The Specter of Representation:
Computational Images and Algorithmic Capitalism

By

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Approval of the Dissertation Committee

This dissertation has been duly read, reviewed, and critiqued by the Committee listed below, which hereby approves the manuscript of Amir Samine Joudat as fulfilling the scope and quality requirements for meriting the degree of Doctor of Philosophy in Cultural Studies, Media Studies Concentration.

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Abstract

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The processes of computation and automation that produce digitized objects have displaced the concept of an image once conceived through optical devices such as a photographic plate or a camera mirror that were invented to accommodate the human eye. Computational images exist as information within networks mediated by machines. They are increasingly less about what art history understands as representation or photography considers indexing and more an operational product of data processing.

Through genealogical, theoretical, and practice-based investigation, this dissertation project traces a lineage of computation through images from early cybernetics to contemporary machine learning under algorithmic capitalist conditions of political economy. It speculates about new conditions and forms of perception and surveillance that result from contemporary technological development in computation. Objects include mundane examples such as smartphone cameras to sublime examples such as the imaging of black holes. The computational sublime is a particular concept developed as a potential escape from automated surveillance culture via the works of Luciana Parisi and Fred Moten and the digital artworks of Danielle Brathwaite-Shirley.

The project builds on theorists of computational media such as Friedrich Kittler, Wendy Hui Kyong Chun, Matteo Pasquinelli, Jussi Parikka, Shane Denson, and

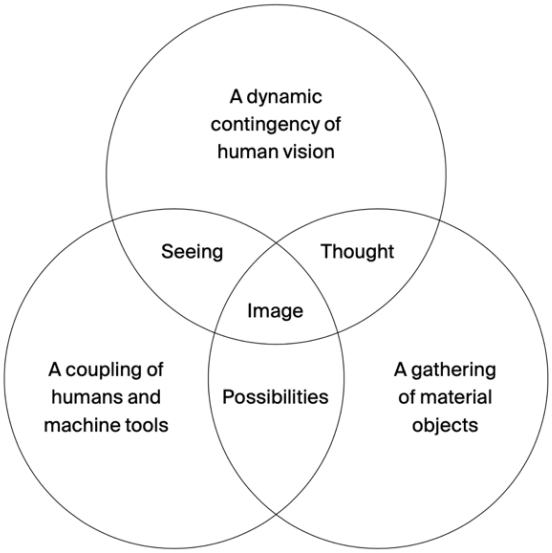
Alexander Galloway to examine the interplay between perception, computation, and epistemology. Further theoretical contribution builds on the work of Jacques Ranciére's articulation of aesthetics and politics, and Michel Foucault's gesture towards a heterotopia. Finally, it draws from Donna Haraway's metaphors of the cyborg and *sympoiesis* to frame the capacity of art to transfigure the limitations of digital network culture into new possibilities for being. Here, it curates and references practices by Harun Farocki, Morehshin Allahyari, and Pierre Huyghe.

Dedication

My deepest gratitude to my family, my partner, my mentors, and my inspirations, without whom this project would not be possible.

Objects Perceive Me[1]

[1] An update of the triangle of meaning, specifically a version published in 1923 in *The Meaning of Meaning* by Charles Kay Ogden and I. A. Richards, to account for the addition of computational language in the relation between speaker as subject, object as referent, and its designation through signs.



The Networked Image [2]

[2] Centre for the Study of the Networked Image, G. Cox, A. Dekker, A. Dewdney, and K. Sluis. "Affordances of the Networked Image". *The Nordic Journal of Aesthetics*, vol. 30, no. 61-62, July 2021, pp. 40-45, https://tidsskrift.dk/nja/article/view/127857.

Epigraph

Everything we see hides another thing, we always want to see what is hidden by what we see. There is an interest in that which is hidden and which the visible does not show us. This interest can take the form of a quite intense feeling, a sort of conflict, one might say, between the visible that is hidden and the visible that is present.

> René Magritte, interview response to his self-portrait painting *Son of Man* (1964)

The fate of the image and of the photographer illustrates the ambiguity of the dominant regime of information,…confirming that the problem is not whether it is necessary to create and view such images, but the sensible system within which it is done.

> Jacques Rancière, *The Emancipated Spectator* (2004)

As nature discovered early on, vision is one of the most powerful secret weapons of an intelligent animal to navigate, survive, interact and change the complex world it lives in. The same is true for intelligence systems. More than 80% of the web is data in pixel format (photos, videos, *etc*.), there are more smartphones with cameras than the number of people on earth, and every device, every machine and every inch of our space is going to be powered by smart sensors. The only path to build intelligent machines is to enable it with powerful visual intelligence, just like what animals did in evolution. While many are searching for the 'killer app' of vision, I'd say, vision is the 'killer app' of AI and computing.

> Fei-Fei Li, interview with *TechCrunch* (2017)

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Preface

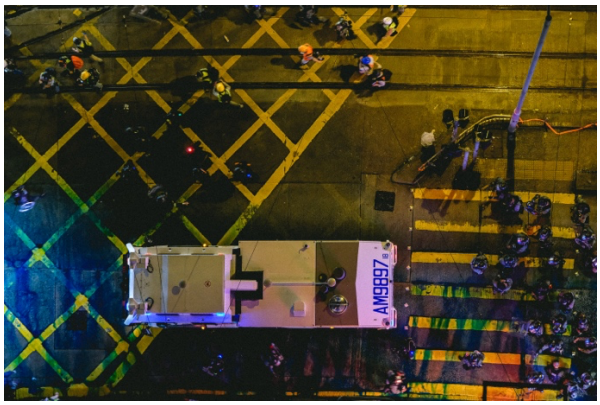
In this project, I take images as objects to help me think about the philosophy of computation. My account includes a history that is not intended to be exhaustive in the way a historian might undertake, but rather to serve as a theoretical framework that problematizes the political, social, and epistemic causes and effects of computation on the concepts of representation and truth. In the pursuit of such a multidisciplinary analysis, my approach melds theory with practice to serve as investigation of the past, critique of the present, and radical speculation for futurity. If this approach retains anything from the history of philosophy, it is the spirit of *askēsis*, an exercise in knowing and becoming myself in the activity of thought. The double bind of critically analyzing representation requires the accounting of oneself in the act, thus the process is always both reflective and self-reflective at the same time. In this context, my analysis takes the form of a neural network, linking ideas, histories, names, and objects in multiple dimensions that can be read in multiple ways. Here, the speculative character of this project is intended to function like a database, affording the reader the chance to draw their own connections and to provoke the forming of new lines for what is possible.

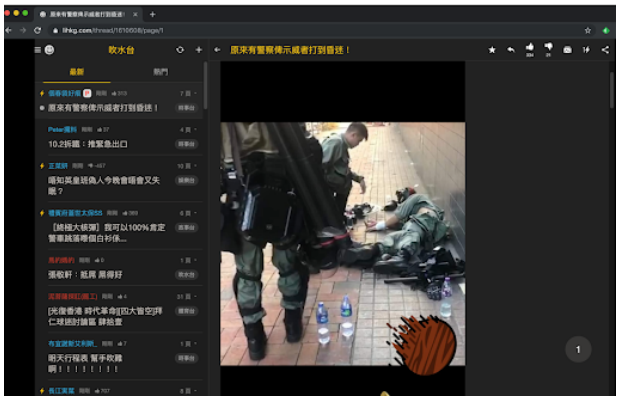
Introduction: Theories of Vision

In a series of days in July of 1999, only a few years removed from having emigrated from Iran, a nine-year-old me sat beside the radio with my parents to listen for live updates coming out of Tehran via the soundwaves of journalist Saeed Ghaemmaghami. He was covering university protests that had broken out to challenge the state-forced closure of a reformist newspaper called *Neshat*. At the time the protests were the most serious contestation of the Iranian government's repressive tactics. Ten years later, more widespread protests blossomed into the Green Movement, this time challenging the process behind the results of a suspicious national election. This time, I desperately tracked the events through content shared on Twitter, YouTube, and Facebook, where Iranians were broadcasting information to one another and the world by circumventing the highly censored Iranian media sphere.

In the late summer of 2019, I spent almost a month in Hong Kong embedded with artists, hackers, and activists on the frontline of the movement against the extradition bill mandated by the Chinese government. I encountered a creative deployment of technology, which included the creation of mesh networks, scrambling and destroying CCTV cameras, and encrypting forms of digital communication used for organizing. There to photograph and document this experience, I was confronted by the challenge of representing things that resisted representation. How to capture dissident construction of mesh networks to create mobile Wi-Fi? How to capture new forms of leaderless, digital solidarity?

Images of mesh network hardware in Hong Kong taken by me. August 2019.





Images of protests in Hong Kong taken by me. August 2019. Screenshot of the HK based LIHKG Internet forum used by the leaderless protest movement to organize.

In 2020, I joined massive uprisings across the United States to demonstrate against targeted police violence and institutional racism that once again offered evidence for the power of digital documentation and distribution to mobilize action.

A quote tweet on the social media platform X (formerly Twitter) by American historian Thomas Sugrue showing protests in Philadelphia, which I retweeted on June 6, 2020.

In early 2023, another large liberation movement in Iran, this time more intense and revolutionary than ever, took place across the nation. Instagram, Signal, Telegram, TikTok and WhatsApp were adopted in addition to X (Twitter), YouTube, and Facebook as communication channels connecting Iranians and the world, a small but vital lifeline in the daunting challenge to state authoritarianism. And then in the autumn of 2023, the streets of cities around the world flooded with people calling for Palestinian liberation in response to witnessing brutal images coming from digital devices in Gaza, despite the efforts of the Israeli state to cut telecommunications and deny media access to the besieged enclave.

Photo of Iranian woman Jina Mahsa Amini provided by her family. Her name, and this image, became the rallying symbol behind Iran's Woman Life Freedom movement against state patriarchy and brutality in Iran.

***Disruptions* (2015-2017) by artist Taysir Batniji collates 86 pixelated screenshots taken between April 24, 2015 and June 23, 2017, during several WhatsApp video conversations the artist tried to have with his mother and family in Gaza.**

This project comes out of experiences that undeniably point to the stakes of digital information, namely images, as a new kind of forum for public opinion and the struggle over truth. To think about what digital images are requires an understanding and definition for computation, the Internet, and pictures, and the role these play in human perception and communication. Attempting to re-frame these otherwise banal categories we take for granted is productive for any analysis of the infrastructures of the digital. How does this broad category of computational images, representative of a new kind of computational mediation, alter what we can think and speak?

I don't claim that broadly distributed digital communication is a cause of these deeply social and political movements cited above, but it's clear that its effects produce a more immediate and decentralized spreading of words and images than older forms of media. More effective documentation and communication, however, are not guarantors of a successful or liberating outcome. The bleak stalemates of the Arab Spring and the Syrian civil war despite the inclusion and affordances of new technological media is evidence for the undecidability of their influence. Images, both old and new, can inform, document, store, move, inspire, enrapture, lie, deceive, confuse, and condemn, but claiming any one inference or ontology as absolute is spurious.

The optimism that coincides with public documentation of abuses of power and the potential for connecting across and beyond state lines is also weathered by a complex set of variables that have shaped the history of computation and digitization when it comes to images. Increased levels of user anxiety, bias, pornography, addiction, polarization, the concepts of post-truth and fake news, disinformation, misinformation, data leaks, cyberattacks, surveillance, and phishing bots are just some examples of

digital media's challenge to our lives. Still, ambivalent outcomes don't diminish how influential digital phenomena have become for how we think and communicate.

This project is theoretically motivated by the question of what it means when information becomes digitally objectified. Setting parameters to this hard-to-pin question helps determine what implications computation has on how we experience reality today. Throughout, I rely on the concepts of the *digital* and the *computational* in ways that are mostly interchangeable, but I hold onto the distinction that digital phenomena can also exist outside of abstract algorithmic systems used to complete tasks *i.e.*, the computational.

The digital generally refers to the discrete numerical units of computing called bits that form the programming languages of all current computers not based on quantum mechanics. Although accurate to describe the bit's logic of *1* or *0* (yes/no), the digital fails to account for how quantum computing mediates information beyond the binary states of classical computing. I rely on both the digital and the computational, however, as concepts to refer to the milieu of electronic devices that require information to be coded in ways that an algorithmic machine can process.

Representation

The specific object of genealogical and theoretical analysis in my project is images, where the fixed idea of representation in Western visual epistemology is breaking down with the added layer of computational languages (*e.g.*, bits, JavaScript, Python) now made responsible for mediating all visual things that exist on computer screens. In order to make claims about images I consider and move between specific events, artifacts, and tools, and between systems of thought, histories of technology and art, and ways of producing and knowing truth.

What is called representation in the English language has a long history specific to the study of thought, language, and aesthetics, most generally referring to a system of communication in which signs stand for referents, where one thing means another thing. The crux of its epistemological value as a concept in my project is that it captures the link between sense perception and understanding or meaning. My intervention unfolds around how the concept of human representation is transformed by the ways computation has entered the equation of reality as an increasing influence in the mediation of truth and everyday common sense.

Representation forms the basis of knowledge and social reproduction, and thus, any meaningful changes to it bring to bear new conditions for politics evidenced by the experiences outlined in the opening pages. The influential work of Jürgen Habermas, *The Theory of Communicative Action*, offers a lucid description of how modern speech acts convey legible meaning when received in the context of a speaker's deliverance, including the affective intention to convince. Applying his framework for language to images, I contend that transparency, intent, and conviction dissolve in the thickness of computation: code, data, protocols, and pixels add layers of mediation that entangle communication in a complex new web. Communicative acts mediated by computation are subject to forces that can intensify, ambiguate, and fragment discourse.

Commenting on deception producing a particular kind of cynicism, Hannah Arendt warns of a resulting refusal to believe in the truth of anything at all, no matter how well established. What follows, she claims, is not the substitution of lies for truth, but a dissolution of the means by which we can even try to judge between the two. An endless possibility of lies can take hold: "…those who adjust images and stories to ever-changing circumstances will find themselves floating on the wide-open horizon of potentiality, drifting from one possibility to the next, unable to hold on to any one of

their own fabrications."[3] Arendt's caution against the relinquishing of factual truth to "image-makers" in the late 1960s is a prescient resource today amid the trend of intensifying divergence across media over the meaning, intent, and factuality of almost everything.

Concerning a specific theory of images, I follow W.J.T Mitchell in distinguishing between *picture* and *image*. Where pictures are concrete objects, images are virtual and phenomenal appearances presented to a beholder through objects. "To picture" is a deliberate act of visual representation, whereas "to image or imagine" is more elusory, general, and spontaneous.[4] Pictures–and photographs–can be taken, while images are made. I think about what to make of images that are made today, co-constructed by sets of computational logic that test the limits of human representation.

Representation is insufficient as a concept to explain instances when images are made and distributed between machines with either subperceptual or little to no human intervention. Here, I identify the capacity of art to transfigure (transmogrify, transduce) the illegibility of computation and Artificial Intelligence (AI) into new pathways for experiencing the world through material investigations that gesture towards the possibilities of difference. The open indeterminacy of computation affords an opportunity to decenter normative ideas of what is defined and counted as rational and human.

Firmly in an epoch of algorithmic culture, where computational agency, intelligence, and creativity are legitimate ideas to ponder, I also want to think about its history and its politico-epistemic effects on images. I argue that at its most insidious, the

[3] Arendt, Hannah. "Truth and Politics." *Between Past and Future: Eight Exercises in Political Thought*. New York, Viking Press, 1968, 257.
[4] Mitchell, W., *Representation*, in F Lentricchia & T McLaughlin (eds), Critical Terms for Literary Study, 2nd edn, University of Chicago Press, Chicago, 1995, 4.

computational automation of imaging and sight (the statistical gaze) leads to second order social consequences that intensify sensory-overload (chaos or arbitrariness or unknowability) and leads to new ways of monitoring, measuring, predicting, commodifying, and controlling individuals and large groups of people. In the case of the computed image, examples are often more quotidian, and include machine learning (ML) models such as generative adversarial networks (GANs) and diffusion techniques, drone vision, facial recognition programs, and computer-generated environments and decision-making processes. In rare cases, they include sublime scientific and artistic outputs that I will consider as a counterweight to the banal and the surveillant.

By second order consequences I mean ones that are not the direct goal of technological development but nevertheless part of its outcomes. Two specific consequences I identify are: 1) the ways in which human correspondence with social reality is obfuscated and homogenized by narrow commercial applications of computation, and 2) how the ubiquity of surveillance as an outgrowth of computation is changing the form of power dynamics.

My unit of analysis follows the development of computation and is thus not reducible to one society or individual, although I focus mostly on its Western origin story and implications. When I consider social relations, I mean the interactions among organisms that live and commune together. Human social relations are increasingly complexified by myriad variables that affect how we communicate, think, exchange, and live. I consider the effects of computation within this broader framework of the social, which also encompasses culture.

My argument implies that computation, as a new form of visually mediating the world, enables a deluge of opaque image production that challenges and changes how we can know or make sense of things. For example, an analysis estimated that from

2022 to 2023 alone, AI was used to produce 15 billion images, a figure that took photography 150 years to reach (circa 1826 until 1975).[5] My argument also implies that beyond simply facilitating this torrent, the human-produced deluge of computation is responsible for the development of visual surveillance tools that enable new ways of measuring and governing people.

These two implications sometimes overlap, and other times are distinct. They are both critical for locating the changing place of the human within a contemporary life replete with computational objects. The inquiry into computational images implicates the histories of communication, art history, politics, photography, math, computation, cybernetics, military-industrial R&D, and capitalism.[6] In relation to the field of media studies, digitally computed images also raise a series of important questions regarding the boundaries of mediation.

Mediation

The term mediation is a cognate to media, the plural form of the noun medium, a Latin word rooted in the late sixteenth century that denotes a middle ground or quality which holds a middle place or position, and through which a force or quality is conveyed. From this etymological position, media is more polysemantic than what is suggested by the popularly known term mass media, popularized in the twentieth century to describe communication and distribution platforms like print publications, radio, cinema, and television.

[5] Valyaeva, Alina. "AI Has Already Created As Many Images As Photographers Have Taken in 150 Years. Statistics for 2023." *EveryPixel Journal*, 15 Aug. 2023, https://journal.everypixel.com/ai-image-statistics?fbclid=IwAR3Su07k8NJPE4Xd3e2x9VFgbhYrX18FESM4HQBuUac4x7NTqduB7iyOJRk. Accessed 2024.
[6] *Computational* and *digital* will be used interchangeably throughout this dissertation.

In the mid seventeenth century, Galileo Galilei uses media to refer to air and water in his explanation of the physical properties of force and motion.[7] Within this ontological framework of media history, John Durham Peters offers a similarly elemental entry, arguing that water, fire, and earth constitute the entire backdrop for human mediation and can thus be helpful in rethinking media altogether.[8] He asks whether we ought to readjust the model for communication by moving beyond the framework of two humans sharing thoughts to one where agents are understood to be co-evolving with their environment.[9]

Rather than searching for an *arche*, or ontological origin of computational images, I consider them through a philosophically related concept called remediation. Inspired by the Hegelian notion of *Aufhebung*, which describes the relationship between two things wherein one sublates (absorbs or assimilates) the other, both abrogating and preserving it, remediation is proposed by Jay David Bolter and Richard Grusin as the process in which one form of media is metabolized by another. For example, speech is remediated in writing; writing is remediated in books; drawings are remediated in paintings; paintings and text are remediated in photography; sound is remediated on records and radio; sound, text, images, and even theater are remediated in film; and so on. Instead of a teleological understanding of media development, I apply remediation as a relational understanding that connects media to the entangled ways meaning and truth are produced in a given time.

Bolter and Grusin also claim that Western culture since the Renaissance is

[7] Galilei, Galileo. *Dialogues Concerning Two New Sciences*. Macmillan, 1638.
[8] The Greek pre-Socratic philosopher Thales believed water was the single substance from which all nature was derived.
[9] Peters, John Durham. *The Marvelous Clouds: Toward a Philosophy of Elemental Media*. United Kingdom, University of Chicago Press, 2015, 4.

different in the way that it "wants both to multiply its media and to erase all traces of mediation."[10] Transporting physical life into the metaverse is one example of this logic. The most extreme application might be Elon Musk's proposed Neuralink; creating implantable brain-machine interfaces that would purportedly communicate through brain activity alone and erase the need for speech or gestures. In a similar vein, new studies are attempting and succeeding at decoding visual stimuli from brain recordings through machine learning (ML), allowing models to reconstruct images from human brain activity alone.[11] The idea: to completely forget the fact that you have hardware implanted in you. The contradiction: feel more liberated than ever while beholden to a constructed, technical product.

Katherine Hayles claims that remediation always entails translation, and that translation always entails interpretation.[12] In the process, something is lost, and something is gained. Another way to put this is that compression is almost always lossy. She dubs the encounter between older cultural practices associated with analog media and the strange flatness of digital media as intermediation. This concept feels useful in thinking about the back-and-forth transfer of knowledge between human and machine intelligence. Intermediation forces us to rethink fundamental questions such as "what is a text or an image?".

Answers to this question can reveal surprising epistemic nostalgia for a specific medium from a specific time and place that comes with its own historical limits. There is no convincing reason to prioritize one definition. In his approach to such a question,

[10] Bolter, J. David and Richard A Grusin. "Remediation." *Configurations*, vol. 4 no. 3, 1996, 311. Project MUSE, doi:10.1353/con.1996.0018.
[11] Chen, Zijiao, et al. "Seeing beyond the Brain: Conditional Diffusion Model with Sparse Masked Modeling for Vision Decoding." *ArXiv:2211.06956 [Cs]*, 14 Nov. 2022, arxiv.org/abs/2211.06956.
[12] Hayles, N K. *My Mother Was a Computer: Digital Subjects and Literary Texts*. Chicago: University of Chicago Press, 2005.

Jacques Derrida suggests the necessity of troubling (or putting "under erasure") any one answer that tries to stake a definitive claim. There has never been a "genuine" or original concept of representation, only its trace. Or rather, all iterations are differences of the same essence, dependent on a set of contingent linguistic conditions.

Computation and AI

The remediation of images by the process of digitization through computation has significantly altered their form and relation to humans. Depending on your level of exposure to screens, the number of digital encounters with images now outstrip analog encounters. The ontic function of images is increasingly less about direct visual representation and more about the facilitation of computational information. The shift towards a digitized culture, or what Tiziana Terranova calls network culture, involves a translation of visuals into machinic language that numerically and textually code and cross-categorize images into bits before pictorially representing them. Machines do not see and communicate through optical systems and signs like humans and animals.

This shift to computation has enabled the path that leads to the invention of Artificial Intelligence. From the incipient days of the modern computer, figures like Alan Turing and Frank Rosenblatt conceived of it as a project to birth a synthetic form of intelligence. Today, the process of computational image production is increasingly automated through the integration of AI. From subtle processing techniques to entirely synthetic images, the role of machine learning grows as a co-constructor of visuality and truth. ML is the umbrella term covering AI research that focuses on how deep neural networks learn from large datasets to produce a variety of desired (and undesired) outcomes through prediction. Since the early 2010s, ML has increasingly become the dominant form of AI research and engineering.

In 2016, DeepMind's AlphaGo model famously defeated Lee Sedol, one of the best ever Go players in the world at the peak of his abilities. The wickedly inscrutable yet ultimately shrewd moves played by AlphaGo marked a cultural tipping point for the realization that AI and its bizarre forms of understanding had arrived. The system didn't simply appear to win through its capability of sheer calculation of possible outcomes for each move, but rather through novel approaches and improbable decisions that defied the wisdom amassed by the masters of the art of Go over 2,000 years since its creation in ancient China. By training on millions of historical human examples and then playing against versions of itself thousands of times, it was able to extrapolate moves that defied human logic in novel ways.

Integral to the architecture of today's most successful ML models similar to AlphaGo are dozens of layers of artificial neural networks, designed to mimic how neurons fire and connect inside the human brain. As an input signal moves through the network during training, each node in these layers is forced to compress and learn (extract) features about its data, which it then transmits to other nodes. These transmissions, called weights, resemble synapses in the brain and are adjusted and optimized during training to guide the learning process towards desired outcomes. The weights store what, and how, the network has learned to create valuable relationships it can use to predict or generate new outputs similar to the data used to train it.

A basic example is a convolutional neural network (CNN), often used for computer vision tasks such as object recognition and image classification. The network, trained on a dataset comprising thousands of labeled images of animals (turned into numerical information called tokens), will learn to classify new images of animals with a really high degree of accuracy.

The larger the dataset, the greater the number of layers with nodes inside, and the more the training process is repeated, the more effective the results of this process of deep learning. In other words, scale leads to better capabilities. This reality is why only a few large companies have thus far been capable of creating foundational generative AI models such as Open AI's Generative Pre-trained Transformer (GPT) and Anthropic's Claude that rely on a specific architecture called a transformer first conceived at Google in 2017 for language translation.

