data, freeRTOS, linux and the community of [developers who] maintain them.”
- “Leonardo is at the top of my list. I also like to look back at books on algorithmic art from the 1960's. I find James Clayson's work inspirational.”
- “Alliance for the Arts in Research Universities (a2ru).”
- “A new term rolling around is anti-disciplinary... The Frank-Ratchye STUDIO for Creative Inquiry at Carnegie Mellon University is an example of an "anti-disciplinary" research laboratory that brings together inter-institutional research at the intersections of arts, science, technology and culture: https://studioforcreativeinquiry.org/”
- “Currently Python Turtle, openprocessing.org, shadertoy.com.”
- The Processing Foundation, Nature of Code, Coding Train, P5JS tutorials, W3Schools, Facebook groups on Creative Coding, Touch Designer Tutorials, Movement in Computing Conference, CHI Play, and SIGGRAPH Educators Forum.
- For all my classes, I have built my own; very tailored to my specific courses. I have yet to find a "go to" aggregate resource. Some links I've come across as models for a shared resource: https://www.indigenous-ai.net/; https://alliedmedia.org/resources/peoples-guide-to-ai; https://aiartists.org/ (missing many people).
- “As an algorithmic music composer and creative, I use mainly JythonMusic (http://jythonmusic.org), and Processing / p5.js. I also create lots of custom code. In terms of conferences, I prefer ICMC (International Computer Music Conference), NIME (New Instruments for Musical Expression), ISEA (International Symposium on Electronic Art), and a few others.”
- “A decent (if incomplete) list of graduate programs around the world that engage in art/tech/design – https://bit.ly/AlgoArtsGraduateSchools ”
- “International Conference on Auditory Displays (i.e., sonification) - icad.org.”
- “Processing.org, Hyperallergic, YouTube, Computer Arts Society (London), SIGGRAPH, ISEA, ICCC (Intl Conference on Creative Computing)”
- https://processing.org, https://natureofcode.org, https://p5js.org, https://opencv.org
- “NIME (new interfaces for music expression) community, Create Digital Music (https://cdm.link), research papers, etc.”
- “Seeds/Procjam; the algorithmic arts community on the Fediverse/Mastodon (alternative to Twitter); private Discord groups (p5.js, babycastles, conditional studio, livecode.nyc); tutorials on youtube; Coding Train; Workshops at Processing Community Day NYC; HOLO magazine”
- “Leonardo LASER talks, ISEA (International Symposium on Electronic Art), The Computer Art Society, The Generative Art Conference."
- “I had to invent many of my own resources because it is difficult to find a good, comprehensive resource for technical people diving into this area.”

- “Georgia Tech's GoSTEAM is a great resource. A2RU is focused on R1s but is also a great resource.”

## Conclusion and Recommendations

An opportunity exists to alleviate the silos of science, technology, and arts fields through continued sharing of expertise and support across the National Science Foundation and the National Endowment for the Arts.

A diverse and capable workforce is vital to maintaining the nation's standard of excellence in STEM: science, technology, engineering and mathematics.

AlgoArts research, practice, and education synthesize technical knowledge in computing and engineering with artistic and design skills from studio, performance, music and other arts.

AlgoArts degree programs combine creativity, problem solving, and computational thinking to prepare students for graduate school, careers in technology and arts industries, or careers with companies that need creative software developers and engineers. This innovative STEM field **brings needed diversity and creativity to traditional STEM fields**.

The workshop brought together **422 researchers, educators, and practitioners**, who combine computing, engineering, and the arts. These are literally the Leonardo da Vincis and Ada Lovelaces of our time.

The breakdown was **46% female, 2% non-binary, and 52% male**, which is typical for Computing in the Arts degree programs (vs. 17-22% female participation in CS and Engineering).

This statistic demonstrates that the AlgoArts as an area of STEM inquiry, clearly addresses NSF's commitment to *Broadening Participation*.

### Discussion

The biggest surprise at the workshop was the **major disconnect between NSF's commitment to innovation, creativity, and broadening participation**, and how proposals that include an AlgoArts component are being handled by the NSF review process.

