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“Explorers of Unknown Planets”: Practices and Politics of Artificial Intelligence in Visual Arts

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Alongside recent advances in artificial intelligence (AI), a new art practice has emerged in recent years that borrows and transforms these advances in the production of artworks. The actors of this emergent practice are coming from contemporary art, media and digital arts. These artists have developed an original practice of AI within their creative field. In this article, we propose a qualitative study to explore the nature of this practice. We interviewed five internationally renowned artists about how AI is integrated into their work. Through a thematic analysis of the interviews, we first find that their practice relies on crafting algorithms and data as materials. We uncover how they explicitly use this material unpredictability rather than avoid it. Secondly, we highlight the politics of their practice that consist of resisting the culture of AI research, as well as its inherent power dynamics. We also highlight how their relationship with the technology is imbued with ethics and how they rethink their role with respect to the technology. In this paper, we aim to provide the CSCW community with a way to expand the framework in which AI can be understood not only as a tool but also as cultural and political design material.

CCS Concepts: • **Human-centered computing** → **Empirical studies in HCI**.

Additional Key Words and Phrases: AI-Art, Creative AI, Art & Technology, Cultural Studies

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1 INTRODUCTION

In recent years, the contemporary and media arts scenes have seen the emergence of a new movement involving Artificial Intelligence (AI), a set of techniques giving the machine the ability to perform high-level tasks such as, for example, image perception (recognition, detection) or image generation. The so-called AI-Art field has developed in the socio-cultural fabrics of the art world, with exhibitions in art galleries, national museums, and international festivals [11]. The name AI-Art evokes both the techniques involved in the production of an artwork (AI) and the purpose of the field (Art). Within this field, artists have appropriated state of the art AI algorithms to explore their potential for artistic creation. They have delved into the technicality of AI algorithms so as to re-purpose the algorithms’ original designs to their own personal expression, aesthetics, and meanings.

The emergence of AI in Art-making parallels the exponential development of AI that we have witnessed over the past decade in both academia and industry, encouraged by public and private incentives, with significant impacts on the creative and cultural sectors [10]. There are now

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50 numerous blog posts, reports, and articles in the media about AI and art practice. Among them, it
51 is striking to observe that the narrative tends to introduce AI in the creative sector through the
52 complexity of the creative tasks that the technology is capable of performing that were previously
53 reserved for humans. AI is depicted as contributing to the “escalation of creativity” where “anyone
54 can write at the level of Shakespeare, compose music with Bach, [and] paint in the style of Van
55 Gogh” [56]. In the same vein, and using the same narrative, the World Economic Forum has recently
56 published a report [28] on the impact of AI in the creative sector, providing a timeline where AI
57 will slowly manage to perform increasingly complex tasks such as composing pop songs, generate
58 creative videos or writing a bestseller book.

59 Once we leave behind the fantasy that AI will acquire human-like artistic genius and supernatural
60 skills, we can look at the complex ways in which artists are currently using AI to produce an artwork
61 be it visual, musical or performative. Researchers in HCI have started to investigate this topic. Recent
62 studies have shown how ML and AI can be used as expressive tools for music performance [25],
63 sound design [58], media art [3], or visual communication [43]. Overall, these works developed
64 systems and evaluated them with creative practitioners to assess how they allow them to conduct
65 specific tasks or explore more open-ended creative spaces. In this paper, we aim to go further by
66 studying how artists who evolve in the AI-Art field, with a long term experience of using AI in their
67 creative process, think, perceive and use AI in their art-making. Understanding the practice of such
68 artists is valuable to CSCW researchers and practitioners. It expands the frame within which we
69 (researchers) understand, talk about and design AI based interactive systems, and particularly for
70 creative applications. Beyond seeing AI as a tool to generate a solution to a problem, understanding
71 the use of AI in real world art practice allows us to consider it as both a design material and an
72 artistic material that practitioners can appropriate and a socio-technical object that has a political
73 and cultural impact.

74 Through an interview study with 5 world-renown contemporary visual artists, we explore how
75 AI shapes their creative endeavour. Our study not only sheds light on these particular uses of AI in
76 art, but also on critical aspects of how AI challenges notions of control, aesthetics and authorship
77 that are at the core of these artists’ identities. Hence, the contributions of this article are twofold: 1)
78 we highlight the characteristics of these artists’ practice with AI, especially the way they use it as a
79 creative material; and 2) we shed light on the cultural and socio-technical implications of involving
80 AI in their practice, in particular we discuss the political stance taken by the artists with regards to
81 the use of this technology. More generally, our paper contributes a critical understanding of how
82 the relationships that artists weave with AI generates both a practice and a new political discourse.

83 2 BACKGROUND

84
85 As a preamble, we start with a brief presentation of AI-Art within the longer history of works in
86 computational creativity. Second, we propose to clarify what “AI” means in this article, showing its
87 scientific and cultural components.

88 2.1 A Brief Presentation of Computational Creativity

89
90 The field of computational creativity aims at simulating human creativity using computational
91 tools such as algorithms, whether they are data-driven or not. Borrowing the words of Colton et
92 al., computational creativity research is: “*The philosophy, science and engineering of computational*
93 *systems which, by taking on particular responsibilities, exhibit behaviours that unbiased observers*
94 *would deem to be creative*” [13]. Computational creativity finds applications in music, visual art,
95 or writing [48]. One of the objectives of the domain is to build autonomous tools endowed with
96 creativity. A particular focus is put on modelling creative behaviours [62]. Another important
97 research direction is on creativity assessment [47]. Researchers have worked on methodologies to
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99 assess creative behaviours and reflected on what it means to be creative [41]. This is a particularly
100 important question in the field of AI-generated art, as discussed by Daniele et al. in [14]. Indeed, if
101 the answer to the question of whether a computer can be creative was most probably negative a few
102 years ago [12], recent advances in AI, especially in generative models, have revived the debate [35].

103 From an artistic perspective, the field of computational creativity finds its heritage in practices
104 that place processes and algorithms at the heart of creation. In visual arts, processes were for
105 instance used by Morris Louis in his paintings, in John Hilliard’s photographs, or Sol LeWitt’s
106 paintings. In music, Stockhausen developed serial compositions based on rules, and John Cage used
107 non-deterministic processes in his compositions. The contemporary community of artistic practice
108 that descended from these early experimentations goes under the name of computer-generated art
109 or algorithmic art. Part of this community thus evolved to explore the next generation of generative
110 algorithm that the AI research released, to form what now became the field of AI-Art¹.

111 2.2 Framing AI in Terms of Technique and Culture

112 In technical terms, we can think of “AI” as an umbrella term that encompasses a set of computational
113 techniques that aim at providing the machine (i.e. computer, smartphone, robotic device, etc.) with
114 the capacity to achieve high-level cognitive or sensorimotor tasks. As such, AI defines a research
115 topic studied across the fields of computer science, statistics, information science and engineering.
116 That being said, the term has recently been associated with more specific methods. Over the past few
117 decades, the evolution of machine learning has seen a breakthrough that has transformed the field
118 and given a modern meaning to AI. In 2012, an algorithm based on Deep Neural Networks (DNN)
119 was shown to largely outperform all other techniques in an image classification task [45]. Since then,
120 DNN-based approach has been the default method for many ML-related tasks: speech recognition,
121 image segmentation and recognition, activity recognition, strategy game to name a few. These
122 algorithms are capable of learning a rich representation from complex input modalities (image,
123 sound, video, motion) in such a way that the machine is endowed with the ability to recognize what
124 an image is made of, to understand what is being said in a dialogue, or to generate rich content
125 indistinguishable from real content. Generative models are maybe the most representative examples
126 of AI research borrowed and appropriated by artists [1]. Historical examples are Deepdream issued
127 by Google [52] (showing visually what the network has learned) and GAN (Generative Adversarial
128 Networks) [33], which works by training two models (neural networks) jointly: a generator intends
129 to produce images that can fool a discriminator, whose task is to classify the input image as ‘real’
130 or ‘fake’. Research in generative models led to impressive and realistic results in image or speech
131 generation. Consequently, the terminology used has changed from ML to AI concomitantly with
132 the increasing complexity of the tasks handled by the technology.

133 From a cultural perspective, the AI topic has been widely addressed in Western culture before the
134 development of the academic field, and its modern incarnation through DNNs. In a recent UNESCO
135 report [46], Kulesz argues that already in the *Iliad* “there were mentions of automatic tripods,
136 fashioned by the god Hephaestus to carry out his tasks”. Western culture imagined very early on
137 other types of intelligence and how human-made techniques can automate the tasks we have to
138 do. In other words, culture and science have worked together on shaping “AI”, perhaps without
139 being fully aware of it. Indeed, AI generated content is far from being culturally neutral. Beyond
140 how AI algorithms are imbued by the representations, values and belief of whoever developed
141 them, the data itself used to train them are culturally-dependent. The content chosen (images,
142 sounds, videos) as well as the annotations associated to them (typically in supervised learning)
143 stem from one or several socio-cultural contexts. A lack of awareness of these contexts can lead to
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146 ¹<https://thegradient.pub/the-past-present-and-future-of-ai-art/>

148 harmful consequences as shown, for instance, in the studies on skin color bias in facial recognition
149 databases [8]. Now that AI is mostly defined as the set of learning functions from data, we argue that
150 both the cultural and scientific domains have an even bigger role to play in the general discourse on
151 AI and its applications. Both aspects, AI as subject matter and AI as a tool diffusing and re-shaping
152 culture-imbued content, are elements that we find relevant to investigate through the study of AI
153 artists' practice.

154 Therefore, in this paper "AI" will involve two sides. On the one hand, we refer to AI as the
155 research discipline interested in computational learning as a subject matter, with a particular
156 interest in DNN-based machine learning algorithms. On the other hand, we refer to AI as a cultural
157 object in the sense of a technology stemming from a collective cultural history as well as built from
158 culturally-curated data (e.g. images) and deployed within a socio-cultural context.

160 3 RELATED WORK

161 Researchers in the field of Human-Computer Interaction and Social Computing have investigated
162 the way artists and creatives are interacting with AI and ML in their creative process. In this section,
163 we review previous works looking at AI and ML as creative tools, especially in music and visual arts.
164 We then review works that proposed to formalise this technology as a (creative) design material.
165 In the final part of this related work, we report on works investigating the cultural and political
166 dimensions of the integration of this technology into artistic practice.