Generative models go beyond classification, and the successful transformer in particular relies on what is called an autoregressive attention mechanism to provide high probability predictions in a sequence. For a simple example, in the cliché "better safe than…" a language transformer model will quickly calculate a really high probability for "sorry" as the next word. I will come back to different AI architectures in various contexts, including ones made for image generation specifically, which are often combined with the transformer architecture.

The hardware involved in AI–thousands of expensive graphics processing units (GPUs) or tensor processing units (TPU) running on data from storage centers in a highly energy-intensive process over many months at a time–in addition to the labor of researchers and workers in the global South fine-tuning and filtering results mean that training processes can cost hundreds of millions of dollars each time (not counting regular operation and maintenance). Representative of the techno-determinist ethos, OpenAI's Sam Altman has stated that compute power will be the most important commodity of the near future, and it will provisionally function as a new form of currency.[13]

[13] Friedman, Lex. "Sam Altman: OpenAI, GPT-5, Sora, Board Saga, Elon Musk, Ilya, Power & AGI." Lex Friedman Podcast, March 18, 2024. iTunes.

The most valuable connections made by a deep learning AI model occur in what are known as hidden layers, a latent space where models represent some correlational structure of their input data. Designed via principles of topology and vector mathematics, the latent space, which informs the kinds of inferences and outputs any given deep learning model can make, is the epistemic space that comprises the so-called intelligence associated with machine learning. In other words, the latent space of representation is perhaps the equivalent of a world model for this new machine.

Yet, what is this representation of data when it is latent, emerging in high-dimensional space opaque to human comprehension? In decisions made by AI, the question of why is subsumed by what. Correlation rather than causation is all we get for now. One potential beauty of emerging AI is how it presents a rupture in the theory of language, creativity, and logic that demand semantic coherence.[14] The abstractions mapped inside the layers of a neural network challenge and potentially transcend the requirements of human representation. Contained within them are patterns of thought that we can never consider, devoid of human comprehension. In this way, AI presents the potential for solving some intractable problems and understanding the universe deeper.

Anil Bawa-Cavia writes that there is no necessary *bijection* between language sets–different vocabularies do not necessarily correspond.[15] If indeed we are now confronted by a profoundly new form of inhuman intelligence we have birthed, how do we interface with it, and what are its limits? Can everything in the world be encoded

[14] I view artificial intelligence as both a field of research and a technology. I define it technically as a set of programmed instructions for predictive systems that can learn to evolve beyond their initial inputs and process human-level tasks (in some common ways not as well as humans, in some complex ways exponentially more efficiently than humans).
[15] Bawa-Cavia, Anil. *Arity and Abstraction*. Glass-Bead. http://www.glass-bead.org/research-platform/arity-abstraction/?lang=enview. 2017.

and predicted probabilistically by billions of artificial neurons running on finite datasets such as the corpus of human language found on the Internet?[16] This is the expensive bet being made within much of the current market for AI. The push to compress, or abstract, images into classifiable computational information is a part of this trend.

Algorithmic Capitalism and Computational Reason

As computing power and algorithmic sophistication expand almost overnight alongside technological demand, new subfields such as computational photography have emerged to completely restructure how we humans produce, organize, and relate to images and visual representation. Although still very much material in the sense of requiring electrical signals, energy, hardware, and human labor, the network culture that upholds computational images adds new layers of abstraction on top of previous forms of media. New logics and properties emerge that, for example, unsettle our ideas of three-dimensional Euclidean space and chronological time. A machine can hold perspectives in nearly infinite ways, while digitization can collapse past(s) and present(s) into nearly instantaneous connection. Already in the late 1980s, art historian Jonathan Crary anticipated how the technical assembly of computer graphics nullified "most of the culturally established meanings of the terms *observer* and *representation*."[17] One can now ask, without adequate certainty one way or another: for an image to be, does a rational agent have to observe and process it?

The fields of computer vision and computational photography emerge from the material modes of production precipitated by contemporary capitalism's increasingly digital, networked, borderless, and automated form I call algorithmic capitalism. The

[16] I capitalize Internet, Western, and Artificial Intelligence to denote the particular historical character of these terms that are not general categories.
[17] Crary, Jonathan. *Techniques of the Observer*. MIT Press, 1996, 1.

circuitry of electronic technology finds its parallel in the circulation of commodities in a feedback loop operating at hyper speeds. The derivation of immanent value in developed economies today is reified in services, transactions, loitering, and clicks that increasingly play out online. Interconnected and progressively abstract with relatively stagnant national growth rates yet ever-soaring corporate profits and stock prices, the global economy of today might best be compared to a video game whose rules are arbitrary and its mechanisms computational.

This comes as supply chains, manufacturing, and warfare trend towards increasing automation. As digitization is merged with protocols for automation like machine learning that augment or replace human volition with machine intelligence, Enlightenment conceptions of representation and the autonomy of human reason are suddenly under threat of dissimulation. This new form of rational computational reason is part of a series of mathematical moves in the twentieth century to produce foundational proofs of logic through abstraction. Discoveries in general relativity, quantum mechanics, and logic upended the foundations of knowledge while war or its specter haunted Europe. Nascent forms of computing were made in service of military technology in light of these ruptures through contributions from European/American mathematicians such as Turing, Georg Cantor, David Hilbert, John von Neumann, Nobert Wiener, and J.C.R Licklider.

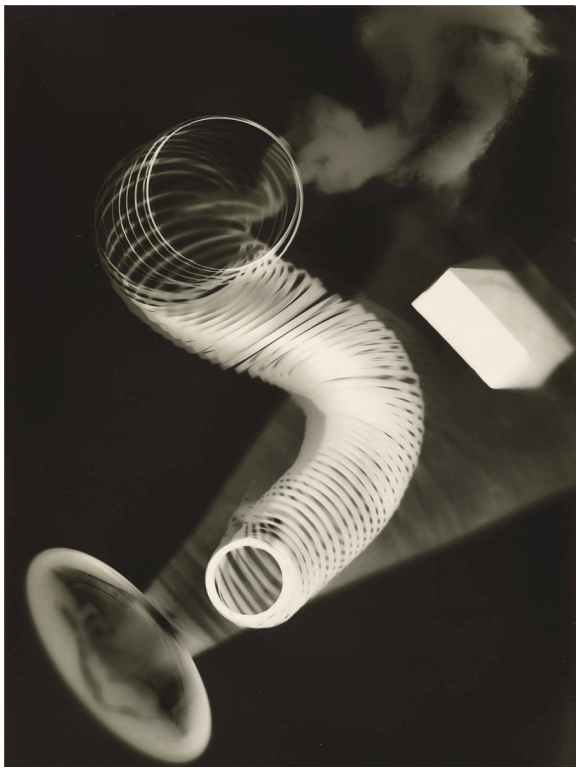
The question of how drastic of a break modern computational reason offers from a historical standpoint can go both ways. Although it emerges in a specific time, place, and milieu, one can also track a continuation with centuries of mathematical breakthroughs across cultures that have contributed to a logical understanding of the universe. A mundane example is the etymology of the word algorithm, which is the

Latinized translation of the name of the eighth century-born Persian mathematician Muhammad ibn Musa al-Khwarizmi.

The basic computer arithmetic that allows for the digital image to exist in the first place is an abstraction of reality into binary formalized by Gottfried Leibniz at the turn of the eighteenth century. The first recorded history of binary digits dates back to ancient Egypt. Leibniz, who was revered by the cybernetics movement, sought in the binary system he helped make famous a way to bring together his philosophy and his fascination with how God could create something out of nothing–*ex nihilo*.[18] I engage with postwar cybernetic history as a philosophical precursor to the computational age of the twenty-first century. Namely, I'm interested in the cybernetic view of knowledge as a theory of information and systems.

In some ways, modern artists inaugurated the onslaught on visual representation before modern computing emerged, flipping the subject of an artwork back onto itself. Man Ray's *rayographs* from the 1920s created photograph-like images without cameras through direct exposure of objects onto photosensitized paper. The purpose, however, was precisely to acknowledge the medium, not efface it.

[18] Leibniz, GW. "Letter H." Received by Joachim Bouvet, 15 Feb. 1701, Brunswick.



Man Ray. Untitled Rayograph, 1922.

It is therefore productive to find distinctions and situate the present in its specific context against the past in the way that Giorgio Agamben echoes Walter Benjamin when he writes: "the historical index contained in the images of the past indicates that these images may achieve legibility only in a determined moment in their history."[19] I attempt to make legible the images of today in a determined moment in their history.

Admittedly, human history is rich with changes that both enhance our capacity for knowledge and distort it. Reflecting on technical developments warping Weimar Germany in the 1920s, Benjamin's poetic ambivalence allows us to ponder what qualities remain the same amid rapid technical changes. On the effects of the typewriter on language, for example, he muses:

> The typewriter will alienate the hand of the man of letters from the pen only when the precision of typographic forms has directly entered the conception of

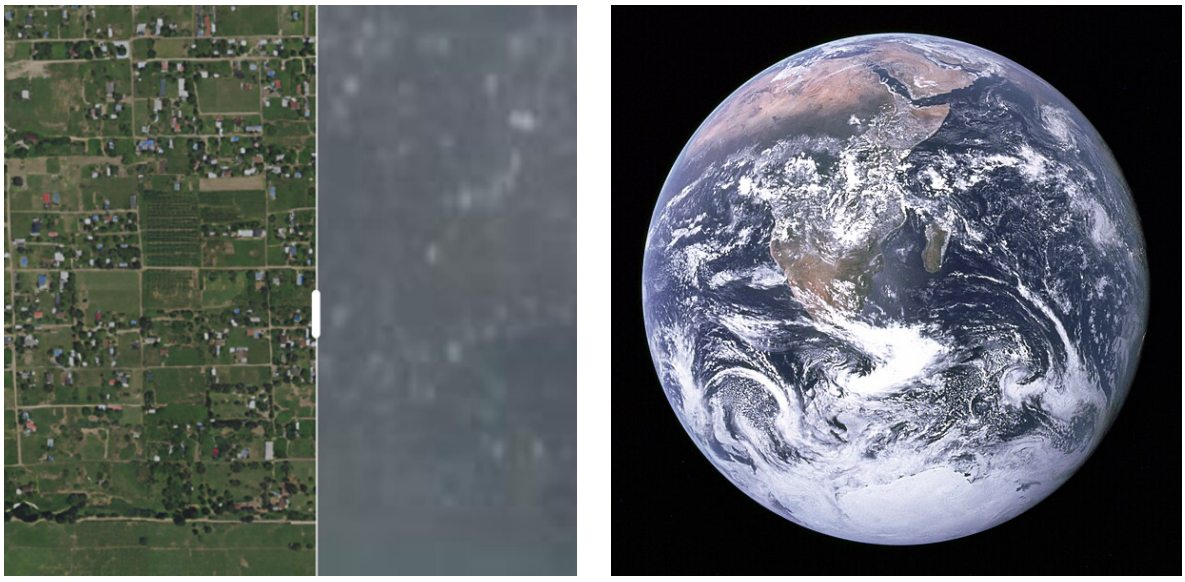
[19] Agamben, Giorgio. *"What is an Apparatus? And Other Essays*." Stanford University Press, 2020.

> his books. One might suppose that new systems with more variable typefaces would then be needed. They will replace the pliancy of hand with the innervation of commanding fingers.[20]

His shrewd anticipation of the proliferating forms of technical expression to come also contains the insight that the pen is already a historical technology that has impacted both language and humanity. All of this is to say that change, including within visual media, is a complex, contingent nexus that can hardly be reduced to one cause or outcome.

For example, computation can enable real time speech translation, potentially even among different species.[21] It can be used to visualize climate change and biological proteins that are far beyond the limitations of human sight. Some believe that visualizing climate change, for instance through high resolution satellite imagery of deforestation or canopies enabled by AI, will bolster public consciousness the way the first spherical image of Earth from space, known as The Blue Marble, allowed for a planetary conception of life that spurred the environmental movement. In this context, I explore visualizing astronomical and cosmological phenomenon like black holes as objects of a new computational sublime.

[20] Benjamin, Walter. *One-way Street and Other Writings*. Penguin, London, 2009. 64.
[21] Beguš, G., Zhou, A. & Zhao, T.C. Encoding of speech in convolutional layers and the brain stem based on language experience. *Sci Rep* **13**, 6480 (2023). https://doi.org/10.1038/s41598-023-33384-9



On the left, the difference between an AI-generated (via upsampling) high-resolution image of Nakuru, Kenya and a low-resolution image of the same location taken by Sentinel-2. Credit: Allen Institute for AI. On the right, *The Blue Marble* image taken by the Apollo 17 crew in 1972.

Computational Images and Empiricism

A motivation for my project is to find a framework for describing and affecting the new realities of computer vision and photography, which confound traditional semiotics. They allow for an open-ended production and control of digital images and image databases that refract our contemporary philosophical, sociocultural, political, aesthetic, ethical, and technological parameters. Computational photography, a subfield of computer vision, is now the dominant technical form of image production.

The implications of computational images and how they are produced and disseminated is under-researched. Specifically, my intervention tries to address how computation in commercial imaging products can tend to make the discovery of the unforeseen and the marginal harder by limiting images to an abstract calculation of an average probability based on past data. Within calculational logic, images mean less on their own than they do in relation to each other. Computationally produced images are a specific product of data compression fed to a computing system. Computational

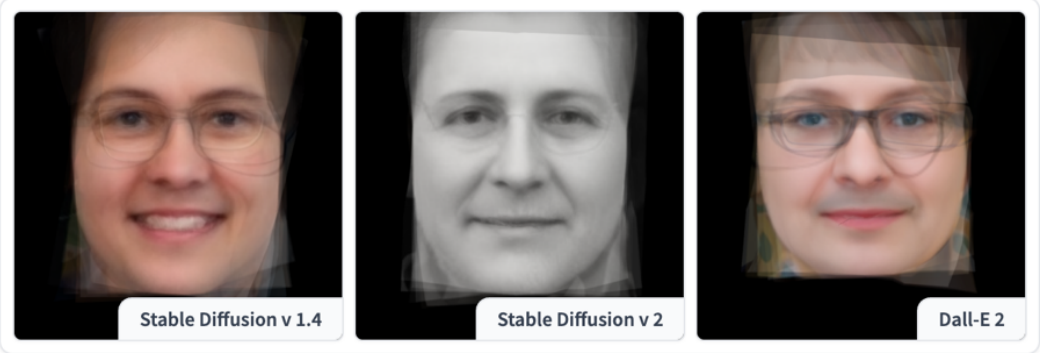
photography, in particular, is the process of digital imaging that relies on algorithms and software instead of optical processes. It is a development in imaging that follows film and then digital photography.

In my project, I define computational images as the evolved extension of machine-readable digital images. In the networked infrastructure of digital culture, images are produced and received in hybrid forms between physical parts that trace their origin to photography and machine-readable digital information that affect both how an image is made and where it ends. We can think of this photographic evolution as a spectrum between the chemical-filmic and the abstract-computational, at the latter end of which exist forms of imaging that are more alien to photography's origins–no lenses, no filters, and all computational processing. Thus, in contemporary reality the human optical system is one part of a larger loop of information processing.

This is not just true of image generators such as Dall•E, Firefly, Imagen, Midjourney, or Stable Diffusion that have captivated the public, but it's also how mobile phone cameras have been producing images for years and how drones and cars can be taught to "see" the world. I argue that the complete automation of images can strip the crucial historico-cultural context that situates artifacts in their present. After all, creative or documentation choices are not solely about form but also a situatedness that an artist or journalist might take into consideration that are not yet–and may never be–computable. On this point, the datasets of present generative large language models (LLMs) crucially lack a sense of chronological order for their training data. This means they currently lack one of the most significant aspects of social awareness: an idea or thing's emergence and subtle relevance in a historical formation. Every event is collapsed into one synchronous instance.

The cliché narrative in blind support of technology claims that it is an empowering and democratizing force that extends the space of what is possible. But what if computed and increasingly automated images are instead homogenizing visual production in a glut of instantly recognizable outputs trained from a chronologically flat Internet? Meanwhile, once the outputs are fed back into the computational models as new inputs, the loop will shrink even smaller and further corrupt the results.

Here, the statistical logic of generative AI images shares a troubling history with the pursuit of genetic superiority in the eugenics movement that relied on principles of statistics such as archetypal averages. In particular, the probabilistic logic of generative AI images resembles Francis Galton's composite portraits of 1878 that attempted to render an idealized form of a murderer. Galton believed he could objectively produce the phenotypic face of a murderer by taking mechanical averages of portrait photos of previously known assailants. Similarly, computer vision is a function of an inherently statistical process tied to its "ground truth," its reality baseline, which is just the data and architecture used to produce it.



A composite face emerges from hundreds of outputs generated from the prompt "Teacher", showing each model's average representation. Credit: Hugging Face.

Finally, to what extent is computation distorting in real time the reality we perceive with our senses? Ubiquitous interfacing with different screens and different

computational simulations guarantees an intensified divergence in shared reality, making the establishment of a baseline increasingly more difficult to imagine in the way Arendt warned. These challenges should not be read as a romantic longing for the past, but rather as an opportunity to think with and beyond the modern notion of technology. If what is commonly referred to as technology is an accomplishment of human activity, it also needs rethinking to account for new overflows escaping its borders.

The way we think about technology today is still largely tied to the modern differentiation between the categories of human, nature, and machine. In this formulation influenced by the Copernican turn and by what is grouped together as Enlightenment thinking, vision is granted a monopoly over access to truth. In the major Western lineage of how we know what we know, what is considered epistemology, the shift from the Greek notion of divine *noemata* to the modern priority given to empirical perception marks a significant rupture.

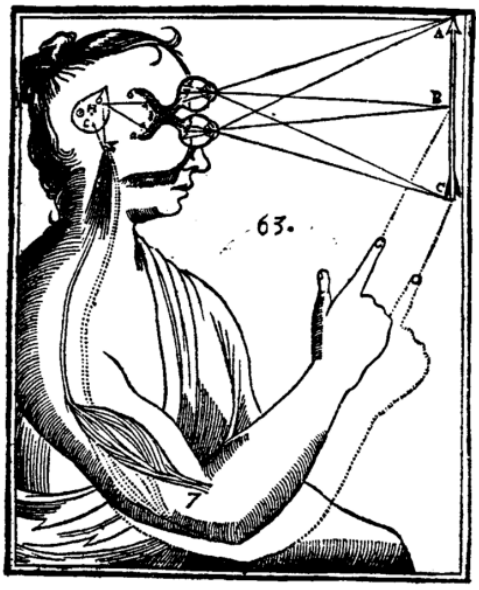
Notable contributions by Leon Battista Alberti, Leonardo Da Vinci, Gerardus Mercator, Galileo Galilei, and Johannes Kepler in the fifteenth, sixteenth, and seventeenth centuries helped carve out the framework for a relationship to truth based in the fidelity of visual sensory experience, rather than one based in access to divine forms and eternal essences. For Alberti, the geometric and perspectival process of seeing enabled the creation of an indisputable basis of knowledge that drawing and painting could perfect. This is an assumption poetically exemplified in the geometric artworks and scientific writings of Da Vinci.

Mercator produced a world map in 1569 with Europe in the center that set a major precedent in cartographic history. Galileo and Kepler, inspired by Ibn al-Haytham's theory of vision, embraced the notion of optics and its relationship to truth.

They became one of the earliest inventors of the telescope and both pioneered enduring work in the field of astronomy.

Rene Descartes' influence is perhaps the greatest in mathematicising the world of *res extensa*, or matter extended into space. The Cartesian coordinate system enabled the exact measurement of spatial points in a plane that are still dominant in the way we navigate the world today. David Hume and Immanuel Kant both loosely followed Descartes in explicating human knowledge by way of sensory experiences mediated by the mind, separating a knowing subject from the objects it can know.

In the span of a few hundred years in Europe, vision and empirical representation acquired a universal truth-producing quality that formed a new ethical basis for rational objectivity. This new ethos translated to scientific processes and included the formalization of optical systems such as the telescope, the microscope, and the camera obscura. The Cartesian and Galilean impulse became the language of science and mathematics, of which photography and photogrammetry emerged as emblematic.



Sketch from Descartes' 1644 *Principles of Philosophy* diagrams. Captures Descartes' theory of vision, which posited that light rays impressed particles into the eyes. The image was then transmitted to the pineal gland, which served as the connection between the mind and body.

What was a triumph for reason, though, also comes with dark downsides. This impulse for reason can quickly turn into positivism, what I define as the desire for a logically provable reality, which can be a modern source of dogma and domination. It can turn into fascist obsessions with purity and perfection, or order and dominance. This dialectic between reason and its pitfalls is present in the history of photography, and it's one that runs throughout my engagement with images in this project. I argue that the epistemological question of representation and computational images is inseparable from the logic of surveillance, control, and commodity production.

Aesthetics as Ethics

Within the contingent relationship between vision, truth, and politics, Jacques Rancière's critical concept of *the distribution of the sensible* provides a helpful framework for how the conditions of sensing can delimit what can be thought at a given time. In *The Politics of Aesthetics*, he defines this idea in the following way:

> …as the system of *a priori* forms determining what presents itself to sense experience. It is a delimitation of spaces and times, of the visible and the invisible, of speech and noise, that simultaneously determines the place and the stakes of politics as a form of experience. Politics revolves around what is seen and what can be said about it, around who has the ability to see and the talent to speak, around the properties of spaces and the possibilities of time.[22]

For Rancière, politics is understood as the determination of possible identities, activities, claims, and spaces. It is just as much about occlusion as it is inclusion. The thinkable and the possible interplay with the spatially and temporally visible. The fictions of art, according to him, point to what Michel Foucault called heterotopias rather than utopias. That is, they can exist in the margins that defy normative representation, suggesting the unthinkable and unsayable.

[22] Rancière, Jacques. *The Politics of Aesthetics*. India, Bloomsbury Academic, 2013, 13.

Vision, the visible, and images are imbricated in a relationship of political subjectivity. The material conditions of visuality produce the epistemic conditions for representation. In this context, images take on a crucial relationship to thinking and governance that ought to be subject to an ethics of seeing I will explore in more detail. Much has been written about the impact of images on politics, truth, and thinking, but less so on how the technical transformation of image production and distribution modifies this impact.

Admittedly, ethical principles can be both hard to define and slippery. They can unintentionally turn into obstacles to ethical evolution. However, without a baseline ethics any argument can become arbitrary. I want to stake an ethical position that admits respect for animate matter, including human and nonhuman, and value the autonomy to think and be in the world without domination or control that fall outside of criticism.

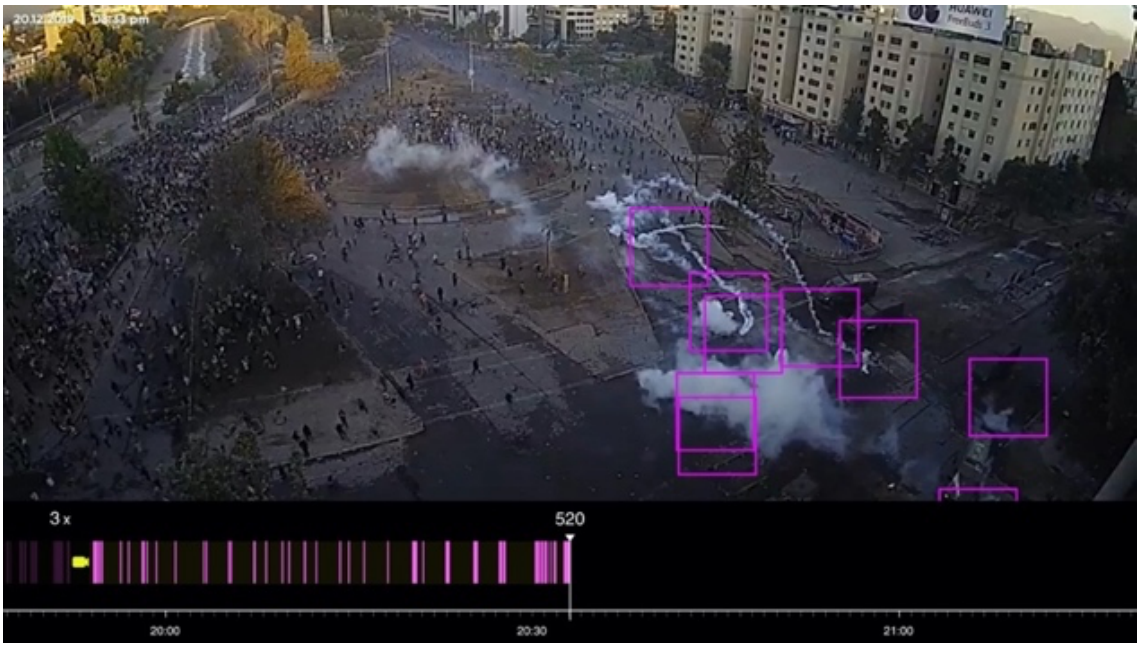
Without the presence of an ethical discourse, change in the broad field of computation can take any direction with any consequence and still be heralded as radical progress, a phenomenon related to what is called the AI alignment problem. Alignment is a field of research and goal for AI systems to produce outcomes that are intended by their creators, usually for the betterment of humans. The choices of these creators bring into question what better and human mean and who gets to define them. What for and for whom do we want to optimize the world? The challenge at hand is to balance ethics without creating a normative prison anchored in the past, and instead comport towards a future that can be different than today.