"We had to hide our *real* work within the NSF proposal, and our creative backgrounds… **we had to deemphasize the creative aspect of the project – in order to get funded**." [6]

[6] Stated by an AlgoArts professor in a large, research university, in "Looking Forward" – a panel with NEA / NSF program directors and other experts – see http://algoarts.org/videos/

Workshop participants who have been funded by NSF agreed that this is usually the case. [7]

This points to a **deeper, systemic issue**:

While **NSF is committed to innovation, creativity, and broadening participation**, and while **AlgoArts research and pedagogy demonstrably bring innovation and creativity, and broaden participation**… it is very hard to get such projects funded. Participants stated repeatedly that it usually takes careful retargeting – to hide the creative aspects, and the potential aesthetic / creative motivations of such projects. This is usually done by disguising them as case studies, or leaving them out completely – and focusing instead on creating STEM theories and technologies, in a strict / narrow sense. This removes most or all strength and legitimacy of innovation and creativity, and of broadening participation that the AlgoArts bring. In other words, this diminishes / acts against / undermines what should set them apart, in the first place.

**For comparison**, the Creative Europe program, which supports related programs, had a budget of € 1.47 billion in its first phase (2014–2020). In its second, on-going phase, it has a budget of € 2.44 billion (2021-2027). [8]

## Recommendations

Given the above, a ***primary recommendation*** from this workshop is to create a special AlgoArts funding program, possibly with the collaboration of the NEA, to foster new research and development in the Algorithmic Arts. Research and development support is primary, since, in order to develop expertise in teaching, people need to learn how to create and run such projects, before they can turn around and write the papers and textbooks that will promote education in this field. Research always fosters and precedes education. There are certain cases where this has happened already (e.g., with large projects, such as Georgia Tech's EarSketch and MIT Processing), but such funding is limited, and is usually directed towards big / established universities or organizations that increase the certainty of success, without any risk taking to support true, out-of-the-box ways of thinking and potential for innovation.

As this workshop has shown (e.g., see Appendix), there are many academic researchers, educators, and innovators in the US, who are eager to pursue research and development, and pedagogy in the Algorithmic Arts. These are the innovators – the Leonardo da Vincis, Ada

[7] See survey results – in this report.
[8] See "EU Funding Overview – Creative Europe" – the European Commission's flagship program to support culture, technology, and creativity – see https://eufundingoverview.be/funding/creative-europe/

Lovelaces, Thomas Edisons, and Tim Berners-Lees of our time. However, such projects cannot easily happen without the safety and time availability that comes from knowing that your university administration will consider your work appropriate, and meaningful for tenure and promotion. This usually translates to a singular metric – is it fundable? Scientist + Artist teams need to be encouraged and rewarded for pursuing work that brings diversity and creative innovation into STEM, and helps address the Broadening Participation problem in such a powerful and decisive way.

Workshop participants who are academic researchers in STEM departments or universities clearly and strongly demonstrate the following (e.g., see the workshop talks – accessible in video through links embedded in this report):

- Creating AlgoArts works, as well as new theories and technologies to create such works, through computational, engineering, and mathematical means… is clearly valid STEM research, and should be considered as such in terms of NSF (or joint NSF+NEA) funding opportunities.

A ***secondary recommendation*** is to **add a requirement, or extension to existing funding opportunities**, to include a STEAM component to grant proposals. This will invite STEAM researchers to NSF review panels, and **ensure that STEAM components are given the proper attention they deserve**, instead of counting against the fundability of a project (as stated repeatedly by various participants during the workshop).

These two recommendations:

- establish a creative, AlgoArts-specific funding opportunity, and
- add an AlgoArts extension (or component) to existing funding opportunities,

**will directly address NSF's commitment to innovation, creativity, and broadening participation**, by infusing new and creative ideas into traditional STEM fields, and by increasing diversity – in significant, measurable, and sustainable ways (see [1-25]). This reframing will recognize and support the technological innovation and societal significance of meaningfully and sustainably combining the creative – art and design – with science, technology, engineering and math (STEM + Art = STEAM).

Additionally, continued sharing of expertise and support across the National Science Foundation and the National Endowment for the Arts presents a wonderful and timely opportunity to bring together arts fields with computer science, engineering, and technology.

## Closing Statement

In closing, the following paragraphs adapt NSF's commitment to *Broadening Participation* statement and enhance it with the findings / recommendations from this Algorithmic Arts workshop:

One demonstrable way to broaden participation is by combining computing and the arts (see [1-25]). While this technologically innovative and creative field – the Algorithmic Arts (or AlgoArts) – maintains depth and quality in STEM research and education, especially in computational / algorithmic thinking and engineering, it opens new avenues for scientific and technological excellence, and creative achievement, being part of the new movement to combine art and design with science, technology, engineering and math (STEM + Art = STEAM).