168 3.1 Using AI as a (Co-)Creative Tool

169 The literature in HCI shows a long history of works investigating art making [36, 39], art recep-
170 tion [21] and creativity [65]. There are multiple conferences that emerged from the particular
171 interests of HCI in art such as C&C (Creativity & Cognition) that deals mainly with the design and
172 research about creativity support tools or NIME (New Interfaces for Musical Expression) for musical
173 interaction research or MOCO (Movement Computing) for research around movement and dance.
174 Within these communities, HCI researchers have investigated how artists use AI in their creative
175 process. Given the generative nature of AI algorithms, researchers have looked more particularly
176 at how AI algorithms work along the artists to co-create artworks. Among the existing research,
177 we can cite applications in game design [34], fashion design [40], moodboarding [44], abstract
178 drawing [16], or music [30, 49]. In this line of work, researchers typically propose off-the-shelf AI
179 algorithms to be used by artists that are not involved in their development nor their training.

180 However, the opportunities that AI and particularly Machine Learning (ML), the technology at
181 the core of it, offer is to allow users to shape the behavior of the algorithm by having an agency
182 on the training pipeline. In other words, instead of explicitly programming a system, an artist
183 could define desired behaviors through examples of those behaviors [25]. This approach is what
184 HCI researchers called Interactive Machine Learning (IML) [2, 23, 32]. IML supports ideation and
185 exploration during the creative process by promoting tight interaction cycles between users and
186 each element of the ML pipeline. It enables artists to build complex interactive scenarios through
187 demonstration, as it has been shown by Françoise et al. in gesture-based interaction [29]. It has
188 been also used to create original mappings between data from multi-dimensional interfaces and
189 sounds or visuals [42, 61], or between dance movements and sounds [53]. In the field of music
190 performance and NIME, Fiebrink et al. showed that music performers rely on alternative evaluation
191 methods (in comparison to those used in conventional ML) in their use of supervised ML as a tool to
192 build mapping between gesture input and sonic outputs [26]. Scurto et al. [58] recently proposed a
193 reinforcement learning model that extends the scope of supervised learning and lets artists explore
194 a high-dimensional sound parameter space through user-provided preferences. Finally, in a recent
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197 article reflecting upon a long term collaboration between a researcher and an artist [27], the authors
198 reflected on the way ML behavior can be crafted in music performance.

199 This literature is growing larger as the HCI communities explore the possibilities of AI algorithms
200 as tools and co-creators in artistic contexts. We are interested in contributing to such research by
201 gaining a deep understanding of how artists develop a long-term AI practice.

203 3.2 Using AI as Design Material

204 Design research has formalised in many ways the extent to which computation is involved in
205 design practice. For instance, Vallgård and Fernaeus [64] discussed the concept of *Bricolage* as a
206 way to characterise the interaction design practice: *bricolage* implies working with imprecision,
207 without planning ahead, and leads to more culturally grounded artefacts. Then, viewing computing
208 as a design material has also invited practitioners to borrow concepts from physical design, such
209 as “craft”, for interaction design. While this notion translates well when dealing with digital
210 fabrication [63], its general application to computing materials have been discussed by Nitsche et
211 al. [55], who have emphasized the fact that a crafter in interaction design is a practitioner who
212 uses the computer more as media-creating tool than a medium [55].

213 In this context, an increasing number of researchers investigated to what extent AI can be
214 considered as a material to be crafted by practitioners in art and design. Such investigations have
215 made AI accessible to researchers, artists and designers [31, 54, 66]. We witness a growing number
216 of design research projects that use AI as a resource to critique and speculate on the use of AI
217 technologies in people’s daily lives [6]. However, considering ML (at the core of many current AI
218 techniques) as a design material leads to many difficulties. Dove et al. [20] and Yang et al. [67]
219 conducted interviews with UX designers and analysed their design process and understanding.
220 They show that UX designers are not trained to integrate ML as material into their design and
221 that the collaboration between designers and engineers is usually not design-driven, but rather
222 technology-driven [20]. Recent research [68] also identified different levels in ML systems in which
223 designers encountered problems. The main challenges are to understand ML capabilities leading to
224 difficulties to collaborate with engineers and envision novel and implementable ML solutions for a
225 given design problem. In practice, prototyping with material such as ML is therefore difficult as ML
226 greatly differs from the type of tools designers use: sketches, film techniques, plans and physical
227 models made of paper for instance. Indeed, ML involves novel workflows for prototyping [20].
228 On the one hand, designers need to consider the long-term dynamic interplay of ML and human
229 intelligence such as co-adaptation mechanisms [32, 50]. On the other hand, designers need to
230 consider the dependence of the system outcomes with the training data.

231 To address the challenges of collaborations between artists and engineers, Scurto et al. [57]
232 proposed an alternative that implements pluri-disciplinary “intra-actions” between collaborators
233 allowing them to integrate AI as a design material mediating these exchanges. The authors present
234 two projects using diffractive methods [4] in the creation of AI-based artworks involving both humans
235 and non-humans collaborators bound together within these complex socio-material contexts.

236 This literature shows the opportunities and challenges of considering AI and ML techniques as
237 design material, the handling of which involves various stakeholders and requires careful hybrid
238 collaborations. We are interested in contributing to alleviate such challenges by studying artists
239 who have developed a long-term involvement with AI as a creative design material.

241 3.3 Cultural Politics of AI in Artistic Practice

242 The involvement of AI in the Arts, as any technology, is not neutral. Researchers in HCI, CSCW
243 and related fields have investigated AI from a cultural perspective, highlighting cultural, political
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and socio-technical characteristics that are enacted by algorithms [19, 59]. However there is little research investigating the cultural and political underpinning of AI in artistic practice.

Looking at the practical use of AI in the wild, two recent works have adopted an auto-ethnographic approach to analyze the cultural and political dimensions of AI use in this context [9, 24]. Caramiaux and Donnarumma [9] described five years of researcher-artist collaboration using AI in body-based performances. They reflected on the methodology used to collaborate and the technological shift from shallow ML to AI (i.e. deep learning-based methods). Interestingly they also reflected on the way ML as a tool became a non-neutral tool that steered the performances towards more critical and political consideration of the technology. In another example, Fdili Alaoui [24] discussed, as researcher and choreographer, how the integration of technology, in particular ML-based systems, in her dance piece SKIN created tensions with the knowledge she was expected to deliver.

To the best of our knowledge, there are no studies beyond these few ones that consider the political and socio-technical impacts of using AI in art-making. Our paper contributes to bridge this gap as we aim to understand through our interviews how technology defines and frames a practice as well as the social, political and cultural underpinnings of integrating it in art.

4 METHOD

In order to investigate how AI as a technological innovation nurtures an artistic practice, we built a corpus of interviews with internationally known artists who are working with AI. We asked them about their relationship with AI, how they use it, how they define it, and how they relate to it in their creative practice.

4.1 Interviewed Artists

We interviewed the following five artists, listed by alphabetical order:

- **Memo Akten** is an artist, experimental filmmaker, musician and computer scientist. He works with emerging technologies and computation as a medium, to create images, sounds, films, large-scale responsive installations and performances.
- **Jake Elwes** is a media artist. Recent works explore their research into machine learning and artificial intelligence. Their practice looks for poetry and narrative in the success and failures of these systems, while also investigating and questioning the code and ethics behind them.
- **Mario Klingemann** is an artist, who uses algorithms and artificial intelligence to create and investigate systems. He is particularly interested in human perception of art and creativity, researching methods in which machines can augment or emulate these processes.
- **Kyle McDonald** is an artist crafting interactive installations, sneaky interventions, playful websites, workshops, and toolkits for other artists working with code. He explores possibilities of new technologies: to understand how they affect society, to misuse them, and build alternative futures; aiming to share a laugh, spark curiosity, create confusion, and share spaces with magical vibes.
- **Anna Ridler** is an artist and researcher who works with systems of knowledge and how technologies are created in order to better understand the world. She is particularly interested in ideas around measurement and quantification and how this relates to the natural world. Her process often involves working with collections of information or data, particularly datasets, to create new and unusual narrative.

We report each artist's short bio in Appendix A. These artists have been among the pioneers in using state-of-the-art AI in their artistic works. They have used AI as a medium to primarily generate visual content. Importantly, they are all developing their own tools based on the latest AI

295 research. Therefore, they are not using off-the-shelf AI services, such as computer vision or natural
296 language APIs (Application Programming Interfaces) that include already trained models. All the
297 artists have shown their artworks in international exhibitions. They have also been involved in
298 discussions and round tables about the topic of AI in the Arts. Figure 1 shows an example of work
299 from each artist.

300 We contacted each artist via the Twitter platform or via emails. The interviews were conducted
301 online through the video-conference tool Zoom or Skype. Each interview lasted approximately 60
302 minutes and was conducted in English. We recorded the audio of the interviews and transcribed
303 them manually. The artists gave their consent to be named in this paper.

304 4.2 Semi-structured interviews

305 We conducted semi-structured interviews where we aimed at collecting stories and testimonies
306 on the way artists use AI in order to create artworks. To this end, we structured the interviews
307 according to three main points: the way they see AI (definitions, perceptions and aesthetics), the
308 way they use it (workflows, interpretations and evaluations), and the way they situate themselves
309 with respect to it (governance and ethics). For each question, we asked the artists to illustrate their
310 response with concrete examples of their work. We structured our interviews according to the
311 following foci:

- 312 • *Introductions.* Following a quick introduction by the interviewer, we gave the interviewee
313 the opportunity to give a general presentation of themselves and how they use AI in their
314 work, illustrated by a specific example of their choice.
- 315 • *Notion of AI.* We asked participants to define AI in their own words. We then asked them to
316 recount how they have come to use it in their practice and the kinds of opportunities and
317 challenges it creates.
- 318 • *Aesthetics.* We asked the artists the extent to which AI conveys an aesthetics and whether
319 and how this technology affects their own aesthetics.
- 320 • *Workflow.* We asked the participant to walk us through a concrete workflow that they have
321 using AI. We asked them to tell us about the AI techniques and data collection (model
322 architectures, trained models, datasets) that they use and how they change, tweak or adapt
323 such material.
- 324 • *Control and Interpretability.* We asked the artists whether their expectations match the
325 outcome and how much control or interpretability AI offers them.
- 326 • *Evaluation, Accuracy and Understandability.* We asked the artists about how they evaluate
327 the result of the AI and how much accuracy and understandability AI offers them.
- 328 • *Authorship and governance.* We asked the artists to tell us how they place notions of author-
329 ship and governance when it comes to using AI in their work.