This dissertation will unfold over six chapters that in sum attempts a genealogical undertaking of the computational image to reveal what is possible to think about it today. By genealogical I mean a method of analysis that is more like what Eyal

Weizman and Mathew Fuller define as investigative aesthetics. Rather than critique, the practice of investigative aesthetics involves creating observable composites using various signals that include forensic, technical, material, cultural, political, and ethical evidence. Various online and offline methodologies are combined together in transdisciplinary or antidisciplinary work to render the causes of an event or the existence of an object visible.

Practitioners deploy computational methods within legal, forensic, artistic, and critical frameworks. For instance, witness testimony might be used to create three-dimensional spatial renderings that are combined with automated open-source image analysis to help piece together evidence for specific incidents to be presented in a legal forum. Or it could be presented in an artistic forum, implicating the funding sources of cultural institutions with ties to the military-industrial complex.

Investigative aesthetics takes seriously the material conditions through which events occur and attempts to create a public alternative to facts presented by power-holding actors. In so doing, it also points to longer historical processes that shape events and outcomes in the present, what I think of as the archaeology of an event. Weizman and Fuller leverage the technical in the spirit of producing a commons for knowledge that resembles a multisensory, navigable architectural model. To experience and make sense of the world and to feel spurred on to imagine it differently are aesthetic experiences and require investigative practices.



Screenshot of automated video analysis by Forensic Architecture identifying the exact time and location of visible 2-chlorobenzylidene malononitrile teargas clouds used in Plaza de la Dignidad; based on footage from Galería CIMA.

This method expands the aesthetic and logical limitations of a single human subject, and thus expands a collective's ability to sense and reason. I loosely follow their concept of investigative aesthetics throughout in attempting to agnostically make sense of computational logics and practices while retaining an ethical commitment to harm reduction and the principle of freedom. My methodology includes producing an archive, constructing a theoretical framework, empirically testing through technical and artistic practices, and relying on transdisciplinary research and pedagogy to support my argument. The goal of my project is to create an ongoing framework for understanding and producing computational images that is open to new information, new case studies, and new practices (evidence).

Following this **introductory chapter**, the **second chapter** situates the emergence of the computational image within the new political economy and culture of networks. Namely, algorithmic capitalism builds on Terranova's work to lay the groundwork for

understanding the material conditions of the computational commodity. This chapter asks: what does it mean to move away from geographically, nationally bound societies towards borderless networks? And: what does it mean for the image to become a digitally relational commodity?

Chapter three presents a brief history of the invention of what I call computational images. This history dovetails but also departs from the history of indexical photography and human optics. The same chapter then segues into juxtaposing cases of computation that introduce new forms of the sublime and of surveillance, and the interplay between the two. Vis-à-vis the sublime, I consider the art of Danielle Brathwaite-Shirley and the synthetic images of new optical instruments through Fred Moten's notion of the in-betweenness produced by the Black aesthetic tradition. Following Luciana Parisi, I'm interested in how these new technical forms of the sublime can embrace the indeterminacy of being and augment the Kantian articulation of reason and its limits.

Vis-à-vis surveillance, I assemble an archive of applications playing out in the world to deconstruct[23]what it means to eschew human vision in acts of representation and about who is interested in the development of such technologies. The work of Anthony Downey connecting computer vision with neocolonial extraction is deeply resonant to my work in this section. Following Ramon Amaro, I also consider how the commodification of these techno-racial and techno-gendered products leads to reinscribing biased ontologies against people and communities (classes) that do not

[23] By *deconstruction* I mean the literary and ontological methodology influenced by Jacques Derrida's approach to representation that posits the idea that any construction of static signification will inevitably contradict itself and reveal the limits of thought and semiotics if scrutinized closely enough.

conform to certain categorical identifications, and who are already vulnerable to adverse exploitation.

Chapter four engages thinkers and practitioners invested in redirecting technological development in ways that are not only transformative but helpful to people, animals, the planet, and how we conceive of machines. Donna Haraway's speculative cyborg metaphor serves as a hopeful starting point for thinking of paths to transfiguring our new reality in which information equals power over life. I take inspiration from the work of Simone Browne on subverting surveillance, a practice she calls dark sousveillance. I also further explain and expand on Weizman and Forensic Architecture's practice of investigative aesthetics in this section. The goal is to imagine worlds different than the one dominated by technological fatalism.

I reference the work of different creative researchers combining critical analysis with artistic practice, from Harun Farocki to Hito Steyerl and Moreshin Allahyari, who produce new epistemic frameworks through the computational tools they simultaneously investigate and reappropriate. That is not to say they collapse all things into quantifiable systems. As in positivism, this is a presupposition shared by the cybernetic hypothesis launched in response to the reigning chaos of the twentieth century that coincided with the outgrowth of computation. The art and artists I cite break from this tradition even as they wrestle with it. Their examples liberate the imagination from categorical distinctions we have held for a long time and embrace the possibilities of a computational reality that is impossible to ignore.

Hito Steyerl. *This is the Future* still image, 2019.

In *Art and Cosmotechnics*, the philosopher of technology Yuk Hui rightly wonders how the question of Being can once again be incorporated in technology, not in a single and universal way, but rather in a way that cherishes a spirit of multiplicity reflecting the diversity of human existence, creativity, and thought. This demands an understanding of the various roots of technology and how they have developed differently in other cultural cosmologies, such as in China or Africa. Hui asks: how can research and development within technology return to the laboratory of philosophy, where thinking about thinking and ethical questions are always present.

Chapter five is a theoretical intervention in the field of computation. It embraces the philosophical challenge and presents a scaffolding conceptual framework for understanding the epistemological parameters that are at stake in the previous chapters. I draw from a wide range of theorists from different periods and places to help make conceptual sense of the causal forces and consequences that are new in this particular epoch of network culture inherited from cybernetics. Thinking with Ranciére and

reconfiguring Foucault's concept of normalizing panoptic power, I consider how new epistemic-political structures in the era of automation operate. Citing works by Mark Andrejevic, Zygmunt Bauman, and Wendy Hui Kyong Chun is helpful for understanding how representational forms of power are expanded by the implementation of automated, constant, and concealed forms of surveillance and data production. Furthermore, I analyze how the productive role of ideology under capitalism drives consumers today to (in)voluntarily consent to this new system of exchange and value.

In light of the prevalence of algorithmic capitalism, I read Jean Baudrillard's critical idea of simulation in the context of emerging AI systems. If we are deep into the era of politicized information and simulation, what did it ever mean to be outside of it– is this even a worthwhile question to ask?

Other insightful frameworks for considering the material and cultural significance of the digitization and automation of images come from Friedrich Kittler's musings on what might constitute the ontological lineage of digital media. Relatedly, thinking about technological origins via Ernst Kapp, Karl Marx, and Bernard Stiegler, I question whether we can ontologically define what technological objects are. Or is an ontological diagnosis too limited to a specific time and place, even when it is intended to be transcendental?

Chapter six presents a series of generative AI image case studies I produced as a form of research for this project. They are intended to raise pedagogical questions afforded by working beyond the written word. Presented through various videos, the exercises investigate what becomes of a visual world mediated first by data points from a specific training set, sometimes expressed through text. I investigated whether the statistical operations of commercial AI-generated images display a tendency to

converge to the most probable averages of their dataset if left unattended by human intervention. In other words, I wanted to know and to show what will become of image production if it is increasingly automated to produce what is most probable on the Internet. What does a statistical gaze that undergirds AI-generated image production mean and look like? At the same time, I play and experiment with what is newly made available by AI through automated creative tools applied to my own images.

The concluding chapter begins with an image and revisits my motivations for taking on this topic, while acknowledging limitations that should serve as a springboard for further inquiry and research. **An addendum** at the very end includes a link to a performative website and digital syllabus I developed while teaching this material during the last three years of research.

In this project, I go through a process of mapping the order of computational images with an aim of articulating insights that apply beyond the field of visual culture. In other words, considering the automated, algorithmically driven construction, storage, and dissemination of images within their sociocultural and political contexts helps highlight the vulnerabilities of this new regime of representation to reinscribing and intensifying racialized and gendered capitalist tendencies that have reality-shifting impacts on our lives. These tendencies obfuscate new forms of extraction, homogenization, exploitation, and accumulation. In the process, I hope that what is possible to think today will be tugged and pulled apart. In the end, the intention is not to stifle or rescue human creativity, but to wrest our capacity for creation and relation from the narrow force of instrumentalization that dominates much of contemporary technological development.

II. Network Culture and the Image

Our society is one not of spectacle, but of surveillance; under the surface of images, one invests bodies in depth; behind the great abstraction of exchange, there continues the meticulous, concrete training of useful forces; the circuits of communication are the supports of an accumulation and a centralization of knowledge; the play of signs defines the anchorages of power; it is not that the beautiful totality of the individual is amputated, repressed, altered by our social order, it is rather that the individual is carefully fabricated in it, according to a whole technique of forces and bodies.

Michel Foucault, *Discipline & Punish*: *The Birth of the Prison* (1974)

In naming algorithmic capitalism, I turn to Tiziana Terranova's description of network culture as "a heterogeneous assemblage" or "meshwork of overlapping cultural formations" that coalesce on a single informational plane to help define our loosely bound contemporary condition.[24] In this new hyperconnected reality, a specific kind of information becomes the locus of power. Computational information, or data, adheres to both the dynamics of systems theory and politics, no longer reducible to sender and receiver or one medium or even one society, but rather a whole emergent network that is shaped by interactions among its various independent nodes.

The most significant implication of network culture is that the experiences once requiring physical embodiment have been remediated by protocols on the Internet via computation. This means that how we live, know, and communicate is currently determined by laws of computing and data science as much as anything else. I will return to the term network culture throughout as the best placeholder for how digital life remediates and produces a new experience of reality; one in which information functions as one of its most valuable cultural commodities.

The term algorithmic capitalism builds on network culture to identify a new intense phase of speed and scale in information production, processing, and circulation

[24] Terranova, Tiziana. *Network Culture: Politics for the Information Age*. United Kingdom, Pluto Press, 2004.

that requires less human intervention. Furthermore, AI introduces a new kind of decision-making embedded in infrastructure, products, and policy that is not solely reducible to its engineering, creating a probabilistic relation between its human design, training data, and various outcomes. Importantly, applying the concept of network culture to appraise algorithmic capitalism entails a systems approach that analyzes the relations between parts within the complexity of a larger whole.

Culture

Raymond Williams describes culture as the tension between the material production of a social formation and its symbolic systems of representation.[25] Culture is a tricky, modern concept about the uniquely complex relations between humans who share certain characteristics and conditions such as language or ethnicity. Tricky because it is hard to determine where culture might begin and end, or how it should be measured or defined explicitly. To home in, I consider a social formation an organization of human relations that includes our environments and other nonhuman forms of life and intelligence.

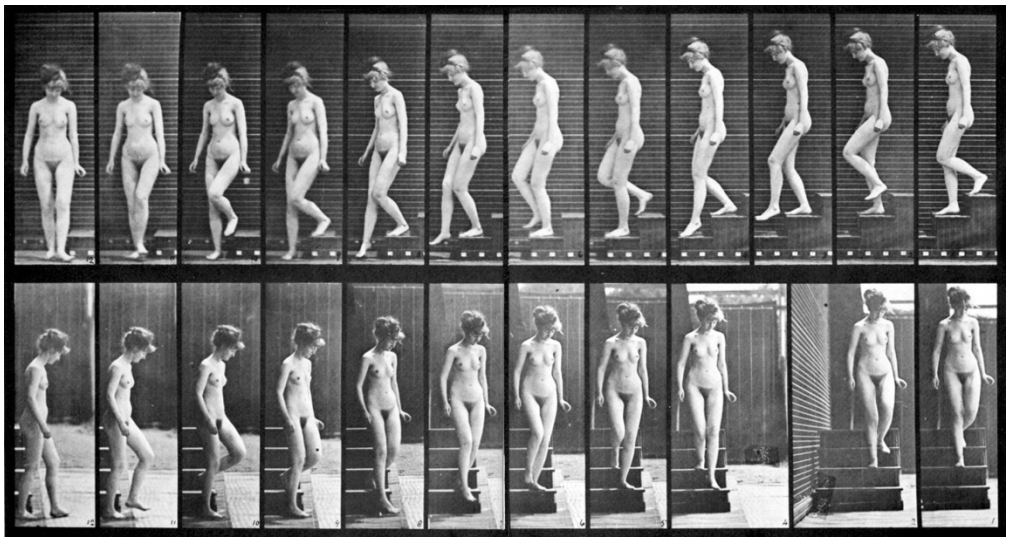
Within this framework, culture is not only about forms of self-expression or identification. Rather, it is about how signification and meaning interplay dialectically with material and political conditions in a specific place and time. I operate loosely within this broader framework namely because of its more rigorous consideration of what materiality and media can do, and also because of its openness to changing what we can consider culture in the first place. I build on and connect Terranova's concept of network culture to study the interconnectedness of communication and the social and

[25] Williams, Raymond. *Keywords: A Vocabulary of Culture and Society.* New York: Oxford University Press, 1985. 87.

political conditions of information in the present. Namely, how the politics of networked information Terranova identified has scaled in intensity. To situate the contemporary effects computation has on images and visual culture specifically, I first chart a political-economic history of technology in Europe and the United States that reaches back to the Industrial Revolution.

Now well into the third decade of the twenty-first century, a vast complexity hovers over any culture in the hyperconnected world we inhabit. An ongoing deluge of data is produced and collected by the post-Fordist economic model that characterizes most of the world's dominant markets. This development has been underway since the 1970s. As labor unions successfully organized for higher wages and better working conditions while domestic consumer markets became saturated, large American and European firms began to look for ways to cut labor costs and shifted towards international markets to retain or grow profits.

Where possible, corporations have steadily increased the application of automation in line with technological advancements that have reduced the need for human labor or made it more profitable and led to new business models beyond the industrial assembly line. Related to automatic, which is formed from the Greek *autos*, meaning self, and *matos*, meaning thinking or animated, automation connotes an action or series of actions performed by machinery with little or no human intervention. The will to act on behalf of oneself, *automatos*, is extended to a machine. As a logic, the concept of automation first emerged during the Industrial Revolution alongside technologies like the steam engine, the Jacquard loom, the Gatling gun, and the Janssen revolver that invented chronophotography. In the imbrication of modern political economy and computing, automation is one of its defining features.



Eadweard Muybridge. *Woman Walking Down Stairs*, a motion study captured using chronophotography, 1887.

Automation

Automation's connection between labor, manufacturing, and machinery in the nineteenth century is an important basis for the eventual invention of modern computation and algorithmic capitalism. Meredith Whittaker points out the continuity of the logic of automation in the transition from plantation slave labor to industrial labor in the early nineteenth century that was championed by Charles Babbage.[26] Babbage invented the difference engine and the analytical engine with Ada Lovelace, both of which are automated calculating and computing systems often fondly remembered as precursors to today's electrical computing. Whittaker connects Babbage's impulse for dividing and controlling manual and intellectual labor as techniques of surveillance first adopted for enslaved workers in plantations. When encoded by engines and machinery in the world imagined by Babbage, worker surveillance takes on a more abstract and computational form.

[26] Whittaker, Meredith. "Origin Stories: Plantations, Computers, and Industrial Control." *Logic(s) Magazine*, 7 Dec. 2023, logicmag.io/supa-dupa-skies/origin-stories-plantations-computers-and-industrial-control/.

In his 1832 management book *On the Economy of Machinery and Manufactures,* published a year before West Indian slavery was abolished, Babbage extols the benefits of mechanization in the context of Britain's changing political economy. He is interested in how harnessing technical power and managing a division of labor could optimize the factory as Britain's new source of industrial superiority. Machinery, in this context, could program, divide, control, and mechanize, in other words automate, both labor and its discipline.

Commenting in the 1850s on automation, Karl Marx identifies the paradoxical movement within capitalism to make labor more productive while seeking ultimately to eliminate it: "The increase of the productive force of labour and the greatest possible negation of necessary labour is the necessary tendency of capital, as we have seen. The transformation of the means of labour into machinery is the realization of this tendency."[27] For Marx, industrial machines were built for the purpose of multiplying labor inputs in the service of increasing profit, to the logical endpoint of entirely overcoming wage labor the day machines could automate nearly all of production. Such a contradictory endpoint would necessitate a long-term fall in prices and a short-term fall in demand that would undermine both workers and profits, leading to irreversible growth crises in capitalist economies.[28]

Marx describes the relations that emerge in complex systems of production and exchange such as capitalism as metabolic, where the determination of causes is irreducible to one element of a greater totality. In explaining the foundation of labor, he writes:

[27] Marx, Karl, and Martin Nicolaus. "The Fragment on Machines." *Grundrisse: Foundations of the Critique of Political Economy*. New York: Vintage Books, 1973, 693.
[28] Best, Beverley. *The Automatic Fetish: The Law of Value in Marx's Capital*. United Kingdom, Verso Books.

> Labour is, in the first place, a process in which both man and Nature participate, and in which man of his own accord starts, regulates, and controls the material re-actions between himself and Nature. He opposes himself to Nature as one of her own forces, setting in motion arms and legs, head and hands, the natural forces of his body, in order to appropriate Nature's productions in a form adapted to his own wants. By thus acting on the external world and changing it, he at the same time changes his own nature.[29]

Disregarding the gendered and anthropomorphic language invoked to describe nature, this description shouldn't be read as Marx instrumentalizing and dichotomizing nature against the human. In fact, his economic description of the entanglement of production and consumption resembling the ecological process of photosynthesis in the *Grundrisse* suggests that that he was attempting to describe the systematic relationship between creative human production and the natural environment: "[Human] Consumption is also immediately production, just as in nature the consumption of the elements and chemical substances is the production of the plant."[30]

In the concept of social metabolism, he suggests a sort of meta organism in which human creativity and the natural world we inherit intertwine in a terraforming totality.[31] Nature conceived as separate from humans, serving as a resource to be extracted and commoditized, is an insight Marx draws on to critique classical political economy. This dualist logic of modern capitalism has led to accelerating the forces of molecular havoc on the natural environment, leading to steady increases in the Earth's average surface temperature that produce catastrophic effects on the habitability of life on this planet. The resources required for the infrastructure of network culture, from intense energy requirements to silicon to minerals used in batteries, is not an exception but an extension of capitalism's rules.

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[29] Marx, Karl. *Das Kapital: A Critique of Political Economy*. Penguin, 2020. 151.
[30] Marx, Karl, and Martin Nicolaus. *Grundrisse. Foundations of the Critique of Political Economy*. Vintage Books, 1973. 90.
[31] Marx, Karl. *Das Kapital: A Critique of Political Economy*. Penguin, 2020.

One vision of automation today, viewed in the context of Babbage and Marx, represents the full alienation of humans from their labor, and thus from being part of any conception of nature. In this bleak imaginary, the working class become even more expendable to production. In recent automation discourse, the argument made by some technologists to resolve this contradiction is to provide a fixed lump-sum stipend, called universal basic income (UBI), to those displaced and fully alienated from the value of their labor. Closer to reality is the fact that even the economy propped up by automation requires massive amounts of labor. Only, this type of labor is often more invisible, hidden behind outsourced material supply chains, content moderation sweatshops, digital click farms, and "freelance" gigs.

Algorithmic Capitalism

During the last five decades of international monetary management, market-driven nation-state regimes have adopted policies of austerity and deregulation that have incentivized corporate capital gains and put further downward pressure on the collective bargaining power of labor, and thus on wages. The move away from the classic Fordist model of organizational hierarchies and mass production to what David Harvey describes as *flexible accumulation* has resulted in specialized products produced for global markets by firms with more decentralized structures.[32] The rapid proliferation of the capitalist market into a global one has relied on complex coordination and organization through the development of logistics and information and communications technologies (ICTs).

In post-industrialized nations like the United States, globalization and offshoring have left the labor force prone to greater control, volatility, and insecurity as firms

[32] Miller, Vincent. *Understanding Digital Culture*. London: SAGE Publications, 2011, 66.

constantly look for ways to decrease costs to maintain or increase overall profit under often stagnant macroeconomic conditions.[33] Marx's predictions for growth stagnation have largely come true, and coupled with changing technological conditions have shaped a new mutation in capitalism in which circulation and not production have become the major source of value. The proliferation of communications technology and networked societies have helped spawn a version of capitalism that is more decentralized in its application of power and one that is constantly reterritorializing social experience in extreme ways.[34] According to Manuel Castells, industrialization has also given way to a prioritization of new forms of knowledge, or what he labels *informationalism*.[35] Chapters four and five will further develop the idea of how information functions as a vital commodity for power today.

Although the logic of capitalism remains the same, its materialization and form have evolved. Production, reproduction, consumption, politics, culture, and even time and space have been altered in new ways. The flatness of the Internet and the valorization of information have turned computational power into a crucial tool of exchange and profit. The conditions of employees, for instance in the "freelance gig economy," are more isolating and precarious today than when György Lukács inveighed in the 1920s against the effects of automation: "mechanisation [sic] makes of them [workers] isolated abstract atoms whose work no longer brings them together directly and organically; it becomes mediated to an increasing extent exclusively by the

[33] See *Smart Machines and Service Work: Automation* by Jason E Smith for a critical take on labor, stagnation, and automation.
[34] Mostly birthed in a privileged culture of technical experimentation, defense industry funding, and venture capital centered in California from the mid 20th century onwards, which eventually localized in Silicon Valley. A version of capitalism that turns Gilles Deleuze and Félix Guattari's concept of the rhizome (a complex system of roots that branch out and connect to each other horizontally) toward its own reproduction.
[35] Beer, David, and Gane, Nicholas. *New Media: The Key Concepts*. India, Berg Publishers, 2008, 35.

abstract laws of the mechanism which imprisons them."[36] For example, independently contracted rideshare workers with scant benefits have to rely on nebulous algorithms on an app to match them with potential riders and destinations while deciding how much their labor is worth on each trip.

When Jean-Paul Sartre wrote about the banal seriality of relations under capitalism in 1960, he imagined isolated physical subjects in a queue at a butcher, or in a supermarket, or in a factory or office workplace.[37] His concept of seriality acquires a new literal meaning when computation today becomes integral to human subjectivity. Seriality no longer requires physical, spatial proximity because we are increasingly bound to digital mediation. There is already ample scholarship about how digitality leads to an increasing gamification of exchange, value, and social relations. In chapter four I discuss gamification in the context of the viral GameStop stock phenomenon.

The struggle over information will continue to define what labor and labor conditions are like as AI applications for automation grow. I agree with Justin Joque when he writes, "It is through a fundamentally metaphysical act of 'making computable' that statistics and capitalism objectify the world."[38] Contending with this objectification means contending with the expansion of computation within the logic of military-industrial capitalism.

Building on this objectification through computation, it is apparent that what is on the Internet increasingly shapes so-called reality. As information and communication increasingly connect to the Internet, they become part of a digital

[36] Lukács, György. "Reification and the Consciousness of the Proletariat." *History and Class Consciousness: Studies in Marxist Dialects*, MIT Press, Cambridge, MA, 1971, p. 143.
[37] Sartre, Jean-Paul, and Jonathan Ree. *Critique of Dialectical Reason. Theory of Practical Ensembles*. Verso/New Left Books, 2004.
[38] Joque, Justin. *Revolutionary Mathematics: Artificial Intelligence, Statistics and the Logic of Capitalism*. United Kingdom, Verso Books, 2022. 33.

economy where power is already concentrated much the same way it has been in the oil industry for over a century. In the United States, Big Tech consists of Apple, Alphabet, Microsoft, Amazon, Nvidia, and Meta, which dominate what is the largest economy in the world and wield access as gatekeepers to most online, digital services.

The consequences of information are not entirely new. Analog media also generate medium-specific forms of chemical and physical information that include unique material qualities like the grooves and scratches on a music record or the artifacts and glare of a lens on a photographic print. But the computational (digital) is unique because it homogenizes all of its information into bits. What is counted as information here is translated or intermediated from different states into machine-readable code. Many new types of (programming) languages most people don't speak (code) emerge as the source for *user experiences* that intend to represent a reality to us that we implicitly accept as our new normal.

Bits are the discrete, foundational units of computing that also build pixels, which are digitized samples of a visual scene at a given point. Pixels are represented to us by display elements, which provide the analog light and color on an interface that mediates between our eyes and the digital information produced by a machine. This era of the pixel we occupy is intrinsically tied to the World Wide Web, where connected information, unless made inaccessible through protocol updates, lives indefinitely on the Internet. We as human users are thus, as Benjamin Bratton regularly argues, like a layer within a stack that includes computing and coproduces who we are.