This is consistent with the National Science Foundation's **commitment to expand the opportunities in STEM to people of all racial, ethnic, geographic and socioeconomic backgrounds, sexual orientations, gender identities** and to persons with disabilities.
It is also consistent with its **commitment to value diversity and inclusion**, to demonstrate integrity and excellence in its devotion to public service, and to **prioritize innovation and collaboration in supporting and enriching the work of the scientific community and of each other**.

**AlgoArts is STEM** – it is deeply rooted in computing, engineering, and math.

As demonstrated collectively during this workshop, AlgoArts projects:

- broaden participation;
- foster excellence in innovation and creativity;
- establish new theories and techniques; and
- enrich society and the nation.

However, as was revealed during the workshop, most AlgoArts researchers have to **hide or disguise** their artistic influence, their strong innovative and creative merits, and their societal contributions – lest they be turned down by NSF reviewers. The frequency and consistency of this came as a surprise to the organizers. This is the biggest contribution of this workshop.

We recommend that **a funding program and/or funding extensions dedicated to the Algorithmic Arts** – with explicit research and education components – together with specific **new review criteria** that expand and inform NSF's standard review criteria – consistent with the findings of this workshop and elsewhere – are created. This will help **address NSF's commitment to innovation, creativity, and broadening participation in significant,**

**measurable, and sustainable ways**, for the foreseeable future. It will also expand creative, and out-of-the-box (silos) thinking in traditional STEM labs and research areas.

This strategic investment will **advance and enrich NSF's Broadening Participation in STEM Portfolio** — and will **introduce new, innovative, and diverse approaches to build STEM education and research capacity, catalyze new areas of STEM / STEAM research, and develop strategic partnerships and alliances**, for years to come.

Similarly to how this AlgoArts workshop was organized, we hope to see continued efforts to bring together science, technology, and arts fields through sharing of expertise and support across the National Science Foundation and the National Endowment for the Arts.

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## Appendix – Participant Areas of Expertise and Interests

The following is a representative subset of the 422 attendees, in terms of their areas of expertise and interests in the Algorithmic Arts. This information is provided to help the reader gauge the range of interests, and caliber of people who attended this workshop. This list is NOT parallel to the list of workshop contributors presented earlier (and has been edited to preserve anonymity):

**Question:** What is your interest in the Algorithmic Arts?

- New forms of art – targeting AR/VR/mobile devices, etc. I work in industry for a big corporation interested in the same.
- I care about developing theory, tools, and techniques that enable programmers to make the change they want to see in the world. I largely work in algorithmic music synthesis, as a way to help users explore and understand code. I am particularly interested in the domain of computer music as a frontier to explore new interaction modalities in the programming process.
- I co-teach a course called "Art, Interactivity, and Robotics" where students learn to build interactive sculpture. Students use Arduinos combined with physical constructions made from wood, metal, and other materials.
- I am a former musician, turned mathematician. Now I am a dean of math and engineering in a relatively large institution.
- Dialogue and collaboration between CS and the arts can facilitate generation of new knowledge toward bettering the human condition. I am a music university professor.
- I am a science-arts integrator, champion, and mentor. My primary modality is sound.
- My university is a STEM+ Research1 university in the heart of a major urban core. As algorithmic arts relate to cross campus collaboration, collective thinking and doing, as well as technology for the community, the subject matter is most interesting and relevant to our work.
- Audio Focused Computer Scientist / Digital Artist / Electronic Musician
- My main interest lies in bringing non-CS or non-technical majors into the space of CS (not to have them major in CS necessarily, but to have them break down their fears and

barriers to enter the field, and explore the field as they see fit in their studies and careers).

- I'm a researcher in AI and creativity from a major university. I teach expressivity in programming. I have co-founded an online learning environment that uses music as an inroads to programming. It has a very large number of users.

- As a computer scientist (professionally) and an artist (amateur), I appreciate the way algorithms and computing can serve as tools for the arts. I also like computational image making as a way to broaden participation in computing. I'm particularly struck by the approach of James Clayson's "radical bricolage", although I have not truly embraced it in my own courses. I also appreciate the overlaps between algorithmic art and conceptual art.

- I am a computer science and mathematics professor who recently became interested in creating digital art after having done abstract mathematical Lego art for several years. I am just getting started in digital art and plan to teach an intro algorithmic art course as a follow up to a Python programming course.