330 4.3 Data analysis

331 From the interview transcription, we conducted a thematic analysis [7] method to extract themes
332 related to the use of AI in artistic creation. We (the two authors of the paper) analyzed the data
333 following a bottom-up approach where we actively defined and named themes, from participants’
334 stories.

335 Precisely, we familiarized ourselves with the data by reading the transcriptions independently
336 twice. Next, we highlighted quotes from the interviews that we identified as relevant to the research
337 question being addressed. Codes were generated by each one of us from the quotes. After this
338 coding step, we put the codes together and kept the ones that were identified by both of us. We then
339 discussed the codes that only one of us identified and kept some of them that we both considered
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A. *Journey through the layers of the mind* (2015)
[courtesy of Memo Akten]



B. *CUSP* (2019)
[courtesy of Jake Elwes]



C. *Decontamination Chamber* (2017)
[courtesy of Mario Klingemann]



D. *Discrete Figures* (2019)
[courtesy of Kyle McDonald]



E. *Mosaic Virus* (2019)
[courtesy of Anna Ridler]

Fig. 1. Examples of artworks by each of the five artist interviewed in this article: **A.** *Journey through the layers of the mind* by Memo Akten [Photo Courtesy: Memo Akten], showing the poetry of what is happening inside the algorithm; **B.** *CUSP* by Jake Elwes [Photo Courtesy: Jake Elwes] where the machine learns qualities of different marsh birds; **C.** *Decontamination Chamber* by Mario Klingemann [Photo Courtesy: Mario Klingemann] showing machine ‘learning’ bodies and identities in order to reveal blurred shapes and colours; **D.** *Discrete Figures* by Kyle McDonald, Daito Manabe and Motoi Ishibashi [Photo Courtesy: Kyle McDonald] explores the interrelationships between the performing arts and machine learning; **E.** *Mosaic Virus* by Anna Ridler [Photo Courtesy: Anna Ridler] shows a grid of continually evolving AI-generated tulips in bloom, bringing together ideas around capitalism, value, and collapse from different points in history.

relevant for the study. Once we agreed on the codes, we organized the codes under themes that we defined ourselves. This step of developing the themes was first done by each of us independently. We then put the themes together and discussed them to reach a consensus. We extracted 8 themes that we organized under two sections.

5 INTERVIEW RESULTS

We organise the themes that have emerged from our analysis according to two parts: practice and cultural politics. First, we report on how AI-Art is a practice, highlighting the experience and skills developed through the work with AI as well as the workflows in place. Second, we report on cultural politics of AI-Art, highlighting the ethical and socio-cultural tensions when using modern AI.

5.1 The Practice of AI-Art

We first examine the practice of AI-Art by highlighting how artists craft AI technology leading to a set of diverse and ad-hoc workflows. In addition, the practice of AI in art takes advantage of the inherent capacities of algorithms to generate surprises, glitches and errors. We report on the way artists build their tools and instruments in order to work with this material in an embodied way.

5.1.1 The central role of crafting. Although AI is an academic field, there are no scientific rules determining how AI should be configured in order to succeed on a specific task. We suggest that the concept of *crafting* best characterises the way artists work with AI algorithm as a tool and a material. From the interviews, crafting appears at different levels of the machine learning process such as the way to handle model training or building a training dataset.

First, working with AI is approached by artists through a concrete experience of the algorithm’s behaviors rather than a theoretical understanding of its capabilities. KM reported:

“It starts with a technique, with the technology. And I kind of manipulate and explore that tech until I find something that is compelling to me, something that has a story that I’m interested in sharing or [...] that I want to pull back for other people as well.”

Starting from the experience of the technology rather than its analytical understanding is therefore essential in the artists’ practice. This learning-by-doing approach leads them to develop specific skills related to the types of algorithms used. These skills do not refer to the ability to build better models in the sense of AI research (better accuracy, better data efficiency). Instead, they refer to the ability to better predict the behavior of the system, so that it is more in line with their expectations. We interpret this specific set of skills as those of crafting, in the sense that artists favour a direct relationship with the algorithmic and data material [63]. MK gave an example of crafting a model, by understanding its behavior when training an image generation model: *“I usually never wait until the end, I constantly watch it and while waiting I learn about the process too [...]. After a few hours, I look at it and try to estimate if this goes where I want this to go”.*

Crafting also appears on the way datasets are built in order to train a deep learning models. AR makes an explicit link between the act of crafting and the creation of the training set, as opposed to the creation of the algorithm:

“I actually think that there are a lot of parallel between craft vs art and dataset vs algorithmic output. I think there are a couple of things like the relation between craft which is anonymous and less well regarded, and how it’s repetitive, versus art. And when you see dataset [...], the datasets are anonymous, and nobody talks or speaks about them, they are there and people use them.”

In AR’s work, crafting occurs explicitly when collecting and building the training set. In addition, AR goes further by politicizing the analogy of the relationship between dataset versus algorithm and craft versus art: *“that kind of hierarchy between the algorithm and the dataset, is like the hierarchy between art and craft”.*

5.1.2 AI as a process and a material. Workflows adopted by artists involve tight interactions with the elements of the ML pipeline such as editing the dataset, or editing the model’s architecture

or parameters. Iterative workflows are fundamental, and shared among the artists, as it is nearly impossible to anticipate which model, and which set of parameters, will be suitable to carry out an idea. For example, AR explicitly describes her process as a combination of tweaking, iterating and playing with the algorithm:

“You start to find a model, maybe find a couple, and make it run on whatever it was trained on, see what the output is and work out if you can make it, start to tweak it like that, iterate it, and then update it and work with it there. Then iterate it because it’s never the first go, it’s never the first thing that gets produced, finding stuff to tweak [and] find the thing that will bring out the things that you want, add in flags, take things out, and then start to play with the algorithm, play with things like the epochs, test it... lots of testing to find whether it works. And then it comes out.”

AR says she focuses on having a general pipeline producing content she finds interesting. Then she starts to play with the model. The whole process involves a lot of iterations.

Each artist’s workflow also shows ad-hoc processes. For example, MK talks about the difficulty to balance abstract and concrete outcomes, which is very much related to his own work: *“I’m wandering between the two and the most interesting is between the two. Very abstract and very concrete, it’s a sweet spot that I’m always looking for. You think you see something but it’s ambiguous. Of course there are interesting juxtapositions of things that are novel”*. According to MK, the critical decision to make is when to stop training. In his words:

“I train the model and watch the training process and, well, there’s usually this transition from something that initially is very, very rough and unclear, and the longer you train the more details are added. You have to decide [...] when it is the moment, when you stop the training. Because of course there’s always too much training, it’s kind of going beyond the point where it is interesting in my eyes.”

Working with AI seems to imply favoring the process (i.e. the workflow) over the outcome because it is difficult to anticipate the result of a specific model with a specific dataset. As AR put it *“I try to use it both as a process and a material”*. JE describes his first works with AI as process-first rather than concept-first: *“not necessarily having a strong concept at first, thinking what if I can kind of stylize it with other images doing different things and seeing how that goes. I really admire that, and look up to that, but at the same time I’m also aware of wanting a kind of really nice, simple concept that isn’t about using technology in that way”*.

5.1.3 Working with AI is working with surprises. AI is used by artists because of its ability to provide surprising results, unexpected errors and glitches. This feature imparts a special appeal to AI as a working material. As KM put it when talking about his first works involving ML: *“That really made me feel like there was something magical in that system”*.

We found three dimensions related to the non-deterministic nature of AI. First, artists talked explicitly about the need for unpredictability and uncertainty. Second, the complexity of AI as a material, and the difficulty of predicting its outcome, seems to be a fundamental element of the expressiveness of the technology. Finally, the non-deterministic nature of AI leads to errors and accidents that can have a critical role in the creation of an art piece.

Unpredictability is an important feature that makes AI technology appealing in an artistic context. As MA said: *“My interest in AI started as an offshoot from this, exploring systems which have a mapping from inputs to outputs that are more nonlinear and more unpredictable than what I’m able to program”*. Indeed, provoking unpredictable behaviors by explicitly programming them is a challenging task. However, the challenge of working with AI seems to be finding a balance between desired unpredictability and unwanted uncontrollability. MK added:

491 *"If you give it too much information [in the training examples] then you limit the*
492 *range of results, or if you give it not enough then good things might be more accidental.*
493 *So you then try to get that sweet spot where the model has still enough freedom to*
494 *surprise".*

495 MK highlights the difference between what is considered as surprising, and therefore positive in
496 his process, as opposed to what is accidental, which relates to an uncontrollable event.

497 Unpredictability is related to a sense of expressivity provided by the algorithms at play and
498 the fact that *"the scope [of possible outcomes] is not defined"* (MA). Along this line, AR said: *"I'm*
499 *really interested in anything that can contain lots of information, or datapoints, or actions, or text,*
500 *or whatever. And then find gaps or silences, or hidden stories, or things that you might not expect*
501 *to be there".* Similarly, JE said: *"I am interested in finding the poetry in it, finding something that*
502 *it wasn't supposed to do or intended to do, and subverting it. I guess scientists are thinking in such*
503 *objective ways, like this is the practical purpose of this thing and artists stand outside and say what*
504 *if we get it to do this thing completely different".* Thus, AI is used as a means to enter a world of
505 data that is otherwise unreachable, and play with it as *"explorers of unknown planets"* quoting
506 MA. In some ways, this approach is reminiscent of the way John Cage used chance in some of
507 his compositions, the way Jean Arp used chance in his collages, or the way Jackson Pollock used
508 processes fundamentally based on unpredictability and uncontrollability in his paintings [11, 18].

509 Artists also highlighted the generation of mistakes and accidents by the algorithms. The notion
510 of mistake is intriguing as it involves the existence of a 'good' behavior that would lead to good
511 results. This conception of a 'good' behavior stems from the engineering culture of AI, within
512 which performance metrics are standardized. *"It's those mistakes that I think a lot of artists are really*
513 *interested in, and it's also those mistakes that software engineers, by-and-large working at companies,*
514 *are trying to get rid of"* as stated by AR. AR is going further saying that *"it's always a race where*
515 *software engineers are optimizing out the mistakes, and the artists who want to grab them, and use*
516 *them, and explore them".* Therefore one of the benefit is to be able to exploit the mistakes that AI
517 models are able to produce, but *"you have to manually make sure you only get the good ones"* as MK
518 expressed. MK also brought forward the notion of accidents that are very important in his work,
519 making a parallel with the work of Francis Bacon:

520 *"This reminds me of Francis Bacon. [...] actually now I feel closer to him. There's this*
521 *work where he worked with oil paint, he's looking for accidents. It's exactly the point*
522 *where when you work with oil paint it also has this certain behavior where everything*
523 *mixes together then you cannot deliberately push it into a certain way - or that's what*
524 *he says. Whilst working with it, there comes the moment where a certain constellation*
525 *just is right. Then you stop, then you also have to decide is this the best? Or do I work*
526 *over it? And that would be like me, continue training and then it might be that you*
527 *destroy it entirely".*

529 **5.1.4 Towards AI as an embodied tool.** Artists described the use of AI in their artistic practice as a
530 tool, and sometimes as an instrument for creation, *"my code is my tool"* as MK put it.