The Image Economy

The image economy is no exception to this technical wave of digital → computational → Internet. Where once images conformed to human perceptual

apparatae, in the milieu of machinic communication they become what Shane Denson, drawing from quantum states, calls discorrelated. A disconnect emerges between the viewing subject and the object of viewing. Indeed, discorrelated images that exist outside human perception trouble the entire presupposition of a subject and object constitution. Denson explains how beyond eliminating indexicality that marked analog image-creation, computational images also become fundamentally operational, "at once inextricably bound up in computational processes and simultaneously initiating a volatile feedback loop between these [images] and the spectator."[39] In this way, they can randomly impact human subjectivity, epistemology, and sense perception at an unconscious level, or at an affective level. Jussi Parikka calls this transformed version of visual culture the invisual because of its crucial non-perceptual characteristics.[40]

Beyond the form of computation and programming languages, it is the concept of data and metadata that allows humans and machines to communicate when it comes to images that are networked online. Metadata enables the classification, accessioning, archiving, and retrieval of a data object through a linguistic inventory that accompanies it. In digital files, metadata denotes details such as date, copyright information, location, camera make, and important keywords. It is created simultaneously with the image but can be added or edited later. Metadata also stores separate details about the life of the image once in circulation, such as interactions that can include views, likes, comments, tags, and ratings.

Daniel Rubinstein and Katrina Sluis describe the implications of this process that allows machines to organize information without senses:

[39] Denson, Shane. *Discorrelated Images*. Duke University Press, 2020, 31.
[40] Parikka, Jussi. *Operational Images: From the Visual to the Invisual*. United Kingdom, University of Minnesota Press, 2023.

> By enabling the exchange and structuring of information, metadata is crucial in shaping information economies and informs the efficient operation of search engines. Facebook's Open Graph, Google's Knowledge Graph, Schema.org, microformats.org are examples of emergent competing protocols which describe the application of metadata to semantic elements on the web to help machines map relationships between entities.[41]

The automated organization of metadata determines how the Internet is organized and presented to each user. Although critics readily warn of the susceptibility of digital image pixels to manipulation, it is the organization of metadata people never see that is potentially even more influential.

Metadata affects who can access an image and what goes viral at any given time and place. It also affects what the computer sees in the image, it affects how and where that image is ranked in search queries, it can ultimately affect what is considered noise (unwanted information or information deemed meaningless or worth censoring) and what is considered signal (information deemed meaningful that is recorded). It is also increasingly used by states and corporations to surveil. In courts, metadata is used to verify the authenticity and admissibility of evidence. Data is crucial for predicting behavior patterns online, for selling advertising, and for training AI models. This new valuation has sparked an insatiable thirst for producing, measuring, and owning evermore data.

In the political economy of what are referred to as Web 2.0 and Web 3.0, where private users and brands are simultaneously both consumer and producer within a social context, the algorithmic traits of virality take precedence over the visual, with a

[41] Rubinstein, Daniel and Sluis, Katrina (2013) "Notes on the Margins of Metadata; Concerning the Undecidability of the Digital Image." *Photographies*, 6 (1). 151-158.

priority on optimization for a nonhuman audience.[4243] Marx's claim that consumption and production are entangled under capitalism is most clear in the data economy. An individual's digital presence alone is often the greatest source of value for private companies online. This convoluted set of algorithmic processes within a new system of exchange involving many human and nonhuman decisions is simply abstracted and made opaque to us by the simple *there-ness* of an image that appears on a digital screen, seemingly detached from all material ramifications.

[42] Rubinstein, Daniel and Sluis, Katrina (2013) "Notes on the Margins of Metadata; Concerning the Undecidability of the Digital Image." *Photographies*, 6 (1). 151-158.
[43] Prosumer is a term used by media theorist Alvin Toffler, and later by George Ritzer, to explain the tendency of users in information driven capitalism to be both a producer and consumer.

III. Invisible Impressions

In the immeasurableness of nature and the inadequacy of our faculty for adopting a standard proportionate to the aesthetic estimation of the magnitude of its realm, we found our own limitation.

Immanuel Kant, *The Critique of the Power of Judgement* (1790)

I've often noticed that we are not able to look at what we have in front of us unless it's inside a frame.

Abbas Kiarostami, *Rain* (2007—2008)

In 2023, the Internet lost its shit when an AI generated image of Pope Francis in a luminescent white puffer jacket flooded everyone's feeds. Operating beyond the uncanny valley, everything we knew about a photo told us that this image was real. Of course it wasn't, yet the moment cleaved apart assumptions about the veracity of an image and catalyzed public conversation around the implications of a new kind of visual phenomenon. The conditions of this watershed, however, didn't materialize overnight. The history leading up to the Pope image is a long one made in the twentieth century and includes the inventions of computer vision, computer graphics, and computational photography. What I call the computational image broaches this history, referring primarily to vision and photography.

The computational image is no longer, like the film photograph, just an object of light, emulsion, and time. It is also an object implicated within an infrastructure of network culture made possible by the digital. It involves coded digital information, data, disparate algorithmic protocols, multiple hardware, electricity, and the Internet. It disappears to human representation as information inside of circuits, devices, and networks.

The history of its invention is imbricated with developments in math and computer science funded by the U.S. military-industrial complex. In the market,

computational images present a new type of commodity whose value is hard to determine alone. As data, images today are packaged together and function like financial securities inside of algorithmic determinants of value. Breakthroughs in imaging capabilities lead to new forms of both surveillance and reification. At the same time, the image in its computational form introduces new realities of kind, scale, time, and aesthetic possibility.

In this chapter, I consider the dreams of early computer researchers influential to the history of the image culminating in Artificial Intelligence today. I analyze how the historically coded and networked production, distribution, and reception of images in their computational form seriously challenge the regime of human representation that has held steady since the Enlightenment. That is, a belief in reason's ability to map and communicate through observable signs in transparent ways that form the basis of a stably reproducing social structure.

The development of computation re-poses some of the old challenges from the photographic milieu, but new capabilities also emerge that offer new possibilities for human understanding and development, including new sensory provocations of the sublime. I contemplate the judgment of the sublime through Immanuel Kant and question its transformation in the realm of digital aesthetics. Relying on Fred Moten and Danielle Brathwaite-Shirley, I point to the indeterminacy of blackness "in the break" as a productive critique of Enlightenment sublime and as a potential mode to wrest computation away from what Luciana Parisi calls its socio-techno-genetic instrumentality. The chapter finishes with a flurry of case studies that gesture towards the overwhelming proliferation of technical automation and surveillance in contemporary visual culture. The dichotomy I set up between the sublime and surveillance is part of an attempt to dwell in the messy ambiguity of the present and to

suggest a need to imagine worlds different than one dominated by either fatalism or utopian determinism.

A Brief History

Computational photography is the process of capturing and processing images digitally through various software applications. It is a development within the larger field of computer vision that began around the end of WWII and took off in the United States in the 1960s as new computing research and power financed by the escalation of the Cold War catalyzed the machine-readable automation of visual perception. Accomplishments included the digital construction of two-dimensional and perspectival images, artifact correction, and object recognition and separation.[44]

In 1957, Russell Kirsch led a team to reproduce a photo of his son. The 5x5 cm black and white image made through a drum scanner at the U.S. National Bureau of Standards was the first time an image was computationally rendered. Kirsch openly admitted that his interest in this kind of research was motivated by what was possible if computers could look at the world. A year later, the Information Systems Branch of the U.S. Office of Naval Research unveiled the perceptron in a project named Perceiving and Recognizing Automaton (Project PARA). It was a machine equipped with a nascent, basic neural network layer capable of automatically identifying objects.

[44] Druckery, Timothy, and Lev Manovich. "The Automation of Sight: From Photography to Computer Vision." *Electronic Culture: Technology and Visual Representation*, Aperture, 1997, pp. 229–240.

The first ever digital image developed for use with a computer. 5x5cm with a resolution of 176 pixels a side.

Building on the image classifier algorithm first formulated by cyberneticians Warren McCulloh and Walter Pitts fifteen years prior, the perceptron project incepted the field of computer vision. Its inventor Frank Rosenblatt, based out of the Cornell Aeronautical Laboratory, claimed at the time that "…we are about to witness the birth of…a machine capable of perceiving, recognizing and identifying its surroundings without any human training or control."[45] The Perceptron was one of the first applications for the idea of a neural network that is now so integral to AI.

[45] Lefkowitz, Melanie. "Professor's Perceptron Paved the Way for AI – 60 Years Too Soon." *Cornell Chronicle*, 25 Sept. 2019, news.cornell.edu/stories/2019/09/professors-perceptron-paved-way-ai-60-years-too-soon.

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CORNELL AERONAUTICAL LABORATORY, INC., BUFFALO 21, NEW YORK

The Design of an

Intelligent AUTOMATON

by FRANK ROSENBLATT

Introducing the perceptron — A machine which senses, recognizes, remembers, and responds like the human mind.

STORIES about the creation of machines having human qualities have long been a fascinating province in the realm of science fiction. Yet we are now about to witness the birth of such a machine — a machine capable of perceiving, recognizing, and identifying its surroundings without any human training or control.

Development of that machine has stemmed from a search for an understanding of the physical mechanisms which underlie human experience and intelligence. The question of the nature of these processes is at least as ancient as any other question in western science and philosophy, and, indeed, ranks as one of the greatest scientific challenges of our time.

Our understanding of this problem has gone perhaps as far as had the development of physics before Newton. We have some excellent descriptions of the phenomena to be explained, a number of interesting hypotheses, and a little detailed knowledge about events in the nervous system. But we lack agreement on any integrated set of principles by which the functioning of the nervous system can be understood.

We believe now that this ancient problem is about to yield to our theoretical investigation for three reasons:

First, in recent years our knowledge of the functioning of individual cells in the central nervous system has vastly increased.

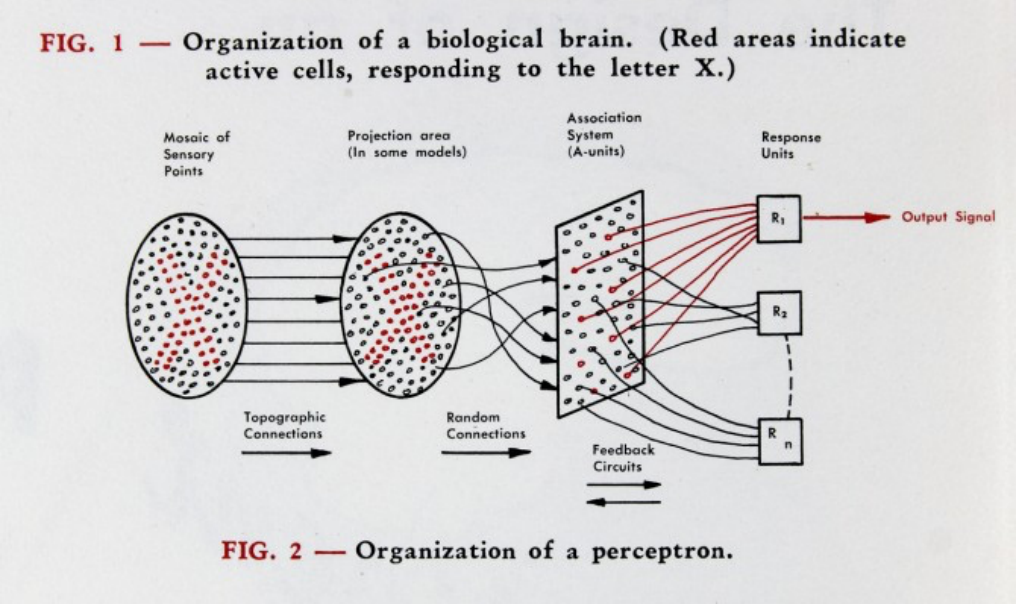
Second, large numbers of engineers and mathematicians are, for the first time, undertaking serious study of the mathematical basis for thinking, perception, and the handling of information by the central nervous system, thus providing the hope that these problems may be within our intellectual grasp.

Third, recent developments in probability theory and in the mathematics of random processes provide new tools for the study of events in the nervous system, where only the gross statistical organization is known and the precise cell-by-cell "wiring diagram" may never be obtained.

Receives Navy Support

In July, 1957, Project PARA (Perceiving and Recognizing Automaton), an internal research program which had been in progress for over a year at Cornell Aeronautical Laboratory, received the support of the Office of Naval Research. The program had been concerned primarily with the application of probability theory to

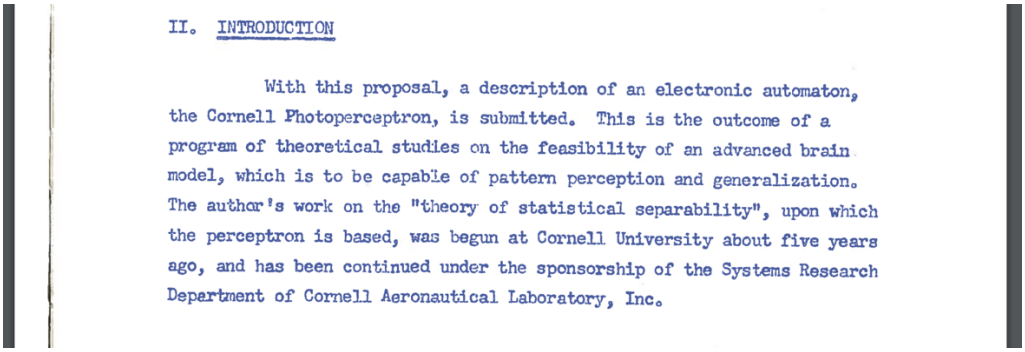
Frank Rosenblatt, "The Design of an Intelligent Automaton." ***Research Trends,*** **1958.**



Frank Rosenblatt, "The Design of an Intelligent Automaton." ***Research Trends,*** **1958.**

Rosenblatt's work was typical of the military-academic foundations responsible for producing a series of technologies that afforded the world of digital media. The

Cornell Aeronautical Laboratory he worked for was founded and later donated to his alma mater, Cornell University, after World War II by the Curtiss-Wright defense corporation. Cornell established a graduate school for aerospace engineering around the same time and attracted funding from both private defense contractors and the U.S. military. Under intense criticism during the Vietnam war, university officials severed ties and tried to distance Cornell from the lab.



II. INTRODUCTION

With this proposal, a description of an electronic automaton, the Cornell Photoperceptron, is submitted. This is the outcome of a program of theoretical studies on the feasibility of an advanced brain model, which is to be capable of pattern perception and generalization. The author's work on the "theory of statistical separability", upon which the perceptron is based, was begun at Cornell University about five years ago, and has been continued under the sponsorship of the Systems Research Department of Cornell Aeronautical Laboratory, Inc.

Screenshot of the proposal for Project PARA written by Rosenblatt on behalf of the Systems Research Department of Cornell Aeronautical Laboratory, Inc.

I consider a large part of these R&D foundations to be work produced by key individuals who at various points engaged with cybernetics, a loosely grouped field of science and philosophy named by the computer scientist and mathematician Norbert Wiener in 1948. Cyberneticians were convinced that the world could be understood through systems of information. They were swayed by the search for universal, mathematical foundations to all of knowledge. Fluid dynamics, statistical probability, and quantum mechanics were deployed for understanding entropy and feedback in applications that included communication, computation, sensing, and prediction. Cybernetics represented an attempt to understand interactions and communication between mechanical, biological, and electronic systems as part of an undifferentiated reality.

In chapter five, I'll dig deeper into the philosophical foundation of this intellectual movement. Here, I want to briefly trace key figures who evidence the influence of cybernetics on computing and further verify the military-industrial context in which so much of this research was conducted. At the end of this short history, I'll return to images to connect how computing led to the development of new imaging techniques.

Claude Shannon, who was a mathematician and engineer at Bell Telephone Labs and a central figure to cybernetics, along with Warren Weaver, published a highly influential essay called "The Mathematical Theory of Communication" in 1949 that developed a systematic way to think about communication through the measurement of information. In the cybernetic epistemology, communication is about engineering a framework of statistical probability to encode and decode information (signal processing) without consideration of its semantic meaning. By making sense of the measurement of the levels of organization and disorganization (entropy) of information passing in channels from senders to receivers, they were able to abstract all forms of communication into a technical basis—creating a standardized framework for processing signal messages.

As it did for Wiener, communication becomes a question of probability rather than semantics. Shannon and Weaver showed that the rate of information as a statistical measure, encoded and decoded, could be a primary model of digital communication. In Shannon and Weaver's model, there are five major components of all such messaging systems: the information source, the transmitter, the channel, the receiver, and the destination. Widely influential, the bit was named after Shannon.[46]

[46] The Soviet scientist Vladimir Kotelnikov discovered the sampling theorem first, in 1933, before Shannon and Nyquist.

Cybernetics quickly grew to include biologists, neuroscientists, anthropologists, and economists looking to incorporate its philosophy in their work. With regards to my genealogical analysis of modern computing in the United States, the cybernetics movement serves as its most immediate philosophical and technical source. From its start, those interested in cybernetics were also interested in how concepts of simulation and automation could be programmed to grow computing machines capable of inorganic forms of human perception. Automata, self-correcting mechanisms, and forms of AI were considered through analogies with human qualities and traits.

During WWII, Wiener was enlisted by the Fire Control Division of the National Defense Research Committee to help automate the aiming process of anti-aircraft missile systems by predicting an aircraft's movement in real time. The proliferating use of ballistics required large calculations that became the impetus for the U.S. Army to fund the ENIAC. Proposed in large part by physicist John Mauchly, the Electronic Numerical Integrator and Computer (ENIAC) became the world's first general-purpose, all electronic digital computer.

A close friend of Wiener and another of cybernetics' central figures, the Hungarian immigrant John von Neumann played a large role in the Manhattan Project and later the development of the hydrogen bomb. He designed the recursive architecture of the MANIAC (Mathematical Analyzer Numerical Integrator and Automatic Computer), the computer at Princeton's Institute for Advanced Study that was used to calculate the potential success of the designs for the hydrogen bomb. Von Neumann's belief in math as the language of teleology and his effervescent brilliance at it resulted in him leaving behind multiple legacies for algorithmic capitalism.

His partnership with Oskar Morgenstern to understand optimal strategies in competitive games led to the hyper-rationalist framework of statistical game theory.

Hyper-rationalist because it assumes all human decisions to be rationally self-interested, and always made in an adversarial manner with perfect information available to all. Game theory's influence can hardly be overstated today.

It produced the belief in the Cold War era's concept of nuclear deterrence through proliferation, known absurdly as Mutually Assured Destruction (MAD). Before the Soviet Union acquired an atomic weapon, von Neumann was even convinced by game theory that a first strike against them was the most logical course of action for the United States. Game theory has been equally foundational to stock market strategies and the way businesses make large decisions. References to *zero-sum decisions* have even pervaded everyday language, serving to reinforce the Liberal first principle of resource scarcity. Although the original application of zero-sum competition was not aimed at visual production, I will explain below how it is repurposed in AI to produce images.

The technology-producing cybernetic milieu, of which Wiener and von Neumann were two of the most prolific, was embedded within a larger infrastructure of military research that was propagated in the industrial shadow of World War II.[47] Media theorist Bernard Dionysius Geoghegan's work explains how digital systems of visual representation, from screens to formats like the JPEG, were invented for military use in an ecology of infrastructure and operations among humans and computing instruments in this era. I build off of his historical work pointing out the American military origins of digital rendering combined with information processing.

[47] See Geoghegan, Bernard Dionysius. "The Bitmap is the Territory: How Digital Formats Render Global Positions." *MLN*, vol. 136 no. 5, 2021, p. 1093-1113. *Project MUSE*, doi:10.1353/mln.2021.0081 and Geoghegan, Bernard Dionysius. "An ecology of operations: Vigilance, radar, and the birth of the computer screen." Representations, vol. 147, no. 1, 2019, pp. 59–95, https://doi.org/10.1525/rep.2019.147.1.59. Also see Kittler, Friedrich. *Operation Valhalla: Writings on War, Weapons, and Media*. United States, Duke University Press, 2021.

Global Positioning Systems (GPS) and radar were technologies invented in this context. The foundation of what became the Internet, called ARPAnet, was developed under similar conditions via RAND researcher Paul Baran. To mitigate the dangers of the U.S. military losing telecommunications access during the Cold War due to nuclear strikes, Baran proposed an electronic network of communication that built in resiliency and redundancy through a process called packet switching. Baran's fellow scientists at RAND Corporation built on this and developed the Transmission Control Protocol/Internet Protocol, the standard protocol for networked computing that is still the basis of the Internet.

By this point, cybernetics was no longer the umbrella under which computing research was being conducted, but its influences, thinking, and military origins persisted. Lev Manovich reminds us of the significance of MIT graduate student Lawrence G. Roberts, who standardized the necessary computational mathematics to generate and modify perspective views of geometric models in papers published between 1963 and 1965. Manovich explains that Roberts was not simply after the automation of perspectival imaging, but rather wanted to allow the machine to recognize and comprehend the photographs of three-dimensional objects. He writes, "Thus, the two fields were born simultaneously: 3D computer graphics and computer vision, automation of imaging and of sight."[48] These advancements made in American university programs funded by military resources built an entire field upon Shannon and Nyquist's sampling theorem for signal processing.

In an archaeological analysis, Jacob Gaboury charts the invention of computer graphics at a research program founded at the University of Utah by David C. Evans

[48] Druckrey, Timothy. Electronic Culture: Technology and Visual Representation. Aperture, 1996, 233.

and funded by the Department of Defense with the goal of advancing "graphical man-machine communication." Between 1965 and 1980, the program graduated students that went on to found Pixar, Adobe, Netscape, and Atari. Gaboury argues that the processes involved in these images' technical formation make them nonphenomenological objects. That is, an ensemble of "coordinate points, image files, and object databases" that exist prior to the appearance of the image.[49] This relates to Geoghegan's articulation of the importance of points, vectors, and ratios in digital graphics. Although both of these definitions are related to my own under the broader umbrella of computational images, in this project I'm more interested in computer vision and computational photography than computer graphics.

It is readily apparent that the technical development of computational images has an adjacent history to that of the mechanical camera and the photochemical process that dates to the history of optics and seeing mentioned in the introduction. Specifically, photography was invented in the nineteenth century around roughly the same time period in Europe by Henry Fox Talbot, Louis Daguerre, and Joseph Niepce. Although it emerged from a similar ethos of technical invention and the desire for enhancing human vision and memory, the twentieth century influence of abstract mathematics and computing make computational images a significant emergence of their own.

The act of photography can be defined as images constructed from light passing through apertures (sometimes via a lens) and registering on light sensitive materials via chemical emulsion or sensors. The transformation to digitization and now computational photography has been gradual and often involves some of the same principals or hardware of photography in what can be best described as a new hybrid

[49] Gaboury, Jacob. *Image Objects: An Archaeology of Computer Graphics*. United States, MIT Press, 2021, 32.

combination. Originally conceived, photography was about a material-specific, lens-based process of transferring light onto a surface that could reveal an image directly.

In 1972, NASA launched the Landsat 1 satellite to observe and image Earth from outside of its atmosphere. This is a milestone in the shift from film to computational photography, representing a first for seeing the world anew afforded by technical breakthroughs in digital sensing. The success of the satellite, which sent back nearly 300,000 digital photographs over its six years in operation, was due to the deployment of the multispectral scanner (MSS). The MSS recorded data as spectral bands–green, red, and two infrared bands that were then interpreted by scientists to produce images. This type of remote sensing presented the first glimpse of how abstract the process of photographic imagining could become, with spectral data serving as the primary medium. Below, I will delve deeper into what kind of difference this imaging makes in relation to human understanding with the example of the black hole.

Not all computational images are made in the same way. This is where the distinction between what counts as something similar to film photography and what is computational becomes ambiguous. Computation is involved in all forms of the digital image. However, digital cameras, first commercially debuted in 1975 by Kodak, still follow film photography in the way that they produce a 2D projection of a scene that is instantly recognizable to human perception.[50] The camera's optical system is still key to producing the image.

[50] In 1975, Kodak introduced the first prototype of a commercial digital camera that recorded information on a digital cassette tape. The advent of digital cameras has evolved today to include mirrorless digital cameras. In a mirrorless camera, a lens is responsible for light capture that is imprinted on a digital sensor, yet as the name suggests, there are no mirrors to produce a frame in the viewfinder. What you see is a software generated digital representation of the frame in view.