- I am an artist and composer working with technology for over twenty years; I was project manager and engineer for ten years at a major company that produces [a well-known software used in the algorithmic arts], and have contributed to other creative coding toolkits including p5.js. I am also on the engineering faculty at a major research university, and co-direct their [algorithmic arts] program. I am co-PI / senior personnel on multiple NSF grants that look at ways in which creative expression can be used integratively with [important] scientific research questions.

- I work in industry creating software for interactive music. I am a classically trained musician with a Ph.D. in the Algorithmic Arts.

- I am researching creative computing platforms and ways AI can enhance the workflows for artists and creators. I have a Ph.D. in robotics.

- My background is both art and tech, and I have terminal degrees in each. I am always trying to find ways to make my intro classes more interesting than the standard stuff that appears in intro texts.

- We developed a computational thinking course which heavily based on having students create artistic drawings with code.

- My research/creative endeavors have somewhat recently shifted from visual analytics into the algorithmic arts. I have also long used media computation as a key component of my computer science courses, especially at the introductory level.

- I work in the Algorithmic Arts, biometric sensors, telematics, machine learning, AI, brain computer interfaces, natural language processing, and computer vision

- Composer and programmer working independently in generative music.

- I think that Algorithmic Arts can be a great way to interest more women in the field. I worked in Fashion Tech and taught P5.JS. I am always trying to find new creative ways of teaching computing.

- I'm a software engineer and working in a big tech company. While I am continuously improving my programming skills, art is my passion. My aim is to bring my profession and passion together in the future.

- My research focus is on CS education at the intersection of music and computing in K-12 contexts, and as chair of a music department at a major research university. I lead interdisciplinary degree programs, and help steer the university's strategic plan in the Algorithmic Arts.

- I am an artist working in creative computation. I create procedurally-generated art, and organize Processing Community Day – a day to celebrate art, code, and diversity – in a major US city. Also, I teach history of algorithmic art and current approaches, as a university professor in the intersection of Algorithmic Arts and Computer Science.

- I work across disciplines in the arts and computer science, as a university professor at a major research university.

- I am a Computer Science professor at a major research university. My research agenda includes producing distributed live theater and dance performances using Virtual and Augmented Reality technologies.

- I am a media artist, educator, and new media developer. I am also a professor at a major research university, exploring interaction and games. I am interested in the Algorithmic Arts as a means of computing education; also as a medium for sometimes meaningful (and sometimes simply mood-setting) artistic expression.

- I approach some of my professional art work (textile and digital arts) within the framework of algorithms, procedures, and iterations.

- I am a professor of computer science at a liberal arts college where we encourage connections between the disciplines. My primary research interest is approximation algorithms, but given the size of our college, I teach a wide range of courses.

- I am a computer engineering professor at a major research university. My interests lie in developing computational methods for analyzing paintings, i.e., computational art critique.

- I am professor of Dance at a major research university. I do collaborative research in the intersection of machine learning and movement, dance and somatic learning. I am also interested in using AI to explore design and creative performance in my work.

- As an architecture professor, I specialize in digital rendering, among other areas. As a way to advance my work and set it apart from others, I create algorithms and use coding to generate new textures and architectural styles in my work.

- I am a professor at a major research university, and the director of an Algorithmic Arts department. I specialize in using data to create new physical renderings and artistic sculptural forms.

- I am a generative artist and an HCI researcher at a major university. I work and teach in algorithmic art. I am interested in designing traditional physical art & craft (e.g., embroidery, painting, soft-material art) through algorithmic approaches. I am particular interested in developing algorithmic design tools for artists.

- I am a professor and director of an arts department at a major university. I am interested in the application of cinematic tools and strategies to non-traditional spaces, either site-specific or digital. My background and training is in filmmaking and in recent years, have expanded into areas such as social sculpture and installation.

- I am a professor at a major university, also the developer of a well-known environment for computer-aided composition and performance in the Algorithmic Arts.

- The research I've undertaken for my PhD in Film and Media Studies consists in bridging pioneer video art to current algorithmic arts (machine learning, generativity) through the prism of the medium's original agency.

- I am university professor at a major research university. My art practice is in the intersection of environmental, ecological, and algorithmic art. As an artist-educator, many of the students I teach are pursuing Computer Science: Bachelor of Arts degrees and take new media courses. I am interested in promoting my own research and the research of undergraduate students interested in algorithmic art.