531 MA highlights the importance of interaction in his work, which he reports as follows: *"I'm not*
532 *solely working in the domain of interactive media and technologies, but a big part is to create systems*
533 *that we can play like a musical instrument".* However, interacting with AI as an instrument remains
534 difficult because of the lack of immediate results after each variation in the inputs or the model,
535 and because of a precarious sense of control: *"I'm trying to find ways of interacting with them [AI*
536 *algorithms] such that what you say [analogy Human-AI interactions and playing an instrument]*
537 *happens. I am at the stage to explore what is possible, what is in this thing, what is in this network and*
538 *how can I get it out"* (MA).

540 Another way artists think of AI in their practice is as a tool for *augmentation*. MA explained to
 541 be “*really fascinated by how we are able to augment ourselves and extend our bodies and minds with*
 542 *the tools that we build.*” For MK, AI is seen as a way to augment his own imagination: “*That’s the*
 543 *important part, that the model is not doing exactly what I want. It could just be in the right space to*
 544 *show me all the possibilities that I’m not able to imagine myself at first. So that’s where I’m seeing it*
 545 *as an augmentation of my own imagination*”. Similarly, AR sees in the use of AI a tool to amplify
 546 elements of her work: “*When I work with AI or ML, I’m very conscious I only want to use it to amplify,*
 547 *exaggerate, or help bring out, or do something with the main message of the work, or the thing I’m*
 548 *trying to explore with the work*”. This shows how the artists conceive AI as tool that can shape the
 549 body and the mind, in the embodied cognition sense.

550

551 5.2 Cultural Politics of AI in Art

552 We found that the culture of the AI-Art field shapes artists’ relationships with respect to AI as
 553 a socio-technical object. First, from an epistemological point of view, AI-Art is distant from AI
 554 research culture and objectives. Second, AI-Art questions the ethics behind AI, particularly around
 555 its inherent power dynamics as well as the artist responsibility. Finally, an important question in
 556 AI-Art is around the role of the artist in the art-making with respect to the technology.

557

558 *5.2.1 Freedom from the values of AI research culture.* The artists expressed that they do not abide by
 559 the epistemological values that are dominant in AI technology and that are defined by the constraints,
 560 goals and standards of researchers, engineers and big corporations. While they depend on the
 561 algorithms that are developed in academia and industry, they seek to express their freedom from
 562 the underlying constraints that result from the values of AI culture such as accuracy, productivity
 563 and performance.

564 MA illustrates his epistemological freedom through the exploratory nature of his approach and
 565 how little of a research question is at stake: “*A lot of the thing I’m doing is so exploratory that there*
 566 *isn’t even a research question. I mean there’s an overarching research question [...] my multi-year*
 567 *long-term research question. But what I’m doing now, I wonder what happens when I do this or this.*”
 568 The focus in his work is not on the technical details of the model chosen to generate his artwork,
 569 because these details will not affect the artwork in a way that is meaningful:

570 “*I don’t want to care about what optimizer to use, I don’t want to care about what*
 571 *activation function should be used. I want to be in a position where the research has*
 572 *been done. Right now it’s a bit like one day a paper comes out and says that ‘don’t*
 573 *use this optimizer because it’s very bad, you should use this one instead’.* That’s very
 574 *frustrating.*”

575 AR, on the other hand, opposes the epistemological values of AI research by reconciling the
 576 distinction that has been made between data and model, and particularly the distribution of visibility
 577 and power between the ones developing the models and the ones developing the datasets:

578 “*In all of the big scientific paper that come out (ICML, NeurIPS, etc.) the scientists are*
 579 *known but the person who put together the datasets [or created the labels] is not known.*
 580 *The datasets are anonymous, and nobody talks or speaks about them, they just sit there*
 581 *and people use them. [...] I think there could be something interesting to unpack and*
 582 *explore there*”.

583
 584 The field of ML has indeed very few examples of datasets whose authors have been acknowledged.
 585 One example is ImageNet [17], that has enabled the development of deep learning and modern AI.

586 Finally, while scientific progress in AI constrains the evaluation of the models on specific datasets,
 587 the artists grant themselves the freedom to choose the data to use, avoiding the standardized
 588

589 mappings between content and annotations for instance. MK pointed out this: *"I can use materials*
590 *that they [research scientists] might not be able to use, for example when I collect training data I do*
591 *really just pick anything. And if you are doing a scientific research you are limited to ImageNet for*
592 *instance."* In other words, AI takes on a different meaning: it is no longer a model that must achieve
593 the highest performance on fixed tasks in order to contribute to the field, but a material that, when
594 fused with data, produces meaning and representations for artists and audiences.

595
596 5.2.2 *Questioning the power dynamics in AI research.* As we mentioned in the previous section, the
597 practice of AI-Art is intrinsically dependant on AI research outcomes. Although these outcomes
598 can be of different types such as academic papers, open source code or video tutorials, their
599 appropriation is overall challenging. This makes crafting AI a difficult and exclusive task that very
600 few have access to, either for lack of skills of computational power. JE describes it as follows:

601 *"With machine learning I feel there is such a steep learning curve, it might take me a*
602 *few days to get something up and running. And then I need to have a good idea what*
603 *to do in the first instance, because it's kind of harder just to play and then to come up*
604 *with some ideas"*.

605 Besides the technical challenges of appropriating AI technology, another challenge is due to the
606 fact that the models are released but the data are not and the artist may not have access to enough
607 computational power to train the models. In this context, KM reported that the main challenge is
608 to make these technologies more inclusive: *"sometimes that means taking something that is very*
609 *complex and technical and sharing it with other people in a way that gives them access to something*
610 *they wouldn't have access to otherwise. Sometimes that means tool building. Sometimes that means*
611 *storytelling in a way that gives you like an immediate experience of something that's happening*
612 *behind the scenes."*

613 According to KM, making AI more inclusive is particularly challenging, because the design of
614 these technology is inherently "opaque" which reinforces how the power of understanding and
615 developing them is retained among the few researchers and corporations that release them.

616 *"They're designed generally to, like I said, reinforce power rather than question power.*
617 *And they resist our attempts to open them up actually. [...] there's just certain kinds*
618 *of curtains we cannot pull back. You know, we can kind of see what's on the surface*
619 *and like dissect that a little bit. But then at some point we hit a wall. We can't look*
620 *inside Google, we can't look inside Facebook. We can't look at their algorithms. We*
621 *can maybe read the research papers that they publish sometimes because it turns out*
622 *that the current iteration of machine learning, which is deep learning, has been very*
623 *open about the research process. But even when we read those papers, like ultimately,*
624 *we don't have access to the data that they use, we don't have access to the computing*
625 *resources that they use"*.

626
627 5.2.3 *AI involves Ethics and the artist' liability.* We found that the artists engage with ethical
628 questions around their responsibility regarding the way they use AI, which does not obviously
629 occur with other technology. For instance, JE says that *"it's your responsibility [as an artist] to not*
630 *necessarily explain the technology, getting people to think slightly deeper of what this stuff is capable*
631 *of, and convey a bit of a message about it"*. This does not mean that an artwork produced with AI
632 has to convey a message about the technology. But the status of AI in Western culture is such
633 that the use of this type of technology will surely trigger an emotional response in the audience.
634 JE expressed regret for a certain use of *"AI to kind of bamboozle the public"* . His way of using it
635 ethically is by being *"very honest about it [AI] because I think there is far too much miscommunication*
636 *around it [AI]"*.

Indeed, AI has been widely used in the media as well as in academic world in order to refer to a wide variety of techniques, systems, and values. These definitions and scope delimitations have an inherent ethical agenda. For example, there have been many discussions around the definition of artificial intelligence, as opposed to human intelligence. KM shares his thought on that:

“There’s the obvious understanding of what artificial is, a kind of artificial as opposed to natural, that we have a sort of natural intelligence in humans. I don’t find that to be a super helpful distinction personally because of the fact that I see intelligence as very collective and hybrid itself. [...] What do you call a crowd of people working together? Is that a natural intelligence or is it kind of artificially created out of their relationships? I’m not sure. [...] I think that there’s also artificial for me ties back to a very long history of basically anybody in power abusing their power to diminish those that they deem kind of lesser. [...] this idea distinguishing between the natural and artificial, for me, it connects to other kinds of classifications that have been used to reinforce power. And that’s disturbing to me. I think we have to be careful about using those kinds of terms.”

Finally, the artists acknowledge that working with AI is not neutral. This inspires them to develop a critical discourse in their artworks about the politics and ethical pitfalls behind this specific technology. First, the development of AI has been exponential in the past decade thanks to massive investment in the private and public sectors. As a technology fundamentally designed to be able to analyse massive amount of data, there has been a high incentive in surveillance application. In the piece entitled “Learning to See: Hello World!”, MA involved elements of reflection on the link between AI and surveillance. The work uses a CCTV camera that captures images of the exhibition hall, then feeds the AI model that ultimately recreates an image based on what it has learned to see, cf. Figure 2 (left). In “Exhausting a Crowd”, KM explicitly involves crowd surveillance, where an online audience is invited to tag human activity from CCTV images from a public space, cf. Figure 2 (right).