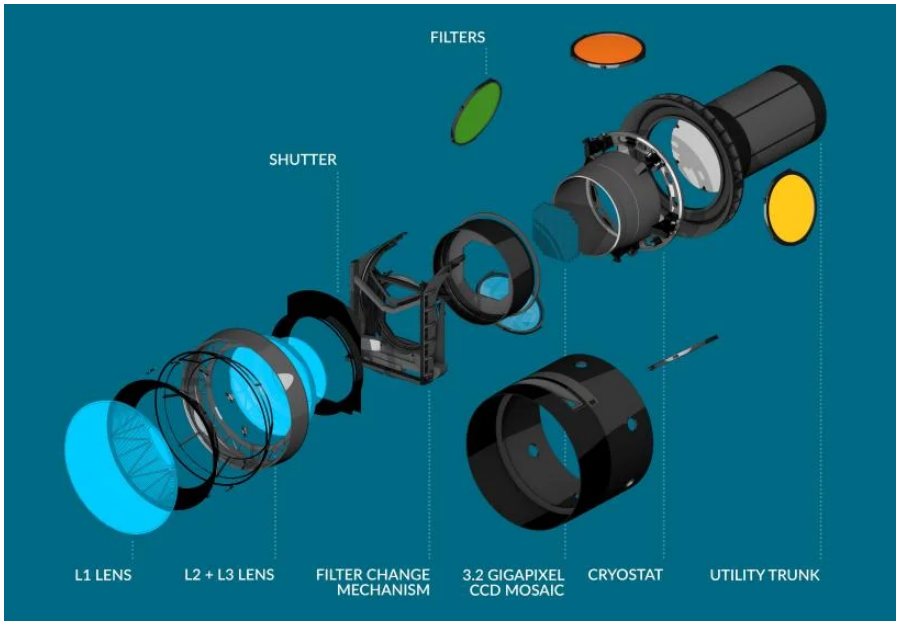
Computational photography instead attempts to build a richer representation of a scene and relies on forms of encoding that can appear distorted or unintelligible to human representation until they are decoded. The use of software allows for a wide variety of automated manipulation and processing that can mimic or defy effects once achieved through lenses and chemical film processing techniques–including focus, exposure, and even scene composition. In computational photography, the key difference to film-like photography is that, once virtualized, imaging can be constructed without large optical elements, human cues, or light requirements. This is achieved through various computational techniques that rely on software and calculation to encode what we perceive as reality into digital information. These include sampling techniques, the rapid fusion of multiple images into one image, graph cut optimization, and gradient domain image processing.[51]

Fast forward to 2024 for an example of a hybrid imaging infrastructure that relies on an optical system, a digital framework, and computational processing all together. Meet the largest ever digital camera–the size of a car–manufactured for the U.S. Department of Energy's SLAC National Accelerator Laboratory. The 3.2 billion–pixel-camera made for the Vera C. Rubin Observatory is made up of around 200 charge-coupled devices (imaging semiconductor sensors) tightly arrayed on 21 nine-sensor pallets inside an extremely flat ceramic grid functioning as a focal plane. Its front lens alone, the largest ever for astronomical observation, is five feet tall.

The engineering of the camera took two decades, designed to sit atop a telescope in the Chilean Andes and, every few nights for 10 years, synoptically image the Southern Hemisphere night sky. The camera will capture nearly 20 terabytes of data

[51] Kirkpatrick, Keith. "The Edge of Computational Photography." *Communications of the ACM*, vol. 62, no. 7, 2019, pp. 14–16., doi: https://doi.org/10.1145/3329721.

every night and requires a new data facility to continuously process and store its information. The project, called Legacy Survey of Space and Time (LSST), will help physicists better understand the mysterious nature of dark matter and dark energy that comprise an estimated 95% of our universe, the latter of which is accelerating our universe's expansion. It will also allow astronomers to better understand the features of our own galaxy and solar system.



A digital diagram of the LSST Camera's main components. Credit: Chris Smith/SLAC National Accelerator Laboratory.

The increased reliance on computation for imaging means that once digitized, information can be processed and compressed in a variety of ways by software and stored on a memory card or hard drive or in a data facility. Without veering too far into technical exposition, the upshot is the ability to computationally *reconstruct* rather than *reflect* reality.

We can update Guy Debord's lamentation that "All that once was directly lived has become mere representation." [52] What Debord decried as mere ideological

[52] Debord, Guy. *Society of the Spectacle*. Rebel Press, London, 1992, 2.

representation inside a commodity spectacle in the late 1960s now fails to capture the computational traits of reality. Computational representation requires synthesizing human and machine languages. It requires new abstractions and techno-social processes that require more engineering and afford less opacity into their production. The outcome of an image today can drastically differ in almost infinite ways from what our eyes can witness.

At the same time, one beneficial consequence of computation is how it has instantaneously connected nearly the entire planet, enabling ordinary people to visually document brutalities and injustices previously veiled. In *How to See the World*, Nicholas Mirzoeff describes how this new reality of visual culture inundated with digital images also enables an exercising of visual activism. As mentioned in the experiences narrated in the introduction, this distributed form of visual activism is what drew me to inquire into the digital. I follow Mirzoeff's critical eye for the digital into the new visual reality unleashed by the acceleration of AI, which is automating image production faster than ever. But first, I want to consider what this new form of visual mediation makes possible in an extreme example of computational photography.

The Computational Sublime

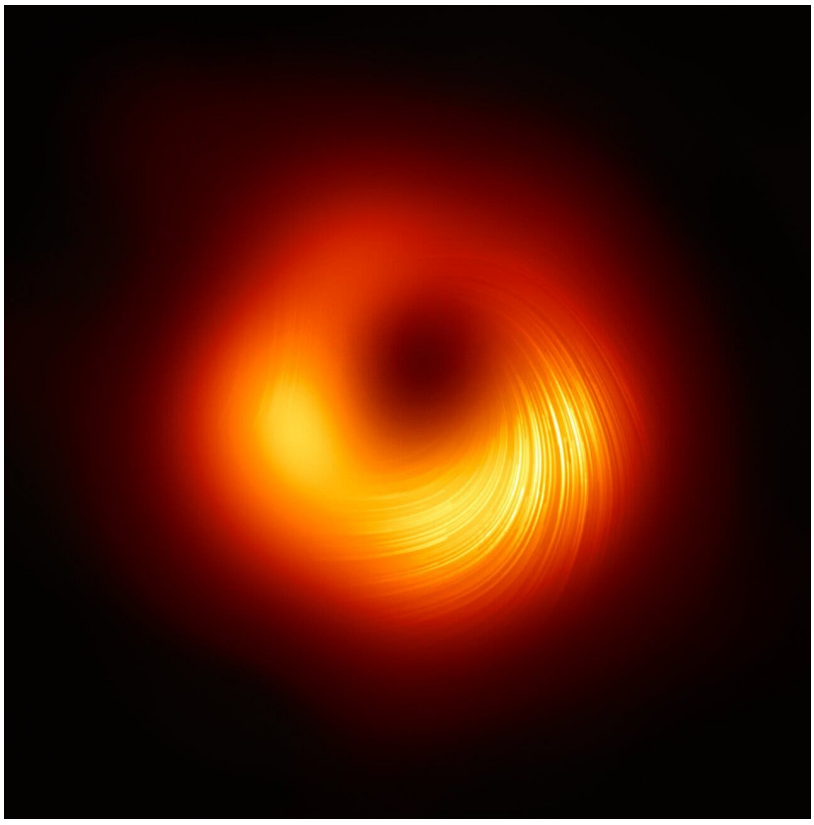
The way computation has pushed the limits of human perception is worth interrogating deeper. Here, I want to return to the legacy of remote sensing cited in the achievements of the Landsat 1 through a critique of the Kantian notion of the sublime.

In 2019, computation was used to compile many terabytes of data from the Event Horizon Telescope (EHT) to produce the first (synthetic) image of a black hole roughly

55 million light-years away in the center of the Messier 87 (M87) galaxy.[53] In 2022, Sagittarius A was imaged at the center of our own Milky Way by the Event Horizon Telescope project. These achievements, and the subsequent images produced by the James Webb Telescope, mark a seminal moment in the history of images.

The first visualization of a black hole required a synchronized array of radio telescopes located across the globe, turning the world's surface into a sort of giant planetary sensor–a theoretical aperture the size of the Earth. The web of telescopes, which are actually radio dishes, produce high fidelity information through an interferometric process called Very Long Baseline Interferometry (VLBI) that combines their individual measurements of wave interference. To model M87's appearance, EHT ran simulations and used ray tracing to describe the gas and plasma surrounding the black hole that were parametrized with its spin and temperature values. Ray tracing describes the computational reproduction of optical effects such as light, shadows, and depth.

[53] Offert, Fabian. "Latent Deep Space: Generative Adversarial Networks (GANs) in the Sciences." *Media+Environment* 3(2). 2021. https://doi.org/10.1525/001c.29905.



An image of the Messier 87 black hole by The Event Horizon Telescope project

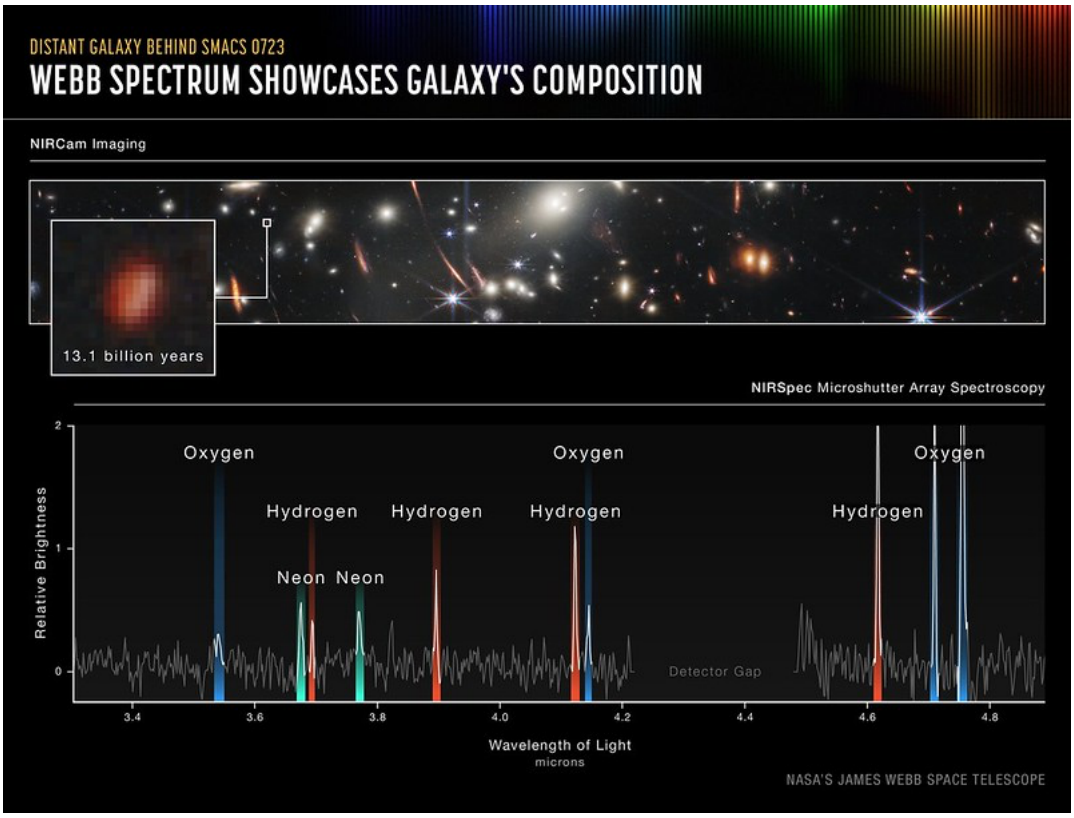
The massive amounts of information recorded over ten days of observation provided data that took two years to compute and process into a verifiable and reproducible image. Scholars such as Shane Denson point to the micro-temporal speed involved in mediating everyday computational images, but in the case of the black hole the process is macro-temporal, stretching over days and years.[54] This scale, both spatially and temporally, is a new capability that affords a new kind of image.

What we see, the orange circle amid a black void, is the light from the accretion disk around the shadow of the mass that is the black hole. The color choices we see are in fact arbitrarily chosen by scientists and correspond to the temperature and wave frequencies observed in the magnetic fields near the event horizon of the black hole at

[54] Denson, Shane. *Discorrelated Images*. Duke University Press, 2020.

the center of M87. The initial blurry image has been subsequently sharpened with new algorithms and upsampling techniques and re-published.

The collaboration brought together institutions and astronomers from all over the world seeking to push the observation of quasars and black holes beyond the limits holding science back: providing a deeper understanding of space, time, and gravity fundamental to understanding the universe. The limits of knowledge and the terrifying yet affectively pleasurable feeling of confronting it through an aesthetic experience is the sublime I want to think through here. The profundity of this astronomical image, and what it verifies and confers, prompts the question of whether it stands for a new form of the sublime.



The light of a galaxy emitted 13.1 billion years ago captured by the James Webb Space Telescope displayed as a spectrum graph. The telescope's micro-shutter array responsible for this data is part of its Near-Infrared Spectrograph (NIRSpec) instrument. NIRSpec was built for the European Space Agency by European companies led by Airbus Defence and Space with NASA's Goddard Space Flight Center supplying its micro-shutter subsystem.

In *The Critique of the Power of Judgement*, Kant analyzes the conditions that enable what he calls reflective judgements of taste, most notably those accompanying the experience of the beautiful and the sublime. Formed without the logical concepts he claimed were prerequisites for understanding and cognition, judgements of taste are closer to the imagination: they arise freely and evoke delight without ends to justify their existence. There are no proofs to validate these reflective judgements. Different than the singular preferences of an individual that he calls agreeable, judgements of the beautiful and the sublime assume a universal validity, although they are subjectively felt, which bonds all humans in what Kant calls the *sensus communis* of taste.

The sublime transcends the limitations of expression and representation while inducing both pleasure and terror. Regarding the limits of reason referenced in the epigraph to this chapter, the sublime allows the mind to recognize its own disposition when estimating the external world. When confronted by the infinity of the sublime, we experience an aesthetic recognition of our own finitude.

For Kant, the sublime is part of his larger critical and moral project to define freedom within the edges of human reason and aesthetic experience. I want to stay with this principal, and indeed with this definition of the sublime, yet also point to Kant's teleology of judgment as a shortcoming that effaces the indeterminacy of experience–or the contingency of experience in the world.

Fred Moten writes about Black aesthetics as a manifestation of indeterminacy and freedom from within unfreedom–in the break, in the cut, in the blur. In reference to Miles Davis' kinetic musical improvisation and the words of Samuel Delaney alluding to Cecil Taylor and Amiri Baraka he summons the sublime as "that which is experienced as a kind of temporal distancing and the out interinanimation of

disconnection…"[55] In words written about the digital art of American Artist, Moten's lyrical exposition is worth quoting at length:

> American Artist rigorously understands that this force and power, in spite of all rhetoric regarding freedom of the imagination under liberalism, which the artist is supposed to embody, has most often, and for most people, been carceral and regulative. In this regard, (black) art has never simply been a place one goes to get free; it is, rather, an experimental constraint one enters, at one's happily necessary peril, in order to test and break freedom's limits.[56]

It is this temporal distancing and disconnection at the edge of reason that captures the power of the (B)lack hole image.

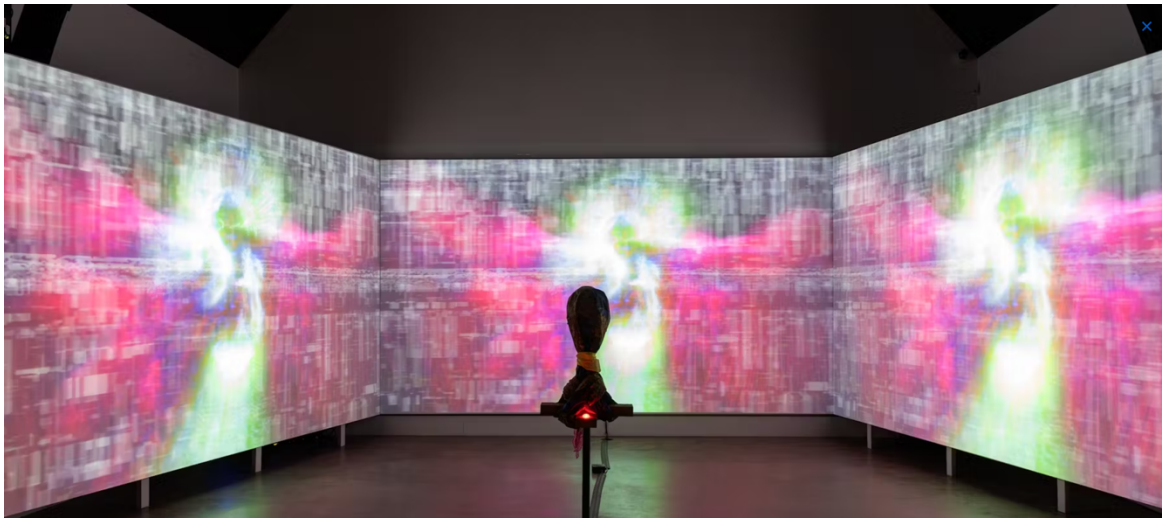
Computation, including AI, introduces the potential to make an image that confounds our sense of representation through the indeterminacy of its making. In the words of Parisi, "the medium is given the task of transducing the unknown."[57] Following Sylvia Wynter's articulation of Black women as representative of chaos, or the outside of reason set against the universality of the Western Man central to the history of science, a conceptually fugitive form of the computational suggests one path away from the instrumentality of dominant technological solutionism.[58]

The artist Danielle Brathwaite-Shirley's work occasions this sublime image that at once challenges our sense of formal representation while invoking a kind of terror that comes with confronting unsettling realities such as self-doubt or the violent negation of Black trans people. Her work taps into the computational–virtual reality (VR), expressive digital images, animation, and interactive video games–as a new form

[55] Moten, Fred. *In The Break: The Aesthetics Of The Black Radical Tradition*. United States, University of Minnesota Press, 2003. 155.
[56] Moten, Fred. "American Artist." *Cura Magazine* 38. 2022.
[57] Parisi, Luciana. "The Negative Aesthetic of AI." Digital Aesthetics Workshop. 2023, Stanford Humanities Center, Stanford Humanities Center.
[58] Wynter, Sylvia. 1984. "The Ceremony Must Be Found: After Humanism." boundary 2 12/13, no. 3/1: 19–70.

to elicit visceral, affective responses in gallery spaces where this type of encounter is not the norm.

In *The Rebirthing Room* (2024), made for Studio Voltaire in London, Brathwaite-Shirley conjures a series of confrontations with demons of the self: anxiety, bias, addiction, loathing, self-doubt, fear. The viewers playing the game attempt to slay these demons in an interaction that demands a critique and transformation of the self, probing them: "will you let yourself be born again?" A VR headset is turned into a personified controller for the audience in an installation that also includes a television set, telephones, and three large screens projection-mapping a virtual environment. The powerful and subjective political engagement of her work doesn't compromise the universal validity of the sublime aesthetic experience she makes available.



Danielle Brathwaite-Shirley, THE REBIRTHING ROOM, 2024. Installation View, Studio Voltaire, London. Commissioned and produced by Studio Voltaire. Credit: the artist and Studio Voltaire. Photography Sarah Rainer.

Danielle Brathwaite-Shirley, THE REBIRTHING ROOM, 2024. Installation View, Studio Voltaire, London. Commissioned and produced by Studio Voltaire. Credit: the artist and Studio Voltaire. Photography Sarah Rainer.

The imaging of cosmic phenomena many light years away that tells us about the nature of being in our universe provokes the same uncanny wonder that Brathwaite-Shirley's artwork brings to bear on the indeterminant conditions of being human. The computational sublime, then, is not about the ineffable quality attributed to landscape paintings in the eighteenth and nineteenth centuries, but about aesthetic experience at the limit of representation.

Yet, in the case of the black hole image, it's important to ask whether this astonishing accomplishment to collectively build a sensing instrument that can capture, verify, and reify the unseeable and hitherto unknowable worth the conditions in which

it is produced. This question also requires asking whether computer science can escape the techno-capital and military-industrial instrumentality within which it is often developed.

W.J.T Mitchell is wise to suggest that "if we are going to have a science of images, then, the first step is to release it from the tyranny of the physical eye…"[59] Imaging that enables cures, discoveries, and new aesthetic experiences of the sublime is a benefit of this new epistemic reality. But a science of images also historically feeds into desires for more control, leading to applications of more intense surveillance. To better understand this dichotomy, turning to the history of photography can be helpful in identifying the important difference today makes with respect to the past.

Photography

Film or mechanical photography birthed new means for spreading information and extended human expression in its own novel ways. What is unique about the expressions of photography, whether its quotidian or avant-garde, is up for argument. In its history from the nineteenth century onwards, a broad range of outcomes could each be argued as definitional for the power of the medium. The experimental abstractions of Man Ray, for instance, immediately question what photographic mediation means when there is no camera involved. The systematic observation of industrial architecture by Hilla and Bernd Becher are a testament to photography's power as both an archival and a fine art practice. The intimate close-up frames of Robert Mapplethorpe, reflecting the artist's vision in the gaze of his collaborators in

[59] Mitchell, W. J. T.. Image Science: Iconology, Visual Culture, and Media Aesthetics. United Kingdom, University of Chicago Press, 2015, 30.

portraiture, are perhaps the most iconic form most associated with photography. Each instance above represents different formal examples of what photography can do.

The artistic allure, however, is not found in an objective formula. I can point to the haunting, unutterable beauty in the quotidian subjects of photos by Walker Evans, Eugene Atget, Robert Frank, Mario Cresci, Fan Ho, Daidō Moriyama, Vivian Maier, Diane Arbus or James Barnor as a testament to photography's ability to seize an excess of life and meaning in the minutiae of everyday mundaneness otherwise inaccessible to the human eye. This beauty, of course, doesn't capture the power that accompanied what became known as photojournalism.

Photojournalism blurs the line between the terror of the sublime and the demand to document moments that can change how the world is known. Here, the work of Dorothea Lange, Gordon Parks, Alfredo Jaar, and James Nachtwey stand out as exemplary. With the emergence of computational images, photojournalism can no longer exist as it did in the twentieth century because of the ease with which synthetic documentation can be manufactured.

Daido Moriyama. *Entertainer on Stage*, Shimizu, 1967.

James Barnor. *AGIP Calendar Model*, 1974.

In film photography, the physical quality of a print alters the encounter with an image much the same way that the resolution of a scan or a screen can affect the experience of a digital one. Analog photography suffered from bias literally built into film, most notable in the case of Kodak and their failure to calibrate their film to deal with a range of exposures that accounted for darker skin tones.[60]

[60] Lewis, Sarah. "Racial Bias and the Lens." *Vision and Justice*. 2023.

In 1882, French criminologist Alphonse Bertillon standardized the use of photos to identify and archive suspected criminals in a process that established the modern mug shot. The chart above shows how police stations typically archived various body parts. Courtesy of The Metropolitan Museum of Art, New York.

Photography also enabled colonial and eugenicist practices, propaganda, and as Allan Sekula reminds us–the othering of the body through the mug shot.[61] Writes Sekula:

> For nineteenth-century positivists, photography doubly fulfilled the Enlightenment dream of a universal language…it promised to reduce nature to its geometrical essence. Presumably then, the archive could provide a standard physiognomic gauge of the criminal, could assign each criminal body a relative and quantitative position within a larger ensemble.[62]

[61] See Azoulay, Ariella. *The Civil Contract of Photography*. Cambridge, Zone Books, 2008. Also see Benjamin, Walter. "A Short History of Photography," Literarische Welt, 1931. Also see Sekula, Alan. (1992) "The Body and The Archive," in Bolton, R. (ed.) *The Contest of Meaning: Critical Histories of Photography*, Cambridge: MIT Press.

[62] Sekula, Alan. (1992) "The Body and The Archive," in Bolton, R. (ed.) *The Contest of Meaning: Critical Histories of Photography*, Cambridge: MIT Press.

Today, we can ask whether facial recognition databases and biometric tracking are the new form of the mug shot. Is an AI training set a transformation of the archive? The answers to these questions are not ones I attempt but raising them is important in the context of locating the kinds of structural logic that drive technological development.

Peter Galison's research on the pursuit of objectivity in the images considered scientific is relevant here.[63] He explains how the rise of atlases in the seventeenth and eighteenth centuries was part of an ethically invented idea that regards perfect images of objectivity in science as both necessary and attainable. The approaches to achieving universal objectivity have changed each century since, but the positivist quest for objectivity persists. As we will see, this desire for an idealized image haunts images produced by generative AI.

It would seem appropriate, then, to consider the remediation of images and image production by digital media with some ambivalence because of the continuity it already shares with the history of photography, and modern image making. The following analysis grapples with continuity and difference in the context of computational processes and objects that are introducing new forms of mediating the visual under similar, if not the same, logics.

Computational Images

Increasingly, smartphones are the most quotidian way we interact with computational photography. Image production here departs sharply from how traditional photography works. Constantly updating integrated circuits (microchips) allow for ever higher computational workloads that keep phones and their optical

[63] Daston, Lorraine, and Peter Galison. *Objectivity*. Zone Books, 2021.

lenses ultrathin while imaging capabilities seemingly continue to improve. Optical and physical techniques from photography such as depth of field, grain, and high dynamic range are introduced through algorithmic shortcuts that simply reproduce these mechanical effects.