- My creative practice & empirical research employ AI & biometrics. I am also co-creating a new Algorithmic Arts program at a major research university.

- I am a professor of African American Studies at a major university. I am working on a computer science pathway program, and I think art is a great way to connect with young people.

- As the director of an undergraduate algorithmic arts program at a major research university, and professor in this program and in computer science, I am very interested in developing excellent courses and programs in the algorithmic arts, supporting faculty research and grant activity, working with departments across the campus on collaborative programs, and organizing events on campus to promote algorithmic arts.

- My research in scientific data visualization and algorithmic generation of music were my starting points. I create digital tools for both digital visual art and algorithmic music. I am a retired professor of music and computer science at a major university.

- I am a university professor in dance and artistic director of a dance company. As an artist, I use coding to expand visual frontiers in dance. As an educator, I use dance as a tool to teach basic CS concepts and get youth from underrepresented communities engaged in coding.

- I am a professor at a liberal arts college. My teaching and outreach activities apply programming visual effects, motion capture, and eye tracking to motivate interest in math and computing and accessible interfaces. My research work builds collaborative tools and human-in-the-loop intelligent assistants for storytellers and movie makers.

- As an applied mathematician and a computer science/data science professor, I have strong interest in the arts personally, and often see students who are drawn to computer science, but also have interests in the arts. I plan to offer a new course in which extends the traditional "Analysis of Algorithms" course to explore the creative side of algorithms. My university recently acquired [and merged with] a private fine arts and design college in the area, which created a great opportunity to synthesize talents and offer new courses for students.

- As a professor in the arts, teaching across disciplines with computer science, I am interested in Algorithmic Arts.
- I co-teach a course every other year in interactive sculpture. Students learn physical construction techniques and ideas, and bring the interactivity to life via Arduinos.
- Our college is exploring the intersection of STEM and the Arts.
- As a creativity expert, I'm interested in all types of arts. I am also a musician, arts manager, and lover of interdisciplinary arts.
- I've used algorithmic arts as a motivational tool in introductory CS. I develop strange computing arts tools based on functional programming models.
- My background is both CS and art. I am always trying to find interesting ways to combine the two, and show my students there is more to CS than coding loops.
- I am a CS professor interested in the merging of VR/AR with theatre, music, and the performing arts. I have been running courses that combine these disciplines for the past 20 years.
- I'm currently making computer-assisted visual art, and also collaborating with other artists in creating works involving dance, music, and visual displays. I began this work before the Personal Computer had become ubiquitous. I had to use analog synthesizers, theatrical lighting equipment, and colorized video at that time. Now everything is much easier.
- I work in film and real-time visual effects.
- I have long been an advocate for building bridges between computer science and the arts. I bring artistic practice into a number of my courses, including one dedicated purely to algorithmic and AI-based artistic practices.
- I am interested in viewing computer science as a liberal art. This includes the intersection of art and science, especially how algorithms are used in the arts.
- I work with an arts and data group on my campus. I'd like to know of more resources that intersect computational sciences with the arts.
- Interested in learning about how others use art to teach computer science concepts.

- I have taught several introductory CS courses based on the concept of algorithmic art. One of my research areas is in using graphics and music generation as a means of learning functional programming.

- My "paintbrush" as a maker/artist is code. My specialty as an educator is using algorithmic arts to teach foundations of computer science.

- I teach in [an AlgoArts degree program at a large, research university]. My role includes helping students learn to use code as a medium.

- I recently became interested in algorithmic art and will be spending my sabbatical this spring learning more about it and developing a class related to it.

- I am an artist using machine learning and software in the generation of visuals and text. My art explores the co-evolution of humans and technology, and the impact these have on our society, culture, environment and psychology.

- I am a professor of social psychology and cognitive science who investigates the relationship between human biases in social cognition and algorithmic bias.

- I am a creative coder working at the intersection of art, aesthetics, and machine learning (ML).

- I am an Arts researcher in machine learning, visualization, critical code.

- I am a practitioner with both an MFA and a BS in computer science and applied math focused on algorithms.

- I have been a practitioner and teacher of algorithmic, generative, and procedural art-making for many years. I am the founder and past director of an MFA [related to the AlgoArts, at a medium size university]. This is a performing arts MFA that includes programming specifically, as a means of facilitating interdisciplinary artistic collaboration, and collaboration between artists and scientists. I have been a co-PI on funded NSF grants.