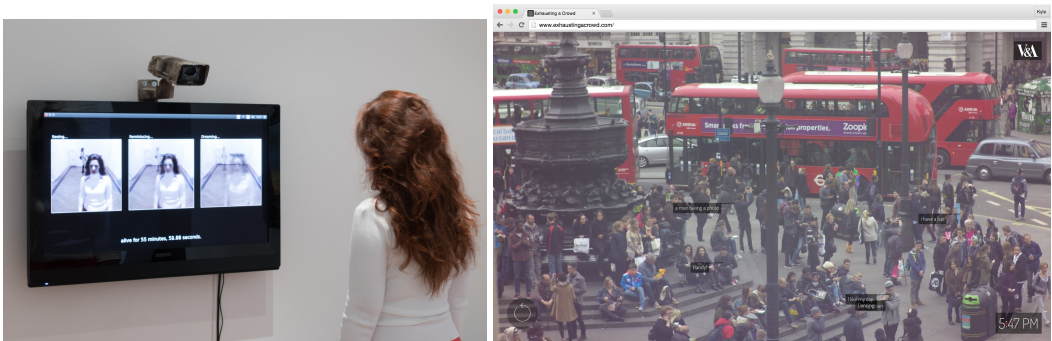


Fig. 2. **(left panel)** *Learning to See: Hello World!*, 2017, by Memo Akten [Photo Courtesy: Memo Akten]; **(right panel)** *Exhausting a Crowd*, 2015, by Kyle McDonald [Photo Courtesy: Kyle McDonald]

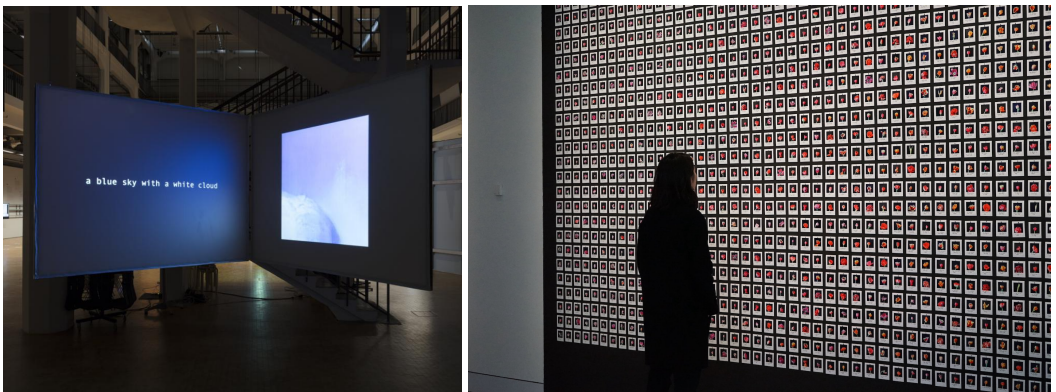
The ability of artists to work within and outside of the AI culture grants them the freedom to create works that critically comment on the politics behind AI and the discourse on AI. Where academia is concerned with scientific and technical progress, and industry with the profitability of these models in the mainstream, artists seize the opportunity to hijack the dominant discourse on AI through poetic, critical and political intervention. as JE puts it:

“I guess ML is sort of cold and sounds like data science, and scientific. You don’t start thinking about the philosophical or ethical implications in that”.

687 5.2.4 *The role of the artist as the one who makes it happen.* The nature of AI algorithms does not
688 allow a substantial degree of transparency nor control over the process. This led the artists to
689 consider their role as either a distant documentary film maker, explorer or voyeur and witness
690 of the process or as a closer author, curator and decision maker whose choices shape directly the
691 artwork. For instance, MA described himself as a documentary film maker because he works within
692 constraints and because the AI process is outside of his total control. In his own words:

693 “You can be a filmmaker where you are in full control over everything. You direct the
694 script writers and everything and you realize your vision. You have full control. Or
695 you could be a documentary film maker where you have constraints that are outside
696 of your control, and your job is to work within those constraints to deliver something.
697 Constraints are based in reality. It might be a true story, it might be a location, the
698 story of the location... So I want something from the external world which in this case
699 is what the network is doing. And I don’t want my expectations to match the output.
700 But as an artist I also want to be a bit in control. So the metaphor that I always use is
701 that I see the relationship as me the director and I’m working with the content creator.”

702
703 MK also describes the role of the artist as a watcher or even protector of the work. He takes the
704 analogy of the “doctor looking for symptoms”. This echoes JE’s metaphor of the AI-artist as a voyeur
705 or a witness of the computer, whose position is at distance from the work itself: “I do love the initial
706 moment when things start to generate and I’m just watching it, like a voyeur. There is something very
707 exciting about seeing what it spits out”. He gives an example of his piece entitled *Closed Loop* where
708 one AI is a GAN that learned to interpret words and generate images and the other AI learned to
709 interpret images and generate words (see Figure 3 left). It is a closed loop because the output of
710 one AI is the input of the next and so on. About this work, JE said: “I don’t curate the material itself,
711 I just kind of watch them have this meaningless conversation. The human can stand there and say ‘oh
712 yeah! I see a bird in that one’, and sometimes I see nothing in that one’... how the computer got to that,
713 how the computer is viewing the world”.



728 Fig. 3. **(left panel)** *Closed Loop*, 2017, 2-channel digital video without sound, 200 minute loop, by Jake
729 Elwes [Photo Courtesy: Jake Elwes]. **(right panel)** *Myriad (Tulips)*, C-type digital prints with handwritten
730 annotations, magnetic paint, magnets, 2018, by Anna Ridler [Photo Courtesy: Anna Ridler]

731
732 AR takes a different stance, not in distance with the process but rather that of the curator. In her
733 work “Mosaic Virus”, she took 10000 photographs of tulips that she labeled manually as an homage
734 to the hidden histories of early programmers who were women and manually performed calculation
735

(see Figure 3 right). The more that process was automatized the more it became dominated by male industry.

“It was a heavily feminized industry of a lots of women doing very boring jobs by hand.. because I’m hand-classifying [the photographs] in the installation [...] Sometimes I even disagree as I’m writing the label on, but it really emphasizes that even with all the systems that exist, there’s a human that is making a decision that something is red and not pink. And the humanity of it is because it’s normally silo-strapped and so algorithmic, that you do forget that in the training set, a human has sat there and made decision that this is this and not this. And so the piece is trying to bring that human element out, and also how flawed that can be.”

MK also states that the authorship remains in the hand of the artist that takes the decisions: *“Of course it’s still me because I train the model, and I make the selections and all the decisions in this process. Let’s say I get to the point where I’m able to make an autonomous machine which is not static but is almost alive in the sense it can deviate from its original instructions. Even then, of course all the information it gets is still coming from our world and information that might have been assembled by a human, or is considered to be cultural heritage. In the end, you’ll never get the human out. [...] everything that humans create is based on stuff they have accumulated over their lifetime and transformed”.*

How the artists define their roles in various scales of closeness and responsibility about the artworks show the tension that emerges from integrating an automated process in artistic creation. As MA says : *“if the machine creates everything then where is the artists signature?”* KM described this relationship with authorship as a *“diluted idea”*. According to him, working with AI shows the complexity of authorship in the arts in general and in AI-Art in particular: a multitude of people contribute to the process, from the researchers who designed the algorithm, the coders who implemented it, the people who circulated it online, the people who generated the data that is used to train it, to the artists that appropriated it. He takes a stance of *“humility”* and thinks of the algorithm as *“a companion and co-improvisor”* and the artist as simply *“someone who makes it happen”*.

6 DISCUSSION

In this article, we have interviewed five internationally renowned artists about how they integrate AI in their work. Our objective was to better understand what it is about AI-Art that makes it a unique practice that captured the attention of the art world as well as the AI and HCI worlds. Specifically, we studied how AI is practiced by artists which allowed us to highlight, first, how AI challenges the notion of authorship, aesthetics, and control in creative work, and second, the specific tensions related to the socio-cultural contexts in which the practice of AI-Art is evolving. In this section, we propose to discuss more in details how AI artists twist the AI narrative, with an intent to resist conventions from the AI field. Then we propose to focus on the question of authorship. We further discuss the political forces that are inherent to use of AI. Finally, we discuss limitations of the current study.

6.1 On the AI narrative in the process of creation

The results of our interviews show how artists re-invent new ways of working with AI. First of all, they embrace the surprises and errors that the algorithms generate and see unpredictability as expressive rather than as a limitation of the algorithm that needs to be fixed. In that sense they work against the current where engineers and developers are fighting accidents and seeking for robustness. Through their exploratory process and openness to emergence, artists implicitly resist

785 the epistemological values of academic and industrial research in AI, and to some extent HCI,
786 where accuracy and performance are at the center of current development of the technology. In a
787 recent paper, Benjamin et al. [5] argue that uncertainty from ML-based systems is a problem for
788 HCI design research because it has not yet been formalized as a design material. Uncertainty is
789 usually unwanted, as opposed to be utilised in design. In this perspective, our results illustrate how
790 AI artists trace the path towards the use of uncertainty and unpredictability as a creative design
791 material, echoing previous design approaches such as the *bricolage* developed by Vallgård and
792 Fernaeus [64] that leverages on imprecision to design more culturally grounded artefacts. Therefore,
793 we can see that what is called “ML as a design material” is actually a collection of various materials
794 that are data, models, uncertainty, metrics, among others. We believe that the inherent difficulty in
795 working with ML as a design material highlighted in previous work [20, 68], stems in part from
796 the fact that this material includes several forms of heterogeneous materials that involve their own
797 competencies.

798 Second, artists invent new workflows. Despite being bound by what an AI system necessitates
799 to process data, artists are finding freedom in curating the data, avoiding standardized measures
800 of success and tweaking conventional steps of the process in order to get the desired outcome.
801 The artists that we interviewed built expertise from years of tweaking and playing with models.
802 Although they do not have the technical backgrounds to invent ML algorithms that contribute to
803 AI research, their experience of tweaking parameters and training models allows them to have
804 an acute expertise and sense of what the systems allow them to do, and how to create a desired
805 artefact out of it. The notion of crafting is here critical, artists are engaged with the media through
806 an immediate relationship with data and the algorithmic material. However, this does not come
807 without effort. The artists had to overcome the technicality of such a design material and develop
808 their own tools to work with it. This shows that, although design tools involving ML exist², they
809 are not widely used in this context. Our results may provide insights for HCI practitioners and
810 researchers to investigate such tools.

811

812 6.2 On the question of authorship

813 Our interviews emphasized the tensions that arise from accepting the opacity of the algorithms and
814 resisting it. On the one side, there seems to be very little agency left to the artists. Indeed, despite
815 the efforts to invent new ways of working with AI, they are ultimately constrained by the models.
816 On the other side, their work consists of constantly resisting such an opacity, by almost guessing
817 how the models would behave in order to gain a sense of control of the process and the outcome of
818 the algorithm. The risk is this: the less control they have over the system, the more standard may
819 be the response, leaning sometimes towards a common aesthetics that escapes the artists and does
820 not represent their work or their vision. This aspect characterises the work with AI as opposed to
821 other technology in artistic practice. And it has created debates about artist’s authorship over their
822 artworks generated by AI in the specialised media as well as the general public media.