Raphaël Millière, who labors in the philosophy of AI, agrees that in a simple AI-enhanced image processed on a mobile phone "the 'contact' between the final output and the depicted scene is mediated, in some way, by the 'contact' between millions of training samples and the scenes they depict."[64] What appears as indexical, archival truth is in fact more synthetic than before, and increasingly the changes occur on the fly, in real time, making them harder to discern from reality. This artificiality undermines the power that Roland Barthes reserved for photography's capability to testify to something "that has been."[65] Manovich believes this will simply turn image production back into a subgenre of painting, with algorithm serving as paintbrush.[66]

Comprised of a complicated ecosystem, computational photography can range from the simple task of using software to automatically remove noise all the way to constructing an entirely synthetic image. As a subtle example, Marc Levoy, a VP at Adobe who was a key tastemaker for the Google Pixel 2 through 4, has revealed that his preference for Caravaggio paintings influenced the company to design the device to compress images in a way that makes them appear darker with higher levels of contrast.[67]

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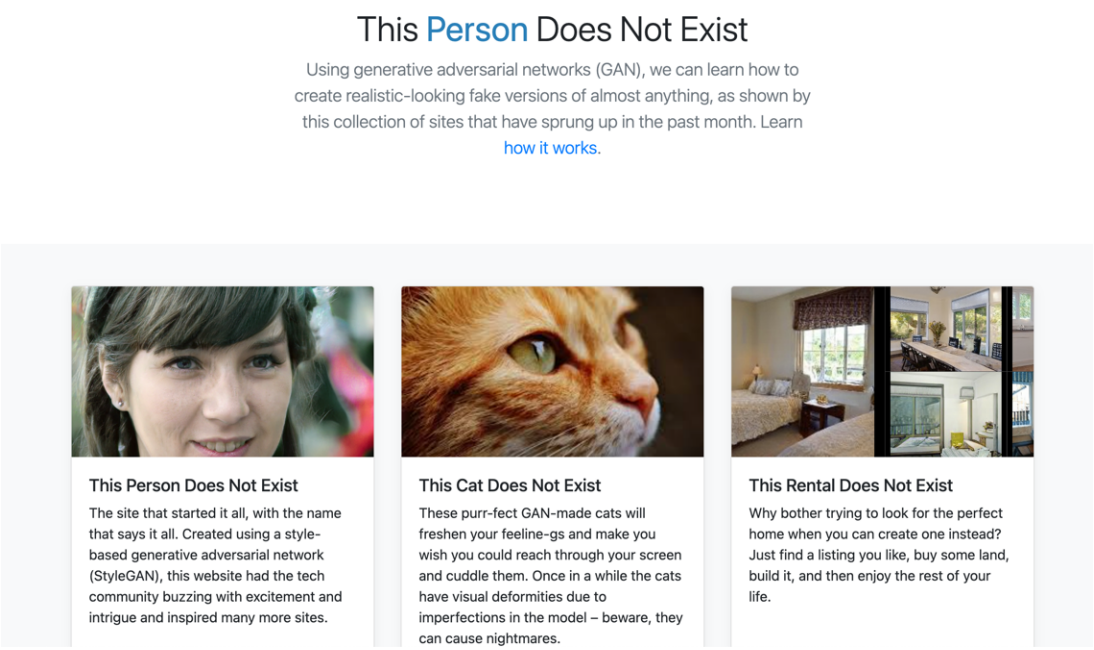
[64] Millière, Raphaël. "Deep Learning and Synthetic Media." *Synthese* 200.3 (2022): 1-27.
[65] Barthes, Roland. *Camera Lucida: Reflections on Photography*. New York: Hill and Wang, 1981.
[66] Manovich, Lev. *The Language of New Media*. Cambridge, Mass: MIT Press, 2001, 293.
[67] Adobe Life. "Q&A with Adobe VP and Fellow, Marc Levoy Following His Election to the National Academy of Engineering | Adobe." *Blog.adobe.com*, 10 Mar. 2022, blog.adobe.com/en/publish/2022/03/10/adobe-vp-fellow-marc-levoy-following-his-election-to-national-academy-of-engineering. Accessed 17 Mar. 2024.

In a more extreme example, a Reddit user in 2023 presented compelling evidence that Samsung phone cameras are using ML to generate details of photos of the moon that are entirely synthetic. They are created from many images that have trained the neural network to simulate an image of the moon based on the blurry one the phone cobbles together. Rather than presenting a blurry, low-res representation that is optically captured, the camera system produces a sharpened, idealized version generated from its neural network that is prompted by the original blurry image.[68] This represents a significant moment where enhancement turns into absolute replacement.

In the case of absolute replacement, the emergence of AI architectures such as generative adversarial networks (GANs) and diffusion models have led to a significant breakthrough that has made the instant production of entirely synthetic images something that is now widely available. Conceived principally by Ian Goodfellow in 2014, GANs follow von Neumann's game theoretical principle of *zero-sum competition* to learn to discriminate between real and synthetic images, which simultaneously improves the model's ability to generate new synthetic images comprised of a combination that lies within a probability distribution of whatever dataset that was used to train it. In other words, the model learns from the dataset and produces photorealistic iterations that are indistinguishable from "real" images taken from the world. The website thisxdoesnotexist.com collates different GAN projects trained to produce entirely made-up photorealistic images of humans, cats, and interiors.

[68] ibreakphotos. "Samsung "Space Zoom" Moon Shots Are Fake, and Here Is the Proof." *Reddit*, 10 Mar. 2023,www.reddit.com/r/Android/comments/11nzrb0/samsung_space_zoom_moon_shots_are_fake_and_here/.



Screenshot from the website thisxdoesnotexist.com showing examples of different GAN generated images of people, cats, and homes that are entirely synthetic productions based on the particular model's datasets of these objects.

The diffusion model is based on a technique of the same name borrowed from non-equilibrium thermodynamics. Because of its gradual process using Markov chains to iteratively denoise an image to produce data samples from noise, it is relatively more effective than GANs at producing a probability distribution from its labeled dataset. Within this distribution, the diffusion algorithm learns to recover its training images (the signal) starting from pure Gaussian noise. In generative AI applications such as Midjourney and Stable Diffusion, diffusion models are involved in the process that matches text prompts to pixels to produce images heavily influenced by its training data (more on this in chapter six).

The diffusion model has replaced the use of GANs for most generative image applications because of its scalability and equal performance in producing high fidelity, photorealistic outcomes. Both are responsible for producing images that have, like the Pope's puffer jacket image, become a viral cultural craze. They are also responsible for

what are known as deepfake images. Technically, deepfakes are a broad term covering partially or entirely synthetic pieces of image, video, or audio cobbled together from an archive of data. They usually refer to algorithmically created simulations of human or object-likeness that are becoming easier to create. Text-to-video generative AI models, like OpenAI's SORA, are already available.[69]

Although used in good faith by research scientists, artists, or visual effects editors, simulated video is problematically appearing in pornography, often to simulate celebrities, and in international political subterfuge.[70] A group established in 2019 called Coalition for Content Provenance and Authenticity (C2PA), which includes Adobe, Microsoft, Intel, and Truepic, is committed to creating processes and technical standards for content provenance verification. Adobe has led an initiative for the group to develop a watermark logo that members have committed to testing.

The training of these AI models relies on massive datasets that are labeled mostly by humans. Between 2006 and 2009, researchers at Princeton University led by one of computer vision's most influential scientists Fei Fei Li, created an annotated 14-million image dataset for visual object recognition training known as ImageNet. They sought to create a comprehensive list that included the entirety of human knowledge, a map of all objects that included 20,000 categories. This database is to date the most significant set of data for the development of ML and computer vision.

The project relied on the Internet and Amazon's Mechanical Turk labor service to complete the tedious task of annotations. ImageNet has come under scrutiny for various

[69] SORA uses a deep learning method known as self-supervised learning with billions of parameters (in a diffusion-transformer architecture) trained on millions of hours of text-labeled video whose exact sources are unclear.
[70] Sample, Ian. "What Are Deepfakes – and How Can You Spot Them?" *Guardian*, 2020, www.theguardian.com/technology/2020/jan/13/what-are-deepfakes-and-how-can-you-spot-them.

biases embedded in its data, something that is not unique to this project and is recognized as one of AI's most persistent problems. More importantly, the incompleteness of datasets raises the question of whether it is possible to formalize and objectify all human knowledge of nouns and concepts into a universal, exhaustive one. This is what makes Professor Li's contribution to computer vision such a vital one for advancing the field of AI. Yet, this advance also intensifies the politics of classification as they migrate into the digital, feeding AI systems an inherently limited epistemology of vision.

A new politics of data, or *infopower*, emerges (more on this in the following chapter). Sekula's notion of an archive of the body extends to the dataset of computer vision, yet the scale here is many times larger and the process of production more inscrutable than in photography. The compression of images as pixels in high-dimensional space in deep learning also means that they are not relied on by AI systems on a 1:1 basis. An image in the training data won't ever come out as an output in exactly the same way. Here, the comparison to an archive doesn't completely explain how AI systems embed their training data the way one image might be used by another human being. Like the transformation of the concept of representation, computational images produced by generative AI also require a new concept of the archive.

As of 2024, many commercial applications, including Midjourney and Stable Diffusion, rely on an open-source dataset called LAION, scraped from the Internet by a German non-profit. Already, they have been named in multiple lawsuits from Getty Images and individual artists for infringement.

LAION-5B contains 5.8 billion image and text pairs that were curated through automation, making it improbable for human oversight. Data journalist Christo Buschek and software artist Jer Thorp investigated the dataset, concluding that the

overwhelming amount of images say "less about how humans see the world" and more about "how search engines see the world."[71]

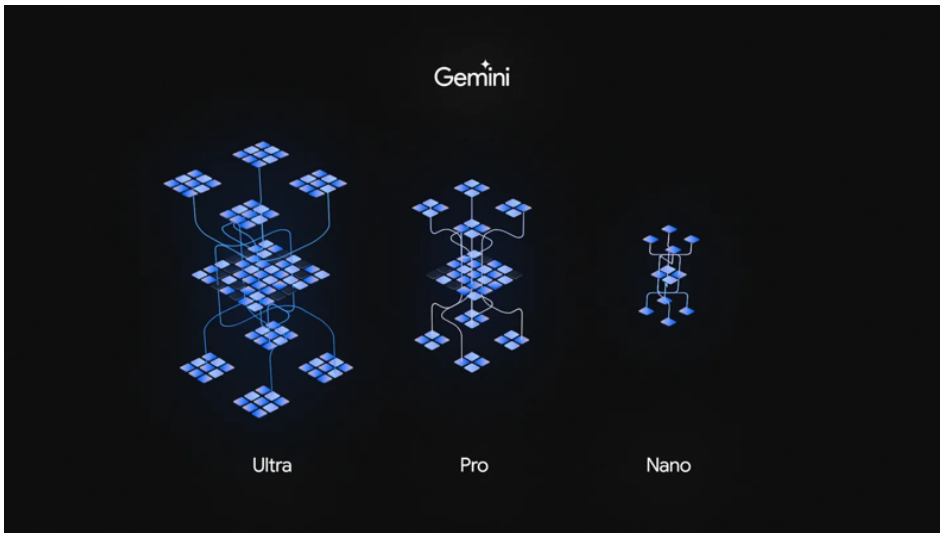
The intense economic appeal of AI means that it will continue to rapidly develop and attract capital for building new applications and products. Alphabet's Google is using AI to add new imaging features regularly, including what are called Magic Eraser and Magic Editor, which are tools that allow for instant removal, manipulation, and replacement of objects in any image with a few simple steps. Don't like how your child is clutched in your hands while held above you rather than floating in the air? With Magic Editor you can simply tap, select, and drag on your phone until your desired outcome is achieved.

The stakes for images are now part of the rush to build general purpose AI. OpenAI's text-to-video model is characterized by the company as a path toward general intelligence, with the model displaying a unique, albeit sometimes strange, aesthetic model of the world. Google's most competitive foundational large language model is currently called Gemini, built through its acquisition of DeepMind and through the leadership of Demis Hassabis. Hassabis' DeepMind was responsible for AlphaGo, the AI program mentioned in the introduction that in 2016 famously defeated Go champion Lee Sedol through a bewildering move that confounded its human observers. Google touts Gemini's general-purpose intelligence, including multi-modal media inputs which can include video, images, and audio formats.[72] Hassabis believes in an increasingly

[71] "Models All the Way Down." Knowing Machines, 2024, https://knowingmachines.org/models-all-the-way. Another interesting subplot to follow is the back-and-forth between developers of CAPTCHAs over their vulnerability against bots armed with improved image recognition algorithms. CAPTCHA, an acronym for Completely Automated Public Turing test, is meant to thwart attacks and other illicit behavior on online services by differentiating between humans and bots–usually through requiring the recognition of objects in an image.[71] Google acquired reCAPTCHA in 2009 and has consistently defended against privacy concerns of clients who rely on its service.

[72] Pierce, David. "Google Launches Gemini, the AI Model It Hopes Will Take down GPT-4." *The Verge*, 6 Dec. 2023, www.theverge.com/2023/12/6/23990466/google-gemini-llm-ai-model.

general form of AI that can sense and interface with humans in increasingly diverse ways, including touch and gestures.[73]



An abstract representation of Google's various Gemini LLM sizes by model. Starting from the largest on the left, they indicate the amount of network layers and parameters, and thus power of each model.

Apple has released its own slew of AI-enhanced applications in imaging, including the recent Cinematic Mode to introduce real time depth-of-field video focus capability.[74] The company's imaging research team identified rack focusing as a fundamental tool of storytelling in cinematography, where blur can direct a viewer's gaze and create dramatic compositions. The ability to create bokeh, a soft blur separating a subject in the foreground from the background through shallow depth of field, is controlled by opening and closing the aperture of a lens on a camera. In videography, this often requires a skilled focus puller responsible for continuously adjusting a camera's aperture in dynamic shots to appropriately shift focus and attention.

[73] Google is also deploying AI in visually interesting ways, for instance in sustainability projects to visualize canopies in its Tree Canopy Lab. Moving forward, generative AI will be increasingly used to create the content for targeted advertisement campaigns optimized for specific demographics.[73] The content will be entirely synthetic, produced by AI almost on-demand.

[74] An algorithm on iPhones, called gaze detection, even attempts to fix your eyes on the device's camera to generate the view of direct eye contact during video messaging.

The production of Apple's silicon A15 Bionic Chip enabled new computing power that could accommodate the introduction of a 16-core neural processing unit called Neural Engine, a dedicated processor for accelerating machine learning operations like matrix multiplications and convolutions. Running these algorithms on-device without straining the CPU or GPU enables Apple's iPhone to meet the high computational demand required to create synthetic bokeh effects on video by simply switching to Cinematic Mode, similar to how the Portrait Mode feature allowed for simulating depth effects in photography. Everyone with an iPhone can be a cinematographer.

Since 2019, the leadership at Snap Inc. has declared that they are now simply "a camera company."[75] Its prominent holding is the popular social media app Snapchat, which is known for its augmented reality (AR) features: virtual content that overlays onto the physical world via the screen interface. A new feature released by the app is a generative AI selfie producer called "Dreams" that inserts a user's likeness into fantastical compositions once you've uploaded some selfies. Another example of AR comes by way of TikTok, a company leading the charge for creating AI-enhanced filter lenses. One applies hyper-realistic makeup to match facial contours in real time. How do these real time alterations affect our perceptions of the self?

The applications of Google, Apple, Snap, and TikTok point to the trend of increasing technical intervention in the human visual field by companies. It's clear that the market for the future of interfacing is inextricably tied to competing for human vision and the ability to manipulate it as quickly and easily as possible to our liking.

[75] *Snap.com*, www.snap.com/en-US. 2024.

Meanwhile, the large repository of images uploaded by users on various sites on the Internet has become the source of the data enabling facial recognition programs like the one developed by Clearview AI. In fact, in a paper published on *arxiv* titled "The Surveillance AI Pipeline," the authors conduct a meta-analysis of AI papers and patents in computer vision research over the last 30 years and find that a majority of computer vision research has contributed to the expansion of physical surveillance.[76] Much like the outcomes of math and science research in the twentieth century spawned more destructive power, AI research poses deeply troubling ethical quandaries that include, but are not limited to, surveillance. I will selectively list some of these accounts here.

Surveillance AI

At the beginning of her article titled "Surveillance Sublime: The Security State in Jerusalem," Palestinian media scholar Helga Tawil-Souri writes that there "is a sublime essence to surveillance."[77] This kind of sublime contrasts intensely with the one articulated above. Here, the sublime connotes a search for a God-like ability to watch over and control. It fulfills Manifest Destiny.

Simone Browne makes the case that any general theory of modern surveillance must consider the reification of blackness constructed through a history of the transatlantic slave trade and the racialization of matter that goes beyond any one technology.[78] Ongoing and sometimes unperceivable, the surveillance of blackness, what she deliberately ambiguates as dark matter, produces an ontology that is crucial to understanding both racial violence and surveillance.

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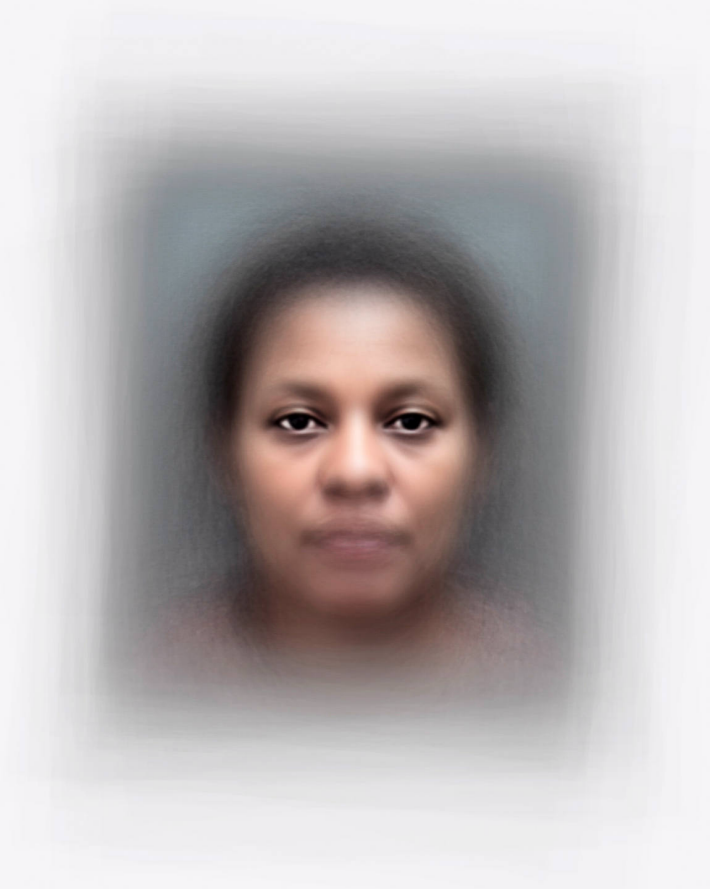
[76] Pratyusha Kalluri, et al. "The Surveillance AI Pipeline." *ArXiv (Cornell University)*, 26 Sept. 2023, https://doi.org/10.48550/arxiv.2309.15084. Accessed 2 Dec. 2023.
[77] Tawil-Souri, H. "Surveillance Sublime: The Security State in Jerusalem." *Jerusalem Quarterly 68*. 2017.
[78] Browne, Simone. "Dark Matters: On the Surveillance of Blackness," *Duke University Press*, 2015.

Tawil-Souri and Browne's work clarify the long-standing logic of surveillance. The goal here isn't to argue that it is unprecedented, but to note and analyze how it intertwines with the development of computation and AI, especially in the construction of a visual field. Thus, the examples I choose modify the concept of surveillance to include a trend within algorithmic capitalism that is moving toward a collapse between what we think of separately as the physical and the digital. The mediation of this collapsed singularity through corporations introduces a new dimension to surveillance that is designed to feel unmediated. Chapter five will more extensively develop what this theory of automated surveillance looks like, whereas in this section I consider state-of-the-art technologies that bring it to bear.

Racialization built into the logic of computation and Internet-based technologies shouldn't be a surprise. The work of Ramon Amaro, an engineer, sociologist, and cultural theorist, locates in contemporary AI a longer history of statistical modelling and social sorting that have a basis in constructing blackness, what he calls the Black Technical Object.[79] These techniques of measurement and prediction produce race–blackness–as an abstract object outside of the reason comprising the seventeenth century concept of the Human. The logic of capitalism and racialized, carceral logics merge into the infrastructure of computation.[80] Problematically, these technologies are often presented to the public stripped of their histories, as if machines emerge out of thin air.[81]

[79] Amaro, Ramon. *The Black Technical Object: On Machine Learning and the Aspiration of Black Being*. Germany, MIT Press, 2023.
[80] Wang, Jackie. *Carceral Capitalism*. MIT Press, 2020.
[81] See Benjamin, Ruha. *Race After Technology: Abolitionist Tools for the New Jim Code*. United Kingdom, Wiley, 2019. Also see Noble, Safiya Umoja. *Algorithms of Oppression: How Search Engines Reinforce Racism*. United States, NYU Press, 2018.

In *The Mathematics of Regression* (2019-2022), the artist Clément Lambelet builds an AI composite image classification system to reveal the technological reproduction of the racist U.S. carceral system in which people of color are predominantly its victims. Fifty-five thousand mug shot portraits are automatically classified by age and gender and anonymized through a technique called superposition, revealing a composite idealized image of each demographic strata.



***The Mathematics of Regression*, Lambelet, 2022. Three hundred and five women arrested at age 42.**

In 2020, Google ousted widely cited AI ethics researcher Timnit Gebru (who has since cofounded the Distributed AI Research Institute) after she co-authored a groundbreaking paper that found LLMs to be susceptible to environmental harm and discriminatory bias against women, people of color, and the LGBTQ community (this was one of several ML risks the co-authors identified in their research). The harms

surface because energy-intensive models are trained with scraped and opaque datasets from across the Internet that are too vast to closely monitor and often overrepresent hegemonic languages, leaving little doubt about their bias.[82] The opaque relationship between vast data and problematic outcomes well-articulated by Gebru *et. al.* in this paper is now widely known and studied. As is the skepticism of whether LLMs have any reasonable understanding of their outputs.

An example of how this plays out in the world is evidenced in the case of the Federal Trade Commission (FTC) banning Rite Aid from using facial recognition technology for five years. In late 2023, the FTC concluded that Rite Aid's flawed deployment baselessly targeted people of color as shoplifters. Image recognition and classification of darker skin tones has been a thorny problem for computer vision. Computer vision researcher Joy Buolamwini started the organization Algorithmic Justice League (AJL) after her research at MIT found that facial recognition programs couldn't capture or identify the faces of dark-skinned women. Her organization leans into computational audits inspired by artistic and Black feminist traditions to advocate for awareness and mitigation of bias embedded in algorithmic systems.

Corporations aware of this problem have attempted to address it, which aligns the answer to bias with the empowerment of disenfranchised identities to take more of a stake in technology, not less. This tension, of course, is at the heart of my project here: how to balance refusal with the appropriation necessary to thrive in the world today. Representational politics is wholly inadequate to address the structural problems of technology that lead to intensifying instrumentalization and surveillance.

[82] Gebru, Timnit, et al. "On the Dangers of Stochastic Parrots: Can Language Models Be Too Big?" Proceedings of the 2021 ACM Conference on Fairness, Accountability, and Transparency, Mar. 2021, https://doi.org/10.1145/3442188.3445922.

In October 2021, Google introduced Real Tone software in its newest mobile phone cameras, heavily marketing its computational sensitivity to darker skin tones in response to years of reported problems with its image recognition applications. The irony of naming a computational process "real" isn't lost here. And presenting past failures as part of a longer failure of photography, as the company does in its marketing material, is misleading since the problems faced by Google are unique to computing and computer vision. For example, the miscategorization of Black faces in photos has nothing to do with the film bias in the old Kodak example. What is consistent is a logic of subtracting the value of Black humanity into Amaro's Black Technical Object–a peripheral problem simply to be measured and solved.