- I'm an artist, composer, and software engineer and have worked on multidisciplinary open-source projects in creative technology for over 20 years; in addition, I've received support from the NSF for research on cyber-physical systems, human-centered design and XR, and disability research.

- My research focuses on AI & computational design, and the development of deep learning strategies for architecture and architectural design process.

- I teach digital art at the university level inside a school of Art. We need to understand how the computer is a creative tool for fine arts and design.

- I am interested in how to advance developments in the arts from the digital domain, both for the artists as for audiences and funding possibilities. Related to this: what is going on with artists and NFT's, how to make sense of this new value system.

- I develop programs for arts students throughout the SUNY System of 64 campuses. I hope to be inclusive of the art tech students in the programs I develop and administer.

- Looking to expand what I can offer students. I currently teach coding based poetry workshops occasionally.

- I teach architecture and rendering at [a midsize university]. In my personal work, I explore how to use algorithms to generate texture for digital renderings of buildings and their landscapes.

- I am an artist who works with video, digital media, and machine learning. I also teach digital media, AI, and AR.

- I am a university professor. I hope to learn how to integrate art with electrical engineering education and research.

- I am interested in computational approaches to the humanities and the arts. We are working on several interdisciplinary programs along these lines in our college.

- I am interested in how art can affect understanding of and participation in science in general and want to understand how computing, digital familiarity, and arts can interact.

- My interests examine the potential of the dynamic relationships between machine learning and human movement capacities. I work from geometric and spatial patterns, influenced by the work of Laban's theories, in the development of performance work, as well as somatic approaches to examine the potential for partnerships of machine learning and human capacity through movement.

- I am a university researcher integrating multi-modal sensing – combining music data with motion capture, EMG, eye tracking, etc. I am interested in continuing to develop means of evidenced-based music teaching/learning, and opportunities for healthy aging and development.

- I am a university professor in a music department, and also have my own startup developing interfaces and game controllers. I am interested in creating new digital instruments

- I am currently a PhD student in computer graphics; as an undergraduate I was a double major in CS and Studio Art, with a focus in painting/drawing. Algorithmic arts are a fascinating, creative field that is more prevalent and important than is often taught in conventional art history or AI courses. It bridges the perceived intellectual gap between STEM and the Arts, and can be a highly engaging educational tool.

- I am working with faculty across the college on creating more opportunities for interdisciplinary work.

- I teach Creative Coding along with other HCI courses to university students. Within my own studio practice, I'm studying the bias of algorithms and how such algorithms create a digital bias and taint AI systems, further perpetuating racism.

- I have been teaching artists to using programming and other digital tools since 1979. I am interested in hearing new voices.

- My teaching and research activities involve developing animation and graphics tools to support artistic creativity using motion tracking and immersive displays.

- I teach digital art and design.

- I teach at a large research university. I want to learn more about how we can incorporate media computation in our courses.

- I support interdisciplinary research at my university, and I'm always looking for opportunities to connect arts faculty with different types of STEM researchers.

- I support research development at an Ivy League school, for the faculty in the arts, humanities, and social sciences.

- I am a director of Research Development at a large university. I would like to learn about funding opportunities in this area and how to best foster collaborative projects in the Algorithmic Arts.

- I have been involved in the development of the algorave algorithmic dance music and toplap live coding movements, the algomech festival on algorithmic and mechanical movement, and the TidalCycles environment for live coding algorithmic patterns. Currently starting a four-year research fellowship titled "Algorithmic Pattern",

investigating how heritage algorithms can inform the design of new creative technology.

- My large research university has recently launched a broad AI initiative, and I am responsible for supporting our Arts & AI faculty cohort.

- I facilitate a program "Code Can Dance" that uses the arts (dance) to teach coding to BIPOC communities and bring awareness (arts advocacy) to real-world problems and issues.

- "The intersection of art and technology has raised many thought-provoking questions; ranging from what's next for the art world to how you can calculate abstraction to whether beauty is just the arrangement of numbers. As an architectural engineer, I have learned to question and decode how everything is made. In my perspective, generative art is about discovering new ways to express your inner feelings. I envisage creating innovative solutions that would make society better, more sustainable, and meaningful. Generative art might be a bubble but 'bubbles always happen around things that change the world' as Mike Novogratz argued."