823 The main reason behind this is the autonomous feature of AI algorithms. Indeed if the machine
824 does the work then who is the artist? Our interviews have shown the extent to which an AI-
825 generated piece involves manual labour of the artist. Doing AI-Art is not limited to downloading
826 source code and running it. We found that AI-Art involves craftsmanship, which implies hours of
827 exploration leading to countless failures and few achievements. Through this process, skills are
828 acquired which turn AI algorithms into instruments for artists. However, this human labour is
829 not always acknowledged. This observation echoes what Daniele and Song discussed in a recent
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831 ²Beyond academic tools, we could cite RunwayML <https://runwayml.com/>, which is a commercial product dedicated to
832 video creation using Ai.

833

834 article [15]. The authors criticized how the narrative changed when presenting a piece involving
 835 AI: from art made “with” AI to art made “by” AI. This formulation tends to minimize the human
 836 labor required for the AI algorithm to produce a meaningful artwork. On the contrary, our results
 837 emphasize the amount of human labour that goes into each of our interviewees artistry and that
 838 leads to the emergence of specific and unique skills.

839 The debate is also fuelled by the phenomenon of anthropomorphism of AI systems, as Epstein
 840 and colleagues point out, which tends to give them superhuman powers (human performance
 841 remaining the baseline to overcome) [22]. From the artists’ point of view, this is not a fruitful
 842 debate and they take it as part of their responsibility not to fuel it. Artists are making art to be
 843 seen and shared. The question whether a computer can be considered as an author of an artwork is
 844 discussed by Hertzmann who argues that “artistic creation is primarily a social act” and, in this
 845 sense, remains human [35]. As summarized by KM: “the artist is the one who makes it happen”.

846 Finally, looking into AI-art practice reveals how much automation redefines the artist’s role. We
 847 found that artists define themselves as documentary film maker, doctors looking for syndromes,
 848 witnesses, or curators of data. Their negotiations between autonomy and control also relate to how
 849 much freedom they have in this process and how much constraints they work with. We found that
 850 they grant themselves the freedom to explore and possibly invent a new practice, a new current and
 851 aesthetics within a constraint environment. One can wonder if truly, a new aesthetics or medium
 852 emerges? According to Manovich, recent achievements of AI-art in visual arts are often still images
 853 that simulate visual appearance of existing artistic movements such as expressionism or cubism
 854 among others [51]. Our results suggest that the novelty in AI-Art does not necessarily reside in
 855 the outcome, as the images usually represent culturally recognizable mashups, the novelty resides
 856 precisely in the scale of the aesthetic possibilities that are given by automation rather than by
 857 human choice.

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6.3 On the political underpinnings

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Our interviews showed the political stance that the artists take with regards to AI. For example,
 AR focuses on manual image annotation to question repetitive work, which is most often a type
 of work given to marginalized workers. It is a type of work that was previously done by female
 workers in the 50s and that is currently performed by people of color or people from the global
 south [38]. The manual labour of annotation currently underlines much of the work that is taken
 for granted in automation [37]. Another example is the piece by KM criticizing how AI-based
 algorithms are used to track and monitor the masses. Through these critical stances the artists
 are taking responsibility in revealing both the darker and constructive sides of the technology
 they work with. In doing so, they create bridges between the cultural and technical natures of AI,
 between a world of representations and a world of operations. These bridges allow us to understand
 AI beyond a purely technical object, according to the philosophical line of Simondon [60]. And
 such a stance may be more prevalent in AI-Art than other movement in Art and Technology due to
 the political tensions as well as the economical incentives that AI has created.

However, in such a stance, there is a political ambivalence. On one hand, the artists acknowledged
 that they rely on the work undergone by Research & Development labs from big corporations that
 are developing the tools that allow them to produce their art and to extend their creative range.
 Yet, the artists do not necessarily adhere to the underlying economical and political agendas of
 these actors. This is similar to the ambivalence that regular AI “consumers”, whether intentional or
 unintentional consumers, feel. Even when we disagree with the role played by these algorithms
 at the core of corporations’ business models, we are contributing to their proliferation through
 our everyday use of them. The feeling seems to be that there is not much that can be done to
 slow it down or redirect its development for human good and for the planet’s sustainable future.

882

883 There are higher economical and political agendas at stake and that dominate how such technology
884 progresses. We believe that AI artists have a political voice that promotes the development of a
885 necessary critical discourse on technology and AI and brings it to the general public³.

886 We think that such critical discourse needs to be promoted in HCI as well, where the role of AI
887 is sometimes taken for granted and rarely questioned. We believe that the insights from artists
888 collected in this study are therefore contributing to this endeavour.

890 6.4 Limitations of the study

891 Our study has its limitations that may open interesting directions for research. First, we are aware
892 that the community of artists working with AI is comprised of a large number of artists, and that
893 this number is constantly growing. We invited the five artists listed above to an interview because
894 they were considered, at the time the interviews were conducted, to be among the early pioneers
895 of what we now call AI-Art. Since the beginning of this study, the community has expanded, and
896 we invite the interested reader to look at the featured artists listed on the aartists.org website for
897 instance⁴, as well as the network built by creative AI curator Luba Elliott⁵.

898 Second, AI research is moving very fast, as is the field of AI-Art. We mentioned for instance
899 the use of GANs [33], which were initially published in 2014. Although there have been many
900 extensions over the past eight years, the current state of the art includes alternative models to
901 GANs, and the current state of the art models may be outdated within a year. In this article, we
902 have tried to extract elements of the practice of AI in art-making that are free from technical
903 constraints, with all the difficulties that this exercise implies. Indeed, as the field is intrinsically
904 linked to AI research, new models could bring new aesthetics. Similarly, new learning techniques
905 could create more fluid interactions between the artist and the system. Thus, more research is
906 needed to understand how AI-Art is evolving and will evolve in the coming years.

908 7 CONCLUSION

909 In this article, we interviewed artists who use AI in their work. The goal was to better understand
910 the role of AI in art making and how artists explain the politics of this technology in their work. Our
911 findings are twofold. First, we found that AI-Art practice relies on craft skills, acquired by fostering
912 learning by doing. AI is then used both as a process and as a material, where unpredictability is
913 fostered rather than avoided. Second, we unpacked the politics of AI-Art that consists of resisting
914 the culture and discourse of AI research, as well as the power dynamics at play. This leads the
915 artists to take on a position of ethics and responsibility with regards to AI, and question their role
916 towards their work, due to the autonomous nature of the technology.

917 As the fields of AI and AI-Art evolve rapidly, so does the research in HCI that aims to capture the
918 complex interactions between artists, technology, and their socio-cultural contexts. Future work
919 should then encompass a broader set of artistic practices to better understand the extent to which
920 AI technology can be appropriated as a tool or as a subject matter.

921 We believe that this line of research can bring a new way of conceptualizing interactions with
922 AI and open up important theoretical and ethical questions for the field of Human-Computer
923 Interaction.

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927 ³This topic has been developed in different contexts, among them this seminar organised by the Council of Europe in 2018
928 <https://www.coe.int/en/web/culture-and-heritage/-/e-relevance-of-culture-in-the-age-of-ai>

929 ⁴<https://aartists.org/ai-artist-founding-members>

930 ⁵<http://elluba.com/>

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A ARTIST BIOS

Memo Akten

Memo Akten is an artist, experimental filmmaker, musician and computer scientist from Istanbul, Turkey. He works with emerging technologies and computation as a medium, to create images, sounds, films, large-scale responsive installations and performances. Fascinated by trying to understand the nature of nature and the human condition, he draws from fields such as biological and artificial intelligence, computational creativity, perception, consciousness, neuroscience, fundamental physics, ritual and religion. He has a PhD in Artificial Intelligence / Deep Learning and expressive human-machine interaction from Goldsmiths University of London, and is Assistant Professor of Computational Arts at University of California, San Diego (UCSD). Akten received the Prix Ars Electronica Golden Nica for his work 'Forms' in 2013. He has exhibited and performed internationally at venues such as The Grand Palais (Paris FR), The Barbican (London UK), Victoria & Albert Museum, Moscow Museum of Modern Art (Moscow RU), Shanghai Ming Contemporary Art Museum (Shanghai CN) and many others. He has also collaborated with celebrities such as Lenny Kravitz, U2, Depeche Mode and Professor Richard Dawkins.

Jake Elwes

Jake Elwes is a media artist living and working in London. They studied at The Slade School of Fine Art, UCL (2013-17). Recent works explore their research into machine learning and artificial intelligence. Their practice looks for poetry and narrative in the success and failures of these systems, while also investigating and questioning the code and ethics behind them. Their current works in the Zizi Project explore AI bias by queering datasets with drag performers which simultaneously demystify and subvert AI systems. Jake's work has been exhibited in museums and galleries internationally, including the ZKM, Karlsruhe, Germany; TANK Museum, Shanghai; Today Art Museum, Beijing; CyFest, Venice; Edinburgh Futures Institute, UK; Zabludowicz Collection, London; Frankfurter Kunstverein, Germany; New Contemporaries 2017, UK; Ars Electronica 2017, Austria; Victoria and Albert Museum, London; LABoral Centro, Spain; Nature Morte, Delhi, India; RMIT Gallery, Australia; Centre for the Future of Intelligence, UK and they have been featured on TV: ZDF Aspekte (Germany) and the BBC Arts (UK).

Mario Klingemann

Mario Klingemann is an artist, who uses algorithms and artificial intelligence to create and investigate systems. He is particularly interested in human perception of art and creativity, researching methods in which machines can augment or emulate these processes, and has been recognized as a pioneer in the field of AI art, neural networks and machine learning. Born in 1970, Klingemann grew up in the age of the first handheld computer games, arcade machines and home computers. An autodidact, Klingemann began learning computer programming in the 1980s, and aspired to a career that synthesized technology and the visual arts. Finding no such option available at the time, Klingemann started his professional life in advertising and design. In 1994, he began creating websites on the still-nascent World Wide Web, and in 1997 Klingemann co-founded coma,

981 a collective of media artists. Since then, his artistic practice has evolved alongside breakthroughs
982 in AI and deep learning, with Klingemann’s contributions at the leading edge. Klingemann has
983 worked with prestigious institutions including The British Library, Cardiff University and New
984 York Public Library, and was Artist in Residence at Google Arts and Culture. His artworks have
985 been exhibited at MoMA New York, the Metropolitan Museum of Art New York, the Photographers’
986 Gallery London, ZKM Karlsruhe, and Centre Pompidou Paris. Klingemann received the British
987 Library Labs Artistic Award 2016 and in 2018 won the Lumen Prize Gold Award, which celebrates
988 artworks made with technology. His installation *Memories of Passersby I* made history in March
989 2019 as the first autonomous AI machine to be successfully auctioned at Sotheby’s.