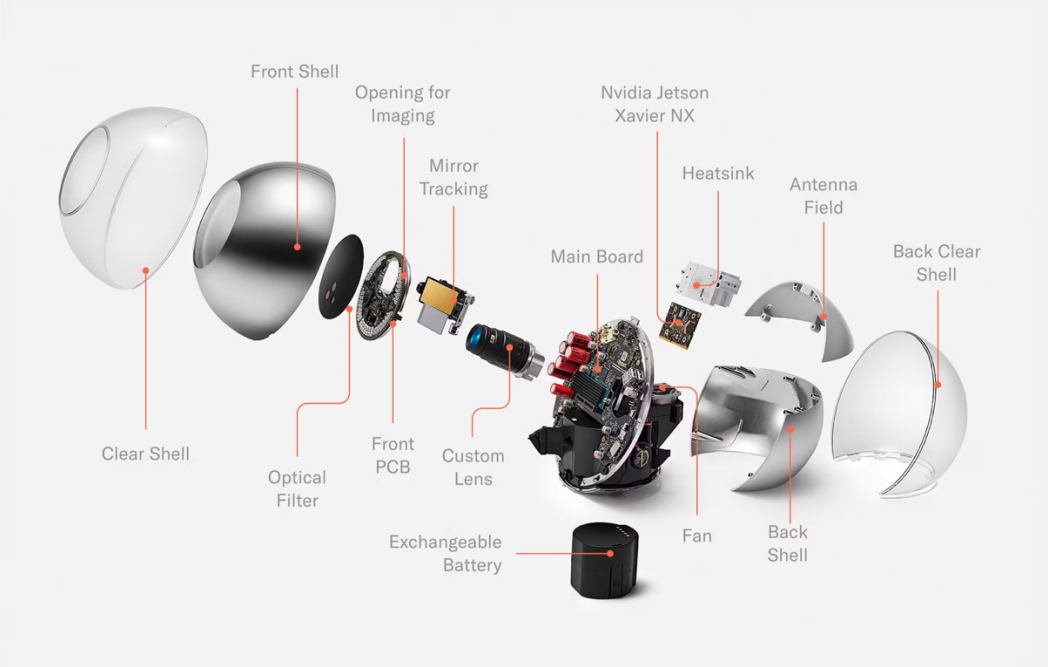
Amazon's Rekognition tool for automated image analysis is another apt case study. Boasting private clients such as the NFL, CBS, and Maurinus Analytics, the company advertises jarring capabilities on its website in rather quotidian tone:

> Amazon Rekognition makes it easy to add image and video analysis to your applications using proven, highly scalable, deep learning technology that requires no machine learning expertise to use. With Amazon Rekognition, you can identify objects, people, text, scenes, and activities in images and videos, as well as detect any inappropriate content. Amazon Rekognition also provides highly accurate facial analysis and facial search capabilities that you can use to detect, analyze, and compare faces for a wide variety of user verification, people counting, and public safety use cases.[83]

Any government intelligence contracts would, of course, not be disclosable. Amazon Web Services (AWS) was forced to suspend U.S. law enforcement from using the technology amid widespread criticism in June of 2020 in the wake of protests following the murder of George Floyd. The obvious relation of Rekognition to the Hegelian notion of recognition is a portentous one. It suggests a reality where human identity only exists in the mutual identification with corporate machines. In a bizarrely ambitious venture

[83] "Amazon Rekognition." *Amazon*, 2020, aws.amazon.com/rekognition.

related to this idea of human-machine recognition, Sam Altman's project called Worldcoin relies on publicly placed orbs around the world to capture an onlooker's unique eye-signature to use for encrypted digital identification and verification purposes. The orbs are the material source of your identity.



Exploded CAD image of Worldcoin's Orb optical infrastructure. Credit: worldcoin.org

For Meta, now the world's largest repository of shared images across Facebook, WhatsApp, and Instagram, its apps are a trove of visual data. Instagram images serve as training data for its AI image generation model called Emu.[84] The repository of images generates all sorts of behavior and preference analysis through automated image recognition tools. For example, data on what users find most interesting or what content gets what sorts of reactions and engagement.[85] Meta relies on these techniques to automate content-moderation. This has, during times of political turmoil, led to the

[84] Giles, Tom. "Meta's Chris Cox on Building AI Into the Product Suite." Bloomberg, 2024.
[85] Tsai, Paige. "Image Recognition at Facebook: How Machine Learning Is Helping Computers - and People Who Are Blind - 'See' Digital Photos." *Harvard Business School Digital Initiative*, 13 Nov. 2018, digital.hbs.edu/platform-rctom/submission/image-recognition-at-facebook-how-machine-learning-is-helping-computers-and-people-who-are-blind-see-digital-photos/.

inexplicable vanishing of posts, accounts, and comments that amount to censorship and raise many questions about the company's ethical decision making.[86]

In terms of the collapsing of the physical and the virtual, products such as Meta's Ray Ban sunglasses are an attempt to migrate the digital experience, including AI integration, directly into the everyday human line of sight.[87] Previously called Facebook, the company made a large bet in the extended reality (XR) market, acquiring the VR platform Oculus for $2 billion in 2014 and officially changing its name to Meta in a nod towards a future spent in the virtual, immersive metaverse. Recent patent filings show the company's interest in collecting biometric information like body and pupil movements that would allow it to monetize its virtual spaces through advertising revenue and commerce generation.[88]

XR, including VR and AR, is made partially possible by software that recreates three-dimensional renderings of an object or scene using images taken from different angles, called volumetric photography, which enables the construction of explorable, large-scale, metastable virtual spaces that eerily mimic reality.[89] Newer worldbuilding and modeling techniques using machine learning such as 3D scanning, gaussian splat imaging, and Neural Radiance Fields (NeRFs) are moving ever closer to enabling real time high-fidelity scene construction from limited or even synthetic data. Palmer Luckey, the founder of Oculus VR who was controversially fired from Facebook for his

[86] Human Rights Watch. "Meta's Broken Promises." *Human Rights Watch*, 21 Dec. 2023, www.hrw.org/report/2023/12/21/metas-broken-promises/systemic-censorship-palestine-content-instagram-and.
[87] FAIR, Meta's AI lab, is constantly releasing new research and making breakthroughs in image recognition quite rapidly, including working towards the first foundational model for image segmentation. Unlike other Big Tech companies, Meta has been proactive in open sourcing its research, which is helpful in increasing transparency and public collaboration. True to this approach, they released a foundational LLM model called LLaMA for non-commercial beta-research that can be operated with much less compute power than comparable models.
[88] Murphy, Hannah. "Facebook Patents Reveal How It Intends to Cash In on Metaverse." Financial Times, 18 Jan. 2022.
[89] Sullivan, Terry. "Computational Photography Is Ready for Its Close-Up." *PC Mag*, 6 Aug. 2018.

right-wing politics, founded Anduril Industries in 2017 to build an electronic and automated warfare weapons start-up company.

Altman's company OpenAI, now funded by Microsoft, has unveiled the most famous large language model to date. Its Generative Pre-trained Transformer (GPT) series of models, based on a combination of diffusion and the transformer architecture first conceived at Google, use deep learning to generate strikingly original text and images from input prompts.[90] The first encounter feels as if there is a machinic interlocutor interpreting your words and responding on the other side. Yet, after the initial awe associated with images like the one of the Pope referenced at the beginning of this chapter wears off, what is the achievement of this costly and labor-intensive process other than its ability to easily produce quirky images through correlative prediction of text sequences? As of this writing, not much.

The most interesting aspect of image generators like Open AI's Dall•E might be what insight they offer about what we humans have already produced on the Internet, which is the source that the model aggregates its references from. It's hard to tell whether this source is akin to what we would consider a source of inspiration, or simply a vomiting of Internet correlations. It's fascinating to see what traces of ourselves are calculated and spit back to us in the form of images. Open AI, increasingly a closed source company, began working with the U.S. military in 2024 in a shift away from an initial company stance to ban military uses of its technologies. Its future will be under close scrutiny as it navigates a turbulent wedge between hype, profitability, power, and technological innovation.

[90] "Dall•E: Creating Images from Text,"*OpenAI*, https://openai.com/blog/dall-e/.

What becomes of images after they are scanned, uploaded, meta tagged, categorized, spammed, manipulated, databased, and crawled online? Are we imbuing programmers, technology corporations, governments, and machines with the power to decide what is noise and what is signal? If AI can create a pattern, an image, or a claim from pure, unrelated noise, what Google researchers once referred to as DeepDreaming and the industry calls hallucinating, we also know it can incorrectly identify a target or site for an unmanned aerial vehicle (UAV "drone") attack.[91]

A term more appropriate than hallucination for this phenomenon might be what psychiatrist Klaus Conrad called apophenia in 1958 to describe the initial stages of schizophrenia.[92] Rather than entirely divorced from sensory reality, Conrad claimed that this form of delusion was self-referential and rooted in over-interpretations of actual sensory information. Apophenia aptly describes both the confidence of AI systems to produce patterns deemed definitive from past data, and the trust corporations and states are placing in these same systems to predict and explain the world. Facial recognition systems can identify a face from a database of 1.6 million photos within 1.2 seconds with 92% accuracy.[93] This number is impressive, but the margin of error is catastrophic if the machine's designation is the only source of proof to determine guilt and impose punishment.

In China, where Xi Jinping's government has vowed to be the world leader in AI, ubiquitous facial recognition cameras already in use to identify and track ethnic

[91] Abraham, Yuval. ""A Mass Assassination Factory": Inside Israel's Calculated Bombing of Gaza." *+972 Magazine*, 30 Nov. 2023, www.972mag.com/mass-assassination-factory-israel-calculated-bombing-gaza/ and Bindemann, M., Fysh, M.C., Sage, S.S.K. *et al.* Person identification from aerial footage by a remote-controlled drone. *Sci Rep* **7,** 13629 (2017). https://doi.org/10.1038/s41598-017-14026-3

[92] Credit to Hito Steyerl for the allusion to apophenia as a framework for computer vision in *Duty Free Art*.

[93] Reardon, Sara. "FBI Launches $1 Billion Face Recognition Project." *New Scientist*, 2012, www.newscientist.com/article/mg21528804-200-fbi-launches-1-billion-face-recognition-project/.

minorities were deployed to enforce quarantine during the Covid-19 pandemic.[94] The U.S. Department of Homeland Security and domestic law enforcement are testing Automated Ground Surveillance Vehicles (AGSV, "robot dogs") to eventually deploy for surveillance and policing of borders and streets.[95]

In 2021, investigative reporting revealed an extensive image-based archive and facial recognition program called Blue Wolf used by the Israeli military (a recent business partner of Google and Amazon) as part of a larger strategy to surveil and control Palestinian movement in the West Bank.[96] In Iran, facial recognition systems have recently been deployed to surveil and enforce the wearing of the mandated headscarf.[97]

Research by Anthony Downey foregrounds the invasion of Iraq as the moment that prompted a new demand for aerial surveillance and computer vision tools (called wide-area persistent surveillance systems, or WAPSS). These were developed as part of U.S. Defense Advanced Research Projects Agency (DARPA) contracts with tech industry companies such as Google and Palantir. One of the most important to computer vision research was named Project Maven.

As part of the apparatus named Autonomous Real-Time Ground Ubiquitous Surveillance Imaging System (ARGUS-IS), the contracts included ML tools for compute, training, classification, and prediction of images coming from unmanned aerial vehicles

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[94] See Kahveci, Aybike Ceren. "In-Depth: Facial Recognition in Mainland China." *SCL Student Bytes*, 28 July 2020, https://bytes.scl.org/in-depth-facial-recognition-in-mainland-china/. Also see Roussi, Antoaneta. "Resisting the Rise of Facial Recognition." *Nature*, 18 Nov. 2020.
[95] "Robot Dogs Take Another Step Towards Deployment at the Border." *US Homeland Security*, 1 Feb. 2022, https://www.dhs.gov/science-and-technology/news/02/01/feature-article-robot-dogs-take-another-step-towards-deployment.
[96] Dwoskin, Elizabeth. "Israel Escalates Surveillance of Palestinians with Facial Recognition Program in West Bank." *The Washington Post*, WP Company, 8 Nov. 2021, https://www.washingtonpost.com/world/middle_east/israel-palestinians-surveillance-facial-recognition/2021/11/05/3787bf42-26b2-11ec-8739-5cb6aba30a30_story.html.
[97] https://www.wired.com/story/iran-says-face-recognition-will-id-women-breaking-hijab-laws/

(drones) that were used for surveillance and the launch of preemptive strikes.[98] In 2022, Project Maven was moved from the Pentagon to the National Geospatial–Intelligence Agency (NGA), prompting outgoing director Robert Sharp to declare that the consolidation of AI systems at the NGA will "give us our millions of eyes to see the unseen."[99]

It's unclear how drones will be further commercialized or weaponized. Photographer Edward Burtynsky started using drones around 2011 to capture aerial compositions of vast landscapes transformed by human intervention. The aestheticization of scale in his work is beautiful in an unsettling way, but also creates an aloof distance that could efface the local human toil. Commercial drone footage is now ubiquitous, typically shot in the spirit of the self-portrait that has become the cliché of the selfie in the digital epoch.

Startups like Skydio market the sale of autonomous drones to police forces and government agencies. They are already a major part of modern warfare, both conventional and asymmetrical. Metadata and drones merge in the way war is waged. Published documents from *The Intercept* revealed that the NSA's massive SKYNET surveillance program was used to actively scour over 55 million cellphones in Pakistan to identify each user's likelihood of being a terrorist, and thus a target for a "signature" drone strike or a visit from a death squad.[100] Michael Hayden, a former National

[98] Downey, Anthony. *NEOCOLONIAL VISIONS: Algorithmic Violence and Unmanned Aerial Systems*. *MIT Press.* 2023.
[99] Hitchens, Theresa. "Pentagon's Flagship AI Effort, Project Maven, Moves to NGA." *Breaking Defense*, 27 Apr. 2022, breakingdefense.com/2022/04/pentagons-flagship-ai-effort-project-maven-moves-to-nga/.
[100] Grothoff, Christian, and J.M. Porup. "The NSA's Skynet Program May Be Killing Thousands of Innocent People." *Ars Technica*, 16 Feb. 2016.

Security Agency and Central Intelligence Agency director, ominously quipped in 2014 that "we kill people based off metadata."[101]

Escape Routes

In the overwhelming deluge of computational systems affecting our senses of perception, Shannon Mattern offers a salient critique of reductive AI. Through the literal and metaphorical role of trees in the histories of human knowledge production, she compares what she calls *tree thinking* to the Monte Carlo decision trees that are used to construct computational logic in search algorithms, suggesting that our dominant attitudes today "promote techno-solutionist responses to problems that are simultaneously ecological, cultural, social, economic, and political."[102] In place of this restrictive and unitary approach, Mattern argues for a type of interdependent *tree thinking* that learns from the practices of stewardship best embodied in indigenous relations with forests and their root systems.

For instance, mycorrhizal networks comprised of tree root systems that display a type of interactive, collective intelligence could reorient how we think about nonhuman intelligence and inspire new possibilities for nonhierarchical interdependence. Mattern is in conversation with a paradigm of thinking about the limits of human exceptionality that includes James Bridle, who also questions how being is oriented and limited by human-centric definitions of intelligence. This paradigm is quickly cascading into a cultural tipping point that should be welcomed, but it's still far from how current forms of media and technology are made.

[101] Ibid.
[102] Mattern, Shannon. "Tree Thinking," *Places Journal*, Sept. 2021. https://doi.org/10.22269/210921

Alexander Galloway further critiques the choices that have led the field of ML to move away from appreciating complex emergences and towards optimizing for the virtues of singular, linear competition (objectives).[103] The search for direct causality within machine intelligence, and thus simple applications applied in products, fits with the contemporary drive to instrumentalize and optimize all parts of life, which is inextricably tied to profit and exchange value under the conditions of algorithmic capitalism today. This choice risks collapsing nonlinear, complex processes such as human relations, decisions, and images into discrete events with single causal chains, creating narrow epistemologies that limit the otherwise rich possibilities of diversity–in systems, beings, knowledges, and outcomes.

Instead, the indeterminacy described in the sublime can inform a new logic of contingency that breaks from the recursive logic of automated systems that risk foreclosing experiences of the world into ever-shrinking pathways. Dissolving the (in)organic binary into an embrace of hybrid systems brings into question what is possible when we decenter normative ideas of what counts as human.

The culmination of Kirsch, Rosenblatt, and the cybernetic dream means that we live in a computational co-reality with new conditions of possibility. As we allow more computation and electronic devices to calculate and mediate our reality, questions arise about the conditions of sensing and knowing the world. Hito Steyerl critiques this phenomenon more sharply: "The result might be a picture of something that never existed, but that the algorithm thinks you might like to see. This type of photography is speculative and relational. It is a gamble on probabilities that bets on inertia. It makes

[103] Galloway, Alexander. *Uncomputable: Play and Politics In the Long Digital Age*. United States, Verso Books, 2021, 172.

seeing unforeseen things more difficult."[104] I have listed and analyzed the costs of this achievement, including control and surveillance regimes and a deluge of images that increasingly short-circuit our abilities to sense a shared reality.

In light of the disturbing cases of automated vision and photography that I document under the computational image, Steyerl's rhetorical question is apt: "Is the state in the age of DeepMind, Deep Learning, and DeepDreaming a Deep State™?"[105] Harm, environmental extraction, labor exploitation, and cultural and racial bias are persistent problems often brushed aside in favor of techno-determinist teleologies that eerily echo the scientific ambivalence leading up to the development of the nuclear bomb in the previous century.

Yet, if we can fight to make this new world fairer and more available, wrestled away from its racialized, gendered, techno-capital-military influences, it's a fight worth having for a future whose cosmology we can start creating today. The relinquishing of the primacy of the human eye and the acknowledgment of the failures of human exceptionalism mean that to experience the world anew and in deeper ways is a potential for a sublime that we should cautiously embrace. Like symbiotes or cyborgs, we have adopted new epistemic instruments that produce entirely new worlds in collaboration with computing intelligence.

The operations and objects in this chapter provide compelling evidence suggesting that the computational production of images cannot be understood in a vacuum. Rather, this production process is part of a larger web that is connected to science and technology developments within larger corporate and state incentives. The common form of the image that results from this web is bequeathed to all of us. It

[104] Steyerl, Hito. *Duty Free Art*: *Art in the Age of Planetary Civil War*. United Kingdom, Verso, 2017, 31.
[105] Steyerl, Hito. *Duty Free Art*: *Art in the Age of Planetary Civil War*. United Kingdom, Verso, 2017, 59.

constructs the unique order that mediates how we experience and make sense of the world. As with the sublime image of the black hole and the art of Brathwaite-Shirley, I look to the characters and methods in the following section to serve as models for alternative visions of computational worlds.

IV. Transfiguration

We may say that the analytical engine weaves algebraic patterns just as the Jacquard loom weaves flowers and leaves.

> Ada Lovelace, "Notes" accompanying her translation of L. Menabrea on Babbage's Analytical Engine (1843)

Sympoiesis is a simple word; it means 'making-with.' Nothing makes itself; nothing is really autopoietic or self-organizing. In the words of the Inupiat computer 'world game,' earthlings are never alone. That is the radical implication of sympoiesis. Sympoiesis is a word proper to complex, dynamic, responsive, situated, historical systems. It is a word for worlding-with, in company. Sympoiesis enfolds autopoiesis and generatively unfurls and extends it.

> Donna Haraway, *Staying with the Trouble: Making Kin in the Chthulucene* (2016)

What can art and theory do when undifferentiated in tandem? In the following two chapters, I grapple with this question by weaving the investigative work of practitioners with the ideas of thinkers who have attempted what I consider to be either conceptualizations of digital representation, visual epistemology, or power relations. I rely on artworks, metaphors, forensic modeling/imaging, performances, books, practices, theories, and methodologies that I synthesize to point to both the limitations and the possibilities of digitized network culture and its transformative effect on images. I frame these interventions through the idea of transfiguration, not for its spiritual connotation but for its evocation of metamorphosis. Transfiguration, similar to the technical process of transduction, explains a changing of form. I deploy it as such, to connote an act of changing the form or appearance of the world into something better or more just rather than denying or resisting it. This multi-perspectival process of transfiguration produces evidence revealing the presence of politics in arenas that purport to be free from it, such as art, legal, military, and academic institutions.

Thinking along this political dimension that engages with the sedimented forms of power today, I admit that it is difficult to imagine how the contemporary emergence of so-called disruptive ideas within computing such as the metaverse, cryptocurrency, or smart contract enabled non-fungible tokens (NFTs–blockchain supported classification of digital objects) will provide the ramp necessary to exit this extractive and hyper-individuated system. Especially if these ideas, as is already the case, are implicated straight into the logic of property enclosure, commodification/speculation, capital hoarding, and what Anna Kornbluh critiques as a vapid immediacy that seeks to erase any space or time for systematic thinking about the conditions of its production.[106]

In any useful iteration, a new aesthetics of experience must include more than immediate sensory immersion, cryptocurrency charts, memes, and encomia for decentralized autonomous organizations (DAOs)–common artifacts of Web 3.0's Internet subcultures. The work of AI artist Refik Anadol, who is well known for visualizing datasets of archives into spectacular exhibitions at institutions like New York's Museum of Modern Art, is representative of a new public desire for an aesthetics of computational information that fails to meet the radicality the moment demands.

Yet there are, of course, exceptions.[107] Beginning with Harun Farocki, a movement of artists and collectives have devoted entire oeuvres to cataloguing, reappropriating, and critiquing the computational turn in imaging and surveillance technologies. Some of the most notable today include Rafael Lozano-Hemmer, Hito Steyerl, Trevor Paglen, and Lynn Hershman Leeson.

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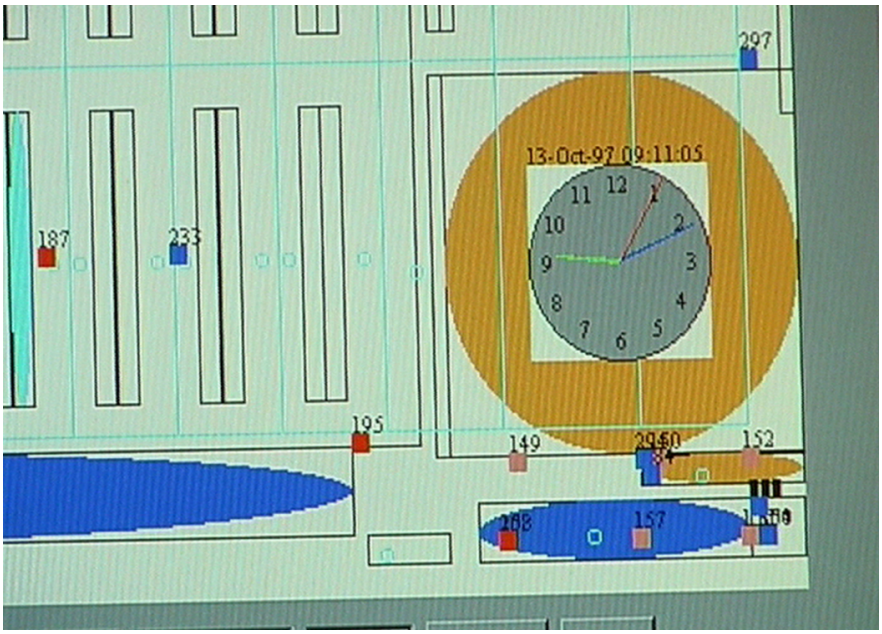
[106] Kornbluh, Anna. *Immediacy Or the Style of Too Late Capitalism*. Verso Books. 2024. Also see Breland, Ali. "Peering over the Edge: Hedging Bets and the Promise of Daos." *ZORA ZINE*, https://zine.zora.co/ali-breland-peering-over-the-edge-daos. Also see Steyerl, Hito. *Duty Free Art*: *Art in the Age of Planetary Civil War*. United Kingdom, Verso, 2017.

[107] Projects by artists like Sarah Friend (*Lifeforms,* 2021) and Jimmy Edgar (*Unreal*, 2021*)* struggle against collection and speculation in creative ways and offer insights into how technology can offer different forms to think about art inside networks.

The appreciation for contingency and military-industrial surveillance aesthetics echoes the way DN Rodowick describes the legacy of Farocki's critical approach to images. All of the works in this chapter are indebted in one way or another to Farocki's critical relationship to images and how they relate to control and power. By appropriating, recombining, and montaging found images from surveillance architecture in new ways, Rodowick suggests that Farocki's work continuously undermines the oppressive reification imposed by images. [108]

In *I Thought I Was Seeing Convicts* (2000), Farocki splices together found footage from various forms of surveillance that force the viewer to question what and who surveillance is for. In other words, Farocki demands an ethics of seeing. The opening sequence of the video shows software from the 1990s used by a grocery store to track customer movement through aisles. The objective is to find ways to optimize and extend these routes for shopping.



Harun Farocki. *I Thought I was Seeing Convicts* still image, 2000.

[108] Rodowick, D. N.. *What Philosophy Wants from Images*. United Kingdom, University of Chicago Press, 2018. 77.

This ethical demand echoes what image theorist Ariella Azoulay writes about as a civil contract in photography. Seeing obligates the maker and the viewer to consider the entire procession of photography: the limits of its production, how it is acted upon, broadcast, viewed, interpreted, and deployed. In other words, there is a responsibility to interrogate the set of relations established between the image producer and the objects and spaces being imaged, including the subsequent use of those images.[109]

This ongoing practice can loosen the ideological structures that seem to petrify the image and its meaning, creating space for a liberated consciousness that is aware of the provisional status of any given formation. Farocki was prescient in his diagnosis of operational images, which he described as processual, actional, and functional rather than pictorial.[110] These images are produced and also produce worlds. His legacy is deeply influential for understanding the abstracted computational images of visual culture today. The movement he incepted shares his approach to art that interrogates the role of computing technologies in mediating the world.

Throughout this chapter, I directly engage with the work of artists and collectives who are the inheritors of this tradition practicing the transfiguration of the computational. Crucially, the works here directly investigate the materiality of objects and technologies. Sometimes, the works presented manifest in affective or more explicitly political ways while other examples are more conceptual or environmentally oriented. The difference between them is one between the particular and the universal; both approaches need to be thought together under the political transfiguration they apply to the conditions of aesthetic experience. Furthermore, the methodological

[109] Azoulay, Ariella. *The Civil Contract of Photography*. Cambridge, Zone Books, 2008.
[110] Parikka, Jussi. *Operational Images: From the Visual to the Invisual*. United Kingdom, University of Minnesota Press, 2023.

practices of these examples act as gestures towards the possibilities of indeterminacy and difference that also speak to the power of what art can do.