- I'm hoping to learn about new way to engage students to learn about how computing impacts all aspects of their lives and in turn broaden their participation in the computing sciences.

- I run a lab that studies and incubates Algorithmic Arts with a focus on documentary media.

- I have a BFA in painting and a PhD in computer science, with my dissertation in computer graphics. I am eager to learn what others are doing in this area.

- I do a bit of K-12 STEAM outreach and engagement, using the Arts (music, media arts, puppetry, comedy, poetry and story telling) to engage and reach under-served/under-represented youth who might not naturally gravitate towards STEM. Looking forward to connecting with others doing the same type of engagement and education.

- I am a computational artist. I love to see the interaction between natural rule systems and computational rule systems, across visual and sonic arts but also deep into more conceptual and performative spaces. A big part of my background is in "generative art" and "interactive art" and these things still have a huge influence on my practice.

- I am executive director of a foundation supporting nonprofits that build stronger communities in inner cities. I believe it important that our organization understands trends and the challenges of arts and humanities organizations so that we can be

supportive. Part of the support is to be able to connect groups to resources, but mostly to understand.

- I am a program director of an independent organization providing funding for the avant-garde art, especially forms that may be vulnerable due to institutional neglect, cultural bias, their ephemeral nature, or politically unpopular content. I am interested in this workshop for both my personal practice and to understand projects of artists we support.

- I am department head of Art History at a midsize university. We are conducting a study in the use of AI in all areas of the institution, including the arts.

- I am program manager at a funding agency. We want to explore creating programming and funding opportunities around tech in the arts.

- We build connected learning spaces across the US, and I am working on incorporating more humanities and arts into the initiative, so combining art and digital literacy more intentionally.

- As a curator, I collect histories of computing and media. As an artist and writer, I engage with these things in my practice.

- I fund and produce emerging-tech projects. Mostly by Black creative technologists.

- I am an artist working with Max, Arduino, Ableton, TouchDesigner, and other algorithmic media tools. I also teach and work in a staff capacity helping [my university's] art students and faculty with media components of their productions.

- I am a professor at a large university. I am interested in best practice applications of a hybrid computer science + arts curriculum, as well as learn about independent grant/funding opportunities in the field of new media arts.

- I'm an industrial designer and product design professor who works with digital technologies in my teaching and research. My interest in this convening specifically comes from my work with wearable technology and dance.

- I am an artist working with computational methods.

- I am a computational designer and researcher who runs a lab focused on the intersection of machines, materials and narratives. My lab pursues formal design research through software, hardware and material experimentation with extensive exploration of digital fabrication methods and material innovations. Additionally, the

lab explores enhanced interaction scenarios which deploy embedded technology including a variety of electronics, sensors, robotics and micro-controllers. Our recent multi-year project [...] examines speculative robotics and synthetic ecologies for the near future. Our outputs include writing, film, objects for exhibition and collaborations across science, technology, engineering, fashion, art & design.

- I am university professor. I have had an interest in generative design since 2010 and its use to engage my students to voluntarily write more code, visualize the algorithms they develop, and embrace the benefits of stochastic methods in particular. Not being a fine artist myself, I hope to contribute my programming skills to project teams lacking skilled programmers.
- I am artist who has worked in the field of art & technology for over two decades.
- I manage a funding portfolio, and am eager to continue deepening learning about and appreciation for this field, as well as looking for opportunities to create new interagency partnerships, funding opportunities, and support for creative practitioners working with computation and the arts.
- I am working on a funded project that aims to assist teachers to integrate computational thinking into middle school social studies, arts, and language arts instruction. This event will provide me further insights into our project.
- I teach in the intersection of arts and computer science.
- I am an AlgoArts curator at a large European university.
- I am an AR/VR designer and developer, in graduate school at a large research university, and looking to become an immersive artist. I'm so excited that an event like this is happening at all.
- I am the head of a startup developing systems for automated music generation in computer games.
- I taught "Storytelling with Code" last semester through the English Department at a large research university, an undergraduate course devoted to the computational arts, primarily computer-generated poetry. I have a strong foundation in the history of the subject, and several associated projects underway.
- I am a university professor creating a new Art & Physics module at the university and exploring creative ideas & links.

- After studying Art History and then working in art galleries for seven years, in 2021, I retrained to become a software engineer. I'm curious about the ways I can connect the two intellectual disciplines living in my head.