990 **Kyle McDonald**

991 Kyle McDonald is an artist working with code. He crafts interactive installations, sneaky inter-
992 ventions, playful websites, workshops, and toolkits for other artists working with code. Exploring
993 possibilities of new technologies: to understand how they affect society, to misuse them, and build
994 alternative futures; aiming to share a laugh, spark curiosity, create confusion, and share spaces
995 with magical vibes. Working with machine learning, computer vision, social and surveillance tech
996 spanning commercial and arts spaces. Previously adjunct professor at NYU’s ITP, member of F.A.T.
997 Lab, community manager for openFrameworks, and artist in residence at STUDIO for Creative
998 Inquiry at CMU, and YCAM in Japan. Work commissioned and shown around the world, including:
999 the V&A, NTT ICC, Ars Electronica, Sonar, Today’s Art, and Eyebeam.

1000 **Anna Ridler**

1001 Anna Ridler (b. 1985) is an artist and researcher who works with systems of knowledge and how
1002 technologies are created in order to better understand the world. She is particularly interested
1003 in ideas around measurement and quantification and how this relates to the natural world. Her
1004 process often involves working with collections of information or data, particularly datasets, to
1005 create new and unusual narratives. Ridler holds an MA in Information Experience Design from
1006 the Royal College of Art and a BA in English Literature and Language from Oxford University
1007 along with fellowships at the Creative Computing Institute at University of the Arts London (UAL).
1008 Her work has been exhibited at cultural institutions worldwide including the Victoria and Albert
1009 Museum, the Barbican Centre, Centre Pompidou, HeK Basel, the ZKM Karlsruhe, Ars Electronica,
1010 Sheffield Documentary Festival and the Leverhulme Centre for Future Intelligence. She was a
1011 European Union EMAP fellow and the winner of the 2018-2019 DARE Art Prize. Ridler has received
1012 commissions by Salford University, the Photographers Gallery, Opera North, and Impakt Festival.
1013 She was listed as one of the nine “pioneering artists” exploring AI’s creative potential by Artnet
1014 and received an honorary mention in the 2019 Ars Electronica Golden Nica award for the category
1015 AI & Life Art. She was nominated for a “Beazley Designs of the Year” award in 2019 by the Design
1016 Museum for her work on datasets and categorisation.

1017 **REFERENCES**

- 1018 [1] Memo Akten. 2021. *Deep Visual Instruments: Realtime Continuous, Meaningful Human Control over Deep Neural*
1019 *Networks for Creative Expression*. PhD Thesis. Goldsmiths, University of London.
- 1020 [2] Saleema Amershi, Maya Cakmak, William Bradley Knox, and Todd Kulesza. 2014. Power to the people: The role of
1021 humans in interactive machine learning. *Ai Magazine* 35, 4 (2014), 105–120.
- 1022 [3] Sofian Audry. 2021. *Art in the Age of Machine Learning*. MIT Press.
- 1023 [4] Karen Barad. 2007. Meeting the universe halfway. In *Meeting the universe halfway*. duke university Press.
- 1024 [5] Jesse Josua Benjamin, Arne Berger, Nick Merrill, and James Pierce. 2021. Machine Learning Uncertainty as a Design
1025 Material: A Post-Phenomenological Inquiry. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing*
1026 *Systems*. 1–14.

1027

1028

1029

- 1030 [6] Nico Brand, William Odom, and Samuel Barnett. 2021. A Design Inquiry into Introspective AI: Surfacing Opportunities,
 1031 Issues, and Paradoxes. In *Designing Interactive Systems Conference 2021 (DIS '21)*. Association for Computing Machinery,
 1032 New York, NY, USA, 1603–1618. <https://doi.org/10.1145/3461778.3462000>
- 1033 [7] Virginia Braun and Victoria Clarke. 2006. Using thematic analysis in psychology. *Qualitative research in psychology* 3,
 1034 2 (2006), 77–101. Publisher: Taylor & Francis.
- 1035 [8] Joy Buolamwini and Timnit Gebru. 2018. Gender shades: Intersectional accuracy disparities in commercial gender
 1036 classification. In *Conference on fairness, accountability and transparency*. PMLR, 77–91.
- 1037 [9] Baptiste Caramiaux and Marco Donnarumma. 2021. Artificial Intelligence in Music and Performance: A Subjective
 1038 Art-Research Inquiry. In *Handbook of Artificial Intelligence for Music*. Springer, 75–95.
- 1039 [10] Baptiste Caramiaux, Fabien Lotte, Joost Geurts, Giuseppe Amato, Malte Behrmann, Frédéric Bimbot, Fabrizio Falchi,
 1040 Ander Garcia, Jaume Gibert, Guillaume Gravier, Hadmut Holken, Hartmut Koenitz, Sylvain Lefebvre, Antoine Liutkus,
 1041 Andrew Perkis, Rafael Redondo, Enrico Turrin, Thierry Viéville, and Emmanuel Vincent. 2019. *AI in the media and
 1042 creative industries*. Research Report. New European Media (NEM). 1–35 pages. <https://hal.inria.fr/hal-02125504>
- 1043 [11] Eva Cetinic and James She. 2021. Understanding and Creating Art with AI: Review and Outlook. *CoRR* abs/2102.09109
 1044 (2021). <https://arxiv.org/abs/2102.09109> arXiv: 2102.09109.
- 1045 [12] Simon Colton, Ramon López De Mántaras, and Oliviero Stock. 2009. Computational creativity: Coming of age. *AI
 1046 Magazine* 30, 3 (2009), 11–11.
- 1047 [13] Simon Colton, Geraint A Wiggins, and others. 2012. Computational creativity: The final frontier?. In *Ecai*, Vol. 12.
 1048 Montpellier, 21–26.
- 1049 [14] Antonio Daniele, Caroline Di Bernardi Luft, and Nick Bryan-Kinns. 2021. “What Is Human?” A Turing Test for Artistic
 1050 Creativity. In *International Conference on Computational Intelligence in Music, Sound, Art and Design (Part of EvoStar)*.
 1051 Springer, 396–411.
- 1052 [15] Antonio Daniele and Yi-Zhe Song. 2019. Ai+ art= human. In *Proceedings of the 2019 AAAI/ACM Conference on AI,
 1053 Ethics, and Society*. 155–161.
- 1054 [16] Nicholas Davis, Chih-Pin Hsiao, Kunwar Yashraj Singh, Lisa Li, and Brian Magerko. 2016. Empirically studying partic-
 1055 ipatory sense-making in abstract drawing with a co-creative cognitive agent. In *Proceedings of the 21st International
 1056 Conference on Intelligent User Interfaces*. 196–207.
- 1057 [17] Jia Deng, Wei Dong, Richard Socher, Li-Jia Li, Kai Li, and Li Fei-Fei. 2009. Imagenet: A large-scale hierarchical image
 1058 database. In *2009 IEEE conference on computer vision and pattern recognition*. Ieee, 248–255.
- 1059 [18] Alan Dorin. 2013. Chance and complexity: stochastic and generative processes in art and creativity. In *Proceedings of
 1060 the Virtual Reality International Conference: Laval Virtual*. 1–8.
- 1061 [19] Paul Dourish. 2016. Algorithms and their others: Algorithmic culture in context. *Big Data & Society* 3, 2 (Dec. 2016),
 1062 205395171666512. <https://doi.org/10.1177/2053951716665128>
- 1063 [20] Graham Dove, Kim Halskov, Jodi Forlizzi, and John Zimmerman. 2017. UX design innovation: Challenges for working
 1064 with machine learning as a design material. In *Proceedings of the 2017 chi conference on human factors in computing
 1065 systems*. 278–288.
- 1066 [21] Steven Dow, Manish Mehta, Ellie Harmon, Blair MacIntyre, and Michael Mateas. 2007. Presence and engagement in
 1067 an interactive drama. In *Proceedings of the SIGCHI conference on Human factors in computing systems*. 1475–1484.
- 1068 [22] Ziv Epstein, Sydney Levine, David G. Rand, and Iyad Rahwan. 2020. Who Gets Credit for AI-Generated Art? *iScience*
 1069 23, 9 (2020), 101515. <https://doi.org/10.1016/j.isci.2020.101515>
- 1070 [23] Jerry Alan Fails and Dan R Olsen Jr. 2003. Interactive machine learning. In *Proceedings of the 8th international conference
 1071 on Intelligent user interfaces*. 39–45.
- 1072 [24] Sarah Fdili Alaoui. 2019. Making an Interactive Dance Piece: Tensions in Integrating Technology in Art. In *Proceedings
 1073 of the 2019 on Designing Interactive Systems Conference (DIS '19)*. ACM, New York, NY, USA, 1195–1208. <https://doi.org/10.1145/3322276.3322289> event-place: San Diego, CA, USA.
- 1074 [25] Rebecca Fiebrink and Baptiste Caramiaux. 2016. The machine learning algorithm as creative musical tool. *arXiv
 1075 preprint arXiv:1611.00379* (2016).
- 1076 [26] Rebecca Fiebrink, Perry R Cook, and Dan Trueman. 2011. Human model evaluation in interactive supervised learning.
 1077 In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. 147–156.
- 1078 [27] Rebecca Fiebrink and Laetitia Sonami. 2020. Reflections on Eight Years of Instrument Creation with Machine Learning.
 (2020). Publisher: Goldsmiths, University of London.
- [28] World Economic Forum. 2018. The impact of emerging technologies on the creative economy. In *World Economic
 Forum, Geneva*.
- [29] Jules Françoise and Frederic Bevilacqua. 2018. Motion-sound mapping through interaction: An approach to user-
 centered design of auditory feedback using machine learning. *ACM Transactions on Interactive Intelligent Systems
 (TiiS)* 8, 2 (2018), 1–30. Publisher: ACM New York, NY, USA.