- I have used algorithmic methods to generate new artworks from a dataset of existing images, and I am a researcher focusing on using data-driven technologies to empower the creative sector through creating new modalities of experience, new business models, new ways of connecting with audiences, and unlocking the value of archives and data sets in the creative and cultural sectors.

- I am a university professor. I enjoy electronic music and minimalism and would like to combine that with computer science. I am looking for ideas for interest courses for my students.

- I am a professor of computer science whose primary research interest is Algorithms. I work at a liberal arts college where making connections between disciplines is actively encouraged, and there is great potential for connections between art and algorithms.

- As a math educator, and AD of a school with CS degrees, I'm constantly looking for ways to incorporate the arts.

- I'm interested in computers and music, in a broad sense, and in the use of topics from music in teaching introductory computer science.

- Years ago I used art to introduce students to programming with Logo. From simple geometric objects to string art to recursive algorithms (e.g. Koch Curve, Sierpinski triangle fractals, drawing trees, etc...). I want to learn more.

- My research focuses on the forms and legacy of feedback in video art from cybernetics to artificial intelligence. I investigate machine-learning art in the latter part.

- I am a university professor. In my PhD studies I encountered the book "The Algorithmic Beauty of Plants" by Aristid Lindenmayer and Przemysław Prusinkiewicz. One of the aims of art is to capture beauty (as in the beauty of nature), so I am interested in how the Algorithmic of Arts can synergize with scientific pursuits.

- As a director of our university's Center for Digital Learning I'm always trying to learn more about how to bring digital principles and practices to a liberal arts education. I'd like to learn about how other institutions are engaging with this work so that I can continue to foster it on my campus.

- I'm working on machine learning and Arts, my interest is developing a space of dialogue between AI and art at our university in collaboration with an affiliated research lab for intelligent systems. I'd like to get more insights into how the technology behind algorithms and arts work, since my background is in the social sciences. I'd like to learn about the social impacts the artists seek to make with their work and if there are any attempts to shift borders between the analog world and the virtual world. What questions are raised in the divergence, and what can we, as a society, learn.

- I am a composer and artist who's learning programming and AI in order to integrate technology as a prominent part of my creativity and artwork. Music with AI is a very interesting field with tons of discovery ahead and I want to be part of that development & education.

- I'm a software engineer and passionate art lover. Both of them take place at the center of my life. One side is professional, and one side is much in personal life for now. On future I want to merge those into one as my main job or additional personal projects.

- I am the director of IT at a large university. As an undergraduate student in the 80's I took a course in Video Art Making. This was one of my favorite electives. I interested in how I might be able to facilitate Algorithmic Art at my institution.

- I am a university professor. I am interested in this from the perspective of computational creativity (how can computers act in a creative way) as well as from a pedagogical point of view (how can artistic examples be used to motivate algorithmic and computational thinking).

- I direct an undergraduate major in "Digital Humanities" and have used digital research methods including text mining. I am interested in emerging large language models and how they may reshape creative writing, literature, and so on.

- I am a science-arts integrator, working for the US government. I work with scientists, politicians and artists, to promote sustainability, to foster research and cooperation, bringing together diverse stakeholders to find mutually beneficial solutions for protecting the environment while promoting responsible development.

- I am a professor at a large university. I am a game designer, and director of a research lab, working in the field of art games. I am interested in new forms art and play.

- I'm an algorithmic composer, using custom software to generate melodies and rhythms using numerous sources of environmental pseudo-randomness. While my work is

solitary, I'm interested in learning how algorithmic arts are and can be integrated into high school and higher learning curriculums.

- I am a leadership executive at a large technology company. I would like to learn more about ways to integrate coding into K-12.

- I am a university professor at a large research university. I am an artist who has worked in the field of art & technology for over two decades.

- As an intern at an interactive design studio and through working with the creative technology center at my university, I have seen firsthand the kind of wonder and excitement provided by the intersection of art and technology. As such, I'm really looking forward to hearing from others in the industry who have different experiences and perspectives than my own.

- I study science, art & engineering equally- devoted to the history and future of interdisciplinary inquiry. While at Carnegie Mellon, I studied how algorithms in computer science can be used to generate visuals- both physical and virtual. My ongoing research in art, algorithms & robotics at Virginia Tech, Princeton University, and, currently, at a [very prestigious university], has continued to be devoted to the aesthetics of artificial intelligence, the poetry of programming, and the potential for new forms of computational media.