- 1079 [30] Emma Frid, Celso Gomes, and Zeyu Jin. 2020. Music Creation by Example. In *Proceedings of the 2020 CHI Conference*
1080 *on Human Factors in Computing Systems*. Association for Computing Machinery, New York, NY, USA, 1–13. <https://doi.org/10.1145/3313831.3376514>
- 1081 [31] Elisa Giaccardi and Johan Redström. 2020. Technology and More-Than-Human Design. *Design Issues* 36, 4 (Sept. 2020),
1082 33–44. https://doi.org/10.1162/desi_a_00612
- 1083 [32] Marco Gillies, Rebecca Fiebrink, Atau Tanaka, Jérémie Garcia, Frédéric Bevilacqua, Alexis Heloir, Fabrizio Nunnari,
1084 Wendy Mackay, Saleema Amershi, Bongshin Lee, Nicolas d’Alessandro, Joëlle Tilmanne, Todd Kulesza, and Baptiste
1085 Caramiaux. 2016. Human-centred machine learning. In *Proceedings of the 2016 CHI conference extended abstracts on*
1086 *human factors in computing systems*. 3558–3565.
- 1087 [33] Ian Goodfellow, Jean Pouget-Abadie, Mehdi Mirza, Bing Xu, David Warde-Farley, Sherjil Ozair, Aaron Courville, and
1088 Yoshua Bengio. 2014. Generative adversarial nets. *Advances in neural information processing systems* 27 (2014).
- 1089 [34] Matthew Guzdial, Nicholas Liao, and Mark Riedl. 2018. Co-creative level design via machine learning. *arXiv preprint*
1090 *arXiv:1809.09420* (2018).
- 1091 [35] Aaron Hertzmann. 2018. Can computers create art?. In *Arts*, Vol. 7. Multidisciplinary Digital Publishing Institute, 18.
1092 Issue: 2.
- 1093 [36] Stacy Hsueh, Sarah Fdili Alaoui, and Wendy E Mackay. 2019. Deconstructing Creativity: Non-Linear Processes and
1094 Fluid Roles in Contemporary Music and Dance. *Proceedings of the ACM on Human-Computer Interaction* 3, CSCW
1095 (2019), 1–21. Publisher: ACM New York, NY, USA.
- 1096 [37] Lilly Irani. 2016. The hidden faces of automation. *XRDS: Crossroads, The ACM Magazine for Students* 23, 2 (Dec. 2016),
1097 34–37. <https://doi.org/10.1145/3014390>
- 1098 [38] Lilly Irani and M. Six Silberman. 2014. From critical design to critical infrastructure: lessons from turkopticon.
1099 *Interactions* 21, 4 (July 2014), 32–35. <https://doi.org/10.1145/2627392>
- 1100 [39] Myoungsoon Jeon, Rebecca Fiebrink, Ernest A. Edmonds, and Damith Herath. 2019. From rituals to magic: Interactive
1101 art and HCI of the past, present, and future. *International Journal of Human-Computer Studies* 131 (2019), 108–119.
1102 <https://doi.org/10.1016/j.ijhcs.2019.06.005>
- 1103 [40] Youngseung Jeon, Seungwan Jin, Patrick C Shih, and Kyungsik Han. 2021. FashionQ: An AI-Driven Creativity Support
1104 Tool for Facilitating Ideation in Fashion Design. In *Proceedings of the 2021 CHI Conference on Human Factors in*
1105 *Computing Systems*. 1–18.
- 1106 [41] Anna Jordanou. 2012. A standardised procedure for evaluating creative systems: Computational creativity evaluation
1107 based on what it is to be creative. *Cognitive Computation* 4, 3 (2012), 246–279. Publisher: Springer.
- 1108 [42] Chris Kiefer. 2014. Musical Instrument Mapping Design with Echo State Networks.. In *NIME*. 293–298.
- 1109 [43] Janin Koch, Andrés Lucero, Lena Hegemann, and Antti Oulasvirta. 2019. May AI? Design ideation with cooperative
1110 contextual bandits. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*. 1–12.
- 1111 [44] Janin Koch, Nicolas Taffin, Andrés Lucero, and Wendy E Mackay. 2020. SemanticCollage: Enriching Digital Mood
1112 Board Design with Semantic Labels. In *Proceedings of the 2020 ACM Designing Interactive Systems Conference*. 407–418.
- 1113 [45] Alex Krizhevsky, Ilya Sutskever, and Geoffrey E Hinton. 2012. Imagenet classification with deep convolutional neural
1114 networks. *Advances in neural information processing systems* 25 (2012), 1097–1105.
- 1115 [46] Octavio Kulesz. 2018. Culture, platforms and machines: the impact of artificial intelligence on the diversity of cultural
1116 expressions. *Intergovernmental Committee for the Protection and Promotion of the Diversity of Cultural Expressions*
1117 (2018), 11–14.
- 1118 [47] Carolyn Lamb, Daniel G Brown, and Charles LA Clarke. 2018. Evaluating computational creativity: An interdisciplinary
1119 tutorial. *ACM Computing Surveys (CSUR)* 51, 2 (2018), 1–34. Publisher: ACM New York, NY, USA.
- 1120 [48] Róisín Loughran and Michael O’Neill. 2017. Application Domains Considered in Computational Creativity.. In *ICCC*.
1121 197–204.
- 1122 [49] Ryan Louie, Andy Coenen, Cheng Zhi Huang, Michael Terry, and Carrie J. Cai. 2020. Novice-AI Music Co-Creation via
1123 AI-Steering Tools for Deep Generative Models. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing*
1124 *Systems*. Association for Computing Machinery, New York, NY, USA, 1–13. <https://doi.org/10.1145/3313831.3376739>
- 1125 [50] Wendy E. Mackay. 1990. *Users and customizable software: A co-adaptive phenomenon*. PhD Thesis. Massachusetts
1126 Institute of Technology.
- 1127 [51] Lev Manovich. 2019. Defining AI arts: Three proposals. *AI and dialog of cultures" exhibition catalog. Saint-Petersburg:*
Hermitage Museum (2019).
- [52] Alexander Mordvintsev, Christopher Olah, and Mike Tyka. 2015. Inceptionism: Going deeper into neural networks.
(2015).
- [53] Tim Murray-Browne and Panagiotis Tigas. 2021. Latent Mappings: Generating Open-Ended Expressive Mappings
Using Variational Autoencoders. *arXiv preprint arXiv:2106.08867* (2021).
- [54] Johanna Nicenboim, Elisa Giaccardi, Marie Louise Juul Søndergaard, Anuradha Venugopal Reddy, Yolande Strengers,
James Pierce, and Johan Redström. 2020. More-Than-Human Design and AI: In Conversation with Agents. In

- 1128 *Companion Publication of the 2020 ACM Designing Interactive Systems Conference (DIS' 20 Companion)*. Association for
1129 Computing Machinery, New York, NY, USA, 397–400. <https://doi.org/10.1145/3393914.3395912>
- 1130 [55] Michael Nitsche and Anna Weisling. 2019. When is it not craft? Materiality and mediation when craft and computing
1131 meet. In *Proceedings of the Thirteenth International Conference on Tangible, Embedded, and Embodied Interaction*.
1132 683–689.
- 1133 [56] Roelof Pieters and Samim Winiger. 2016. *Creative AI: On the Democratisation & Escalation of Creativity*. Technical
1134 Report. <https://medium.com/@creativeai/creativeai-9d4b2346faf3>
- 1135 [57] Hugo Scurto, Baptiste Caramiaux, and Frédéric Bevilacqua. 2021. Prototyping Machine Learning Through Diffractive
1136 Art Practice. In *Designing Interactive Systems Conference 2021*. 2013–2025.
- 1137 [58] Hugo Scurto, Bavo Van Kerrebroeck, Baptiste Caramiaux, and Frédéric Bevilacqua. 2021. Designing deep reinforcement
1138 learning for human parameter exploration. *ACM Transactions on Computer-Human Interaction (TOCHI)* 28, 1 (2021),
1139 1–35. Publisher: ACM New York, NY, USA.
- 1140 [59] Nick Seaver. 2017. Algorithms as culture: Some tactics for the ethnography of algorithmic systems. *Big Data & Society*
1141 4, 2 (Dec. 2017), 205395171773810. <https://doi.org/10.1177/2053951717738104>
- 1142 [60] Gilbert Simondon, Ninian Mellamphy, and John Hart. 1980. *On the mode of existence of technical objects*. University of
1143 Western Ontario London.
- 1144 [61] Koray Tahiroğlu, Miranda Kastemaa, Oskar Koli, and others. 2020. AI-terity: Non-rigid musical instrument with
1145 artificial intelligence applied to real-time audio synthesis. In *Proceedings of the International Conference on New*
1146 *Interfaces for Musical Expression*. 331–336.
- 1147 [62] Hannu Toivonen and Oskar Gross. 2015. Data mining and machine learning in computational creativity. *Wiley*
1148 *Interdisciplinary Reviews: Data Mining and Knowledge Discovery* 5, 6 (2015), 265–275. Publisher: Wiley Online Library.
- 1149 [63] Cesar Armando Torres. 2019. *Hybrid Aesthetics: Bridging Material Practices and Digital Fabrication through Computa-*
1150 *tional Crafting Proxies*. University of California, Berkeley.
- 1151 [64] Anna Vallgård and Ylva Fernaeus. 2015. Interaction design as a bricolage practice. In *Proceedings of the ninth*
1152 *international conference on tangible, embedded, and embodied interaction*. 173–180.
- 1153 [65] Hao-Chuan Wang, Susan R Fussell, and Dan Cosley. 2011. From diversity to creativity: Stimulating group brainstorming
1154 with cultural differences and conversationally-retrieved pictures. In *Proceedings of the ACM 2011 conference on Computer*
1155 *supported cooperative work*. 265–274.
- 1156 [66] Qian Yang, Nikola Banovic, and John Zimmerman. 2018. Mapping Machine Learning Advances from HCI Research to
1157 Reveal Starting Places for Design Innovation. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing*
1158 *Systems (CHI '18)*. Association for Computing Machinery, New York, NY, USA, 1–11. [https://doi.org/10.1145/3173574.](https://doi.org/10.1145/3173574.3173704)
1159 [3173704](https://doi.org/10.1145/3173574.3173704)
- 1160 [67] Qian Yang, Alex Scuito, John Zimmerman, Jodi Forlizzi, and Aaron Steinfeld. 2018. Investigating how experienced UX
1161 designers effectively work with machine learning. In *Proceedings of the 2018 designing interactive systems conference*.
1162 585–596.
- 1163 [68] Qian Yang, Aaron Steinfeld, Carolyn Rosé, and John Zimmerman. 2020. Re-examining whether, why, and how human-
1164 AI interaction is uniquely difficult to design. In *Proceedings of the 2020 chi conference on human factors in computing*
1165 *systems*. 1–13.
- 1166
1167
1168
1169
1170
1171
1172
1173
1174
1175
1176