Infopower

First, I want to consider what ethics and epistemics can mean today in light of the admission that they are not bound to universal categorizations. In attempting to capture what the contemporary is we always lag just behind it or slightly outside of it. The significance of ascertaining the contemporary is not only to understand it, but to actively transfigure it into a world we want to inhabit. I consider network culture as part of a slightly longer durée leading up to the present. This is a notion of the contemporary that begins with the advent of computing in the United States.

To be a contemporary of today means to reckon with the world of computational objects, networked relations, and algorithmic capitalism where increasingly automated and electronic supply chains circulate digital services and interactions in a gamified global market. Nowhere is this more apparent than in stock market fluctuations fueled by rumors and information spreading online. In 2021, Reddit users in a subreddit called r/WallStreetBets coalesced to squeeze the fading game retailer GameStop's stock price. The price soared from this artificially induced demand, leading to major losses for hedge funds that had shorted the stock, betting on it to decrease in price over the same time span. The scenario played out as a meme, a piece of media that spreads virally across the Internet, oftentimes for its humorous or ironic or satirical qualities. If algorithmic capitalism leads to the major benefit of a select minority–companies, states, or powerful individuals–we can cherish and learn from moments such as these in which the swarm reappropriates tools and short-circuits the system.

In her seminal essay "A Cyborg Manifesto," Donna Haraway sees the computational age as a framework rooted in information systems and defined by polymorphous networks that are shifting away from the visibly material nature of industrial production. She rightly anticipates that the emerging world will be characterized by intense insecurity and unpredictable system failures that disproportionately hurt the vulnerable: think financial crisis, pandemic, and global warming. In this increasingly cybernetic age–driven by rationalization, control, reproduction, and system dynamics–bodies and material objects lose their inviolability because everything can ultimately be coded and interfaced through one unified language used to process signals (whether it be through the genetic or the binary code).

The home, market, workplace, public arena, and the body are all subject to this collapse. The world, she explains, is "subdivided by boundaries differentially permeable to information."[111] Control strategies are thus enacted on boundary conditions and interfaces, and on rates of information flow. Although I deploy Haraway to think about the digital, I can't help but to also think of crises such as water contamination, air pollution, and radiation through this same framework.

This "unhindered instrumental power" is decentralized, resides in networks of information systems, and permeates across all aspects of contemporary life. Commenting on Haraway's imbrication of language and power, McKenzie Wark writes that "information is more than a powerful metaphor extended via substitution into an explanatory causality for the world, or even for the cosmos. It becomes a powerful means of organizing worlds."[112] In other words, Haraway makes clear that information

[111] Haraway, Donna J. "A Cyborg Manifesto," *Simians, Cyborgs, and Women: The Reinvention of Nature*, 1991, 164.
[112] Wark, McKenzie. *Molecular Red: Theory for the Anthropocene*. United Kingdom, Verso Books, 2015, 148.

is not simply a metaphor to explain network culture, but a material means by which the invention of computation produces and organizes worlds.

I want to suggest that a new term, such as *infopower*, is required to characterize this intense shift in the scale of power relations where power requires control over information. The exclusive right to life, or biopower, is sublated by infopower. In *The Imperial Archive: Knowledge and the Fantasy of Empire,* Thomas Richards explores how late nineteenth century Victorian England was the first information society in history that merged an axis of knowledge with the state. [113] Following an archival impulse, where the height of British imperialism induced a mania for synchronized knowledge and intelligence gathering in the wake of massive information coming in, institutions such as the Royal Geographical Society, the Royal Photographic Society, the British Museum, and the Colonial Office were established as archive-makers. Specific maps, images, surveys, censuses, statistics, and demographics all become ways to produce and reproduce official British narratives. So too did the work of nineteenth century British landscape painters that depicted colonial visions of land development in British colonies such as India and the Pacific Islands.

What draws me to Haraway's pathos is a rejection of the impulse to see the digital as anathema to human definitions of subjectivity. For Haraway, to resist the instrumentalizing infopower that intensifies in scale in the cybernetic age, or inside of network culture, means to interrupt the perfect flow of information upon which it relies. It also means to claim its particular affordances and embrace alternative paths to meaning as equally human rather than trying to deny them in search of an idealized past. Her ironic construction of a cyborg that includes the long struggles of feminism

[113] Richards, Thomas. *The Imperial Archive: Knowledge and the Fantasy of Empire*. United Kingdom, Verso Books, 1993, 15.

and queerness serves as a possibility to think the computational in liberatory ways. The cyborg–part human, part machine–can challenge dominant narratives and norms by introducing noise into signals of communication. Code switching and anonymity, for example, can be means of survival and forms of expression.

It makes sense that Haraway is inspired by queer women of color like Audre Lorde and bell hooks, who represent a fusion of identities that speculate away from the status quo. An outsider too, the cyborg can represent the potential for a code-mixing, networked resistance to domination-by-information through an embrace of porousness, "suggesting the profusion of spaces and identities and the permeability of boundaries in the personal body and in the body politic. 'Networking' is both a feminist practice and a multinational corporate strategy–weaving is for oppositional cyborgs."[114] Perhaps humans-with-machines can produce new knowledge and behaviors that better realize and embrace our own connectedness across differences, species, and with this planet. This change can allow us to morph into new identities and enter different worlds to see ourselves anew. We can reach across space and time to connect with one another. We can complement or overcome some of our physical limitations.

What Haraway wants to challenge is the control of information over bodies. If you consider this logic independently of its substrate, it describes a pattern that fits as part of a longer history of surveillance. Techniques of transfiguration are not new. Borrowing from Steve Mann's concept of sousveillance, or inverting the surveillant gaze, Simone Browne calls the act of Black sub/inversion of hypervisibility dark sousveillance. She locates the roots of this practice in techniques of camouflage and

[114] Haraway, Donna J. "A Cyborg Manifesto," *Simians, Cyborgs, and Women: The Reinvention of Nature*, 1991, 170.

escape from slavery that reappropriate and resituate visual markers of Black identity into tools for freedom.

Sondra Perry's practice sits somewhere inside Brown's articulation of refusal, resistance, and transfiguration. Throughout her installations, computer-based media, and video art, Perry deals with both the historical and contemporary production of blackness through surveillance–from chattel slavery to network culture. Juxtaposed to this hypervisibility is the fact that film photography and computational images were designed without Black subjects in mind. Her work turns this paradox of simultaneous hypervisibility and invisibility imposed on Black subjectivity into a trait and tool of survival that acts to disrupt surveillance.

Haraway's weaving and Browne's dark sousveillance concepts can take many forms. Alexander Galloway, for example, draws a compelling connection between the actual history of textile weaving and modern computation in his genealogy of the digital age.[115] The web, in all its forms, can exude femininity. Cultural critic Alex Quicho writes that "everyone is a girl online."[116] What she means by girl is a condition of psycho-social and symbolic inheritance that, like Haraway, she identifies as both a capitalist-patriarchal imposition and a possibility to slip out from under its weight into something unknown:

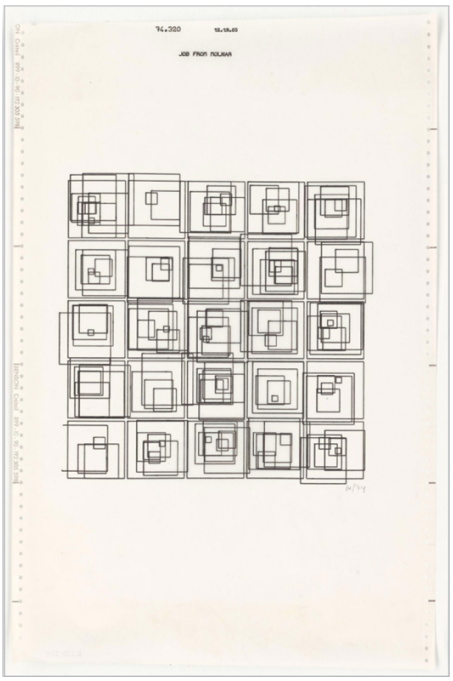
> It may well work in our favor to accelerate our way into Total Girl—that is, to consider the girl as a specific technology of subjectivity that maxes out on desire, attraction, replication, and cunning to achieve specific ends—and to use such technology to access something once unknowable about ourselves rather than for simple capital gains, blowing a kiss at individually-scaled pleasures while really giving voice to the egregore, the totality of not just information, but experience, affect, emotion.[117]

[115] Galloway, Alexander. *Uncomputable: Play and Politics In the Long Digital Age*. United States, Verso Books, 2021. Part II.
[116] Quicho, Alex. Everyone is a Girl Online. https://www.wired.com/story/girls-online-culture/ *Wired.*
[117] Ibid.

The circular attention economy of algorithmic network culture produces a desire, even among men, to perform a version of themselves online that attracts the attention of others. Quicho ascribes this desire to the archetype of the girl. Embracing the performativity is maybe the most liberating thing to do. The work of the artist Maya Man, facetiously hyper-visible online, bubbly, and invoking self-care culture, is a sharp example of Quicho's description.

Weaving is both a formal, systematic approach unique to networks and a stand-in for the deconstruction and reformulation of what gender, race, and sexuality mean. In contemporary speculative science fiction (or speculative documentary), weaving and sousveillance appear in the writings of Alexis Pauline Gumbs, whose experimental literary form tells a cautionary but hopeful story from the vantage of a researcher from a better future that uncovers evidence of the cataclysmic conditions destroying our present.[118] I consider the pen plotter graphic visuals of Vera Molnár from the 1960s that pioneered computational art decades before the hype of generative AI as a form of weaving too. Weaving computational patterns like a web, as a form of art.

[118] Gumbs, Alexis Pauline. *M Archive: After the End of the World. United Kingdom*, Duke University Press, 2018.



Vera Molnar. *Structure of Squares*, 1974.

Haraway's cyborg, like women glitching against an identity predetermined by ideology, is a "disassembled and reassembled…collective and personal self."[119] The cyborg disrupts predetermined and dichotomized classifications of property, race, class, gender, and sexuality and refuses their reproduction in the digital era. Although Haraway wrote this text in the mid 1980s, its radical potential endures. Today, an element of cyborgian weaving is infused in the Iranian-Kurdish artist Morehshin Allahyari, who describes her work and research practice as "weaving together complex counternarratives in opposition to the lasting influence of Western technological colonialism."[120] She uses computational tools and imagines new archives and fabrications through a reappropriation of the digital.

[119] Haraway, Donna J. "A Cyborg Manifesto," *Simians, Cyborgs, and Women: The Reinvention of Nature*, 1991, 163.
[120] Allahyari, Morehshin. *Morehshin Allahyari*, 19 May 2016, www.morehshin.com.

In *Moon-Faced* (2022), Allahyari trains a machine learning model on Persian paintings from the Qajar dynasty. The gender-queer identities that are generated as outcomes–with thick eyebrows, mustaches, and smooth lips–critique the gender-binary that dominates the Western canon from the same time period. Moon-faced (ماه طلعت), which in Persian literature once referred to all genders, is today only reserved to describe woman. Allahyari's moving image installation renders the source of data–the archive–as the medium, a political act of transfiguration drawing from non-Western traditions.

Morehshin Allahyari. *Moonfaced* video installation at the Onasiss Foundation, 2022.

A Forensic Approach

The era of infopower assumes the right to quantitively know more about you than you do yourself. In the footprint of your presence online, the opaque accumulation and structuration of data, both yours and others, produces a version of you that is as real as any other. There is no inherent telos in this world. The right kinds of data might well be the answer to pandemic, climate change, and contagion mitigation. Undeniable though is the power coursing through networks automated by algorithms in search of optimization for corporate and state interests.

Broadly assessing the contours of our lived world today, Eyal Weizman goes so far as to ask what the alternative to the present Liberal epistemic order might be as it undergoes a major rupture in the digital, Brexit, post-Trump, unstable poly-crisis era. Like Foucault, Weizman is interested in the social production of truth and the powers that monitor its borders, or the threshold of its visibility. Weizman's transnational and collaborative research group Forensic Architecture engages in the practices of counter-forensics and investigative aesthetics. Like Ranciére's *distribution of the sensible*, aesthetics here functions as a recognition of the "what" and the "how" of all that can be sensed in the world. It is a collective, relational concept that involves a multiplicity of organisms and forms of sensation that produce different forms of knowledge within a power-knowledge nexus. In this conception, that which we call reality passes through an aesthetic process that transforms matter into information and knowledge.

Operating under this definition, sensing is related to the eyes, but also includes how a thermostat senses and responds to humidity, how water in oceans respond to shifts in climate, how specific forms of measurement under capitalism create specific forms of value and exclude others, and how computational sensors and machines afford

their own versions of a planetary reality. The computational matches this definition's agnosticism for sensing in so far as the visual is remediated the same as every other form of sensory experience: as data and information.

From the perspective of investigative aesthetics, this operational mode of sensing, storing, filtering, and arranging phenomena is not objective, but in each instance implicates the tools and subjects of measurement and shapes the phenomena it is observing. Like a parallax effect, an objects shape and orientation will appear to change when the trajectory, environment, or mechanism through which it is imaged changes.

Weizman and Fuller explain:

> Parallax is useful as a term here in that it marks the alignment or displacement of a trajectory of seeing. A common example of parallax is the way that different materials modify the passage of a ray of light. A lens, or a body of water, for instance, will have different kinds of parallax effects. The way that an event occurs, in the widest sense of its coming together, will entail what is there to witness it.[121]

Forensic Architecture expands this notion of aesthetics to encompass not just material objects but incidents that involve myriad conditions and variables that cause them. Beyond the immediate minimal or proximate cause, they look to the wider *long durée* of social, economic, political, and environmental causes that provide the conditions of a moment's possibility.

By considering the framework of architecture across material and built environments–buildings, details, bones, bombs, cities, and landscapes, including their representation in media and as data–this practice allows for an appraisal of contemporary processes that shed light on juridical, social, economic, and political

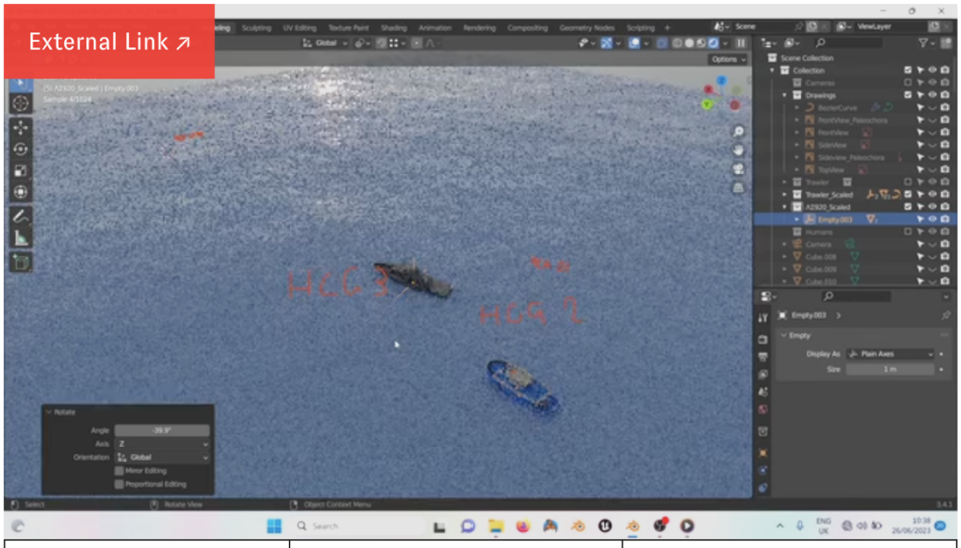
[121] Fuller, Matthew, and Weizman, Eyal. *Investigative Aesthetics: Conflicts and Commons in the Politics of Truth*. United Kingdom, Verso Books, 2021.

abuse. In practice, counter-forensics functions as architecture-in-reverse. It seeks to overturn the common practices associated with the discipline of architecture that have been historically used by states, law enforcement, and increasingly corporations to surveil publics, enforce order, and regulate deviations.

Using techniques such as automated open-source investigation and spatial re-renderings in dialogue with witness testimony, Forensic Architecture presents a radical opportunity to open new ways of sensing, knowing, and investigating abuse, evidence, and judgement. The split-second of a police shooting, the capsizing of a migrant ship, a political assassination, and a building catching fire can all be measured as incidents rich for an investigation that reveals the invisible in what is visible, or the secrets of power hiding in plain sight.

The investigations of Forensic Architecture, which sit somewhere across the disciplines of art, forensics, technology, and the law, which are collected in the field, assembled in the lab and in the studio, and presented publicly in a forum, provide an alternative explanation for the genesis of violent incidents. At the same time, these investigations function like art and present new epistemic structures for countering powerful forces of oppression. They do so while relying on some of the same technological tools that they seek to interrogate.

SP.2 THE PYLOS SHIPWRECK SUPPORTED PROJECT



DATE OF INCIDENT	LOCATION	FORUMS
13.06.2023 - 14.06.2023	Mediterranean Sea, Greece	Media, Web Platform
AN FA-SUPPORTED PROJECT BY Forensis	On 14 June 2023, a boat carrying hundreds of migrants sank inside the Greek search and rescue zone in the Mediterranean Sea—the deadliest migrant shipwreck in recent history. Our digital reconstruction of the boat and mapping of its trajectory reveal inconsistencies in the Hellenic Coast Guard's (HCG) account and indicate that over 600 people drowned as the result of a failed towing by the HCG.	

Screenshot of an overview describing Forensic Architecture's Pylos shipwreck investigation taken from the organization's website.

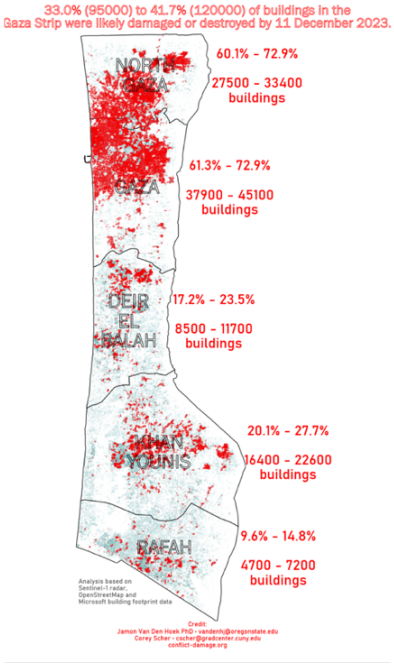
While drawing on the methodologies of critical theory to reveal the hidden and underlying sources that produce objects of knowledge, the method of investigative aesthetics looks for evidence embedded in objects themselves. Rather than observing with skepticism and paranoia, it requires paying hyper-attention to the medium in question and leveraging tools of observation to look for details and omissions that reveal traces of abuse. Pixelated satellite images, metadata in files, and the shape of tear gas canisters can provide clues that, once stitched together, can be used as material evidence to augment critique. This process is transparent but not intended to be objective, instead it openly avows to be constitutive of knowledge because the operating claim assumed is that *all* knowledge is always already constructed and mediated.

Contemporary conflicts, Weizman explains, generate new forms of optical footprints, such as: satellites and drone-mounted sensors, helmet-mounted cameras, and optical heads that produce automated images that are "by machines for machines and transferable and interpreted as data without ever being converted into anything recognizable by humans as a representation of the visual field."[122] The crucial importance of meaningfully sorting these kinds of images is more apparent than ever in the Russian invasion of Ukraine, or in satellite images of Uyghur camps in Xinjiang, or in fragmented clips of Israeli bombings of Gaza. Thus, one of Forensic Architecture's principal practices is to extend the "elaboration of precise means of sensing and sense making."[123]

The access to and role of satellite imagery is a powerful example of how the means of sensing are contested. In 1997, the Kyl-Bingaman Amendment forbid U.S. companies to publish images of Israel that were more than 2-meter resolution. In 2020, the National Oceanic and Atmospheric Administration (NOAA), tasked with regulating the U.S. atmosphere, expanded this limit to 40-centimeter resolution (the company Maxar today is allowed to release 30-cm resolution footage of Ukraine, which allows for images that include very small details on the ground). In Israel's recurring bombing, invasion, and occupation tactics in Gaza that include controlling the strip's Internet and media access, satellite imagery has been a critical resource for assessing damage and providing some independent accountability. Due to U.S. pressure, these higher resolution images are often provided weeks after they are taken.

[122] Weizman, Eyal. 2017. *Forensic Architecture: Violence at the Threshold of Detectability*. MIT Press. 97.
[123] Fuller, Matthew, and Weizman, Eyal. *Investigative Aesthetics: Conflicts and Commons in the Politics of Truth*. United Kingdom, Verso Books, 2021. 12.

A state's largescale actions are increasingly harder to hide from the world because of commercially available satellite imagery and data. A constantly updated, time-stamped visualization of building damage in Gaza created using infrared satellite data by geographers Jamon Van Den Hoek and Corey Scher, for example, has been cited by many organizations seeking information on the ground. Says Van Den Hoek, "Our images were shown on Israel's channel 12 news and Al-Jazeera. They were both talking about it. That's powerful. That's a new kind of—I won't say truth—but it's an agreement of an approximation of reality."[124]



Screenshot of Jamon Van Den Hoek and Corey Scher's visualization of building damage in Gaza created using infrared satellite data.

As nonstate controlled forms of satellite imagery expand, the U.S. has responded by requesting companies to limit images it wants hidden, or it has used contracts to buy them all and prevent their distribution. NOAA also has the ability to invoke what is

[124] Leffer, Lauren. "Inside the Satellite Tech Revealing Gaza's Destruction." *Scientific American*, 20 Feb. 2024, www.scientificamerican.com/article/inside-the-satellite-tech-revealing-gazas-destruction/.

known as "shutter control," which is an order that can be issued to any U.S. company to halt its satellite services over a specific area or period of time.[125] In the course of events and situations where an imbalance of power produces asymmetrical knowledge, the forensic practices of investigative aesthetics act as a counterbalance for awareness and accountability. As companies like Elbit Systems, Palantir, Anduril Industries, and Shield AI introduce more automation and machine intelligence into decision making on battlefields on behalf of states, investigative aesthetics will only become more valuable for highlighting and transfiguring the methods of abuse.

The London-based visual research group Rake Collective follows the forensic approach to highlight the cryptic automation of the visual field. With work spanning science, technology, activism and education, RAKE aims to stretch the limits of traditional photography and reportage to create interfaces between art, politics, and the Internet. And to inform collective visual inquiries that examine human rights violations, government censorship, surveillance, and bureaucratic violence.

The group was awarded The Photography Gallery's New Talent Award for its project titled "Police State." An ongoing collaboration to visualize the network of surveillance deployed against the public, the group collective describes "Police State" as inviting the viewer to "return the glare of state, looking past the camera to challenge the systems of power which govern our everyday lives." [126]

[125] Decker, Audrey. "US Says It Won't Tell Space-Imagery Companies to Stop Showing Gaza Photos." *Defense One*, 8 Nov. 2023, www.defenseone.com/technology/2023/11/us-says-it-wont-tell-space-imagery-companies-stop-showing-gaza-photos/391851/.
[126] *Rake Collective*, www.rakecollective.com.

A GAN's data visualizations by Rake Collective

Art has the capacity to interrogate the ideological dimensions of network culture and the ability to appropriate its tools as its own. It can make the subject of an art project the medium in question. Artist Adam Harvey's research project *Exposing.AI*, for example, investigates how biometric image datasets that train facial recognition models are quietly using public photos as one part of an information supply chain. AI artists Holly Herndon and Matt Dryhurst have created a suite of tools under the name Spawning that allows artists to search for and request to remove their images from training datasets used by the generative AI model Stable Diffusion. Glaze is a similar tool, a computational system developed by University of Chicago researchers that corrupts the ability of an AI model to mimic the images it scrapes. Ways to mark digital images and opt out of data scraping is a budding field of research.

An Environmental Approach

Curator Jesse Damiani cleverly calls the opportunity for the present era of creativity *Postreality*, arguing for an expanding vision for art that treats reality as a medium. Here, digital art, for lack of a better term, shares a heritage with conceptual art that should be embraced. The conceptual molds material substrate in service of ideas

that can offer new epistemic possibilities. One way I think of contemporary conceptual art is through its use of environment as a subject and as material.

The ecological psychologist and notable contributor to theories of visual perception James J. Gibson's thinking is germane to this connection. He claimed that environments interact with their observing agents in a process that creates unique material *affordances* for the observer.[127] Environments–physical or virtual–are media that co-create our understanding of ourselves and the world around us. They forge the conditions and limitations of our possibility, or the horizon of our thoughts. This concept is in play in the artworks of Pierre Huyghe ("*A Way in Untilled,* 2013; *The Human Mask*, 2014; *UUmwelt*, 2018; *Variants*, 2021), where categories and boundaries of individuation dissolve in dynamic umwelts and milieus. It's hard to tell where one thing ends, and another begins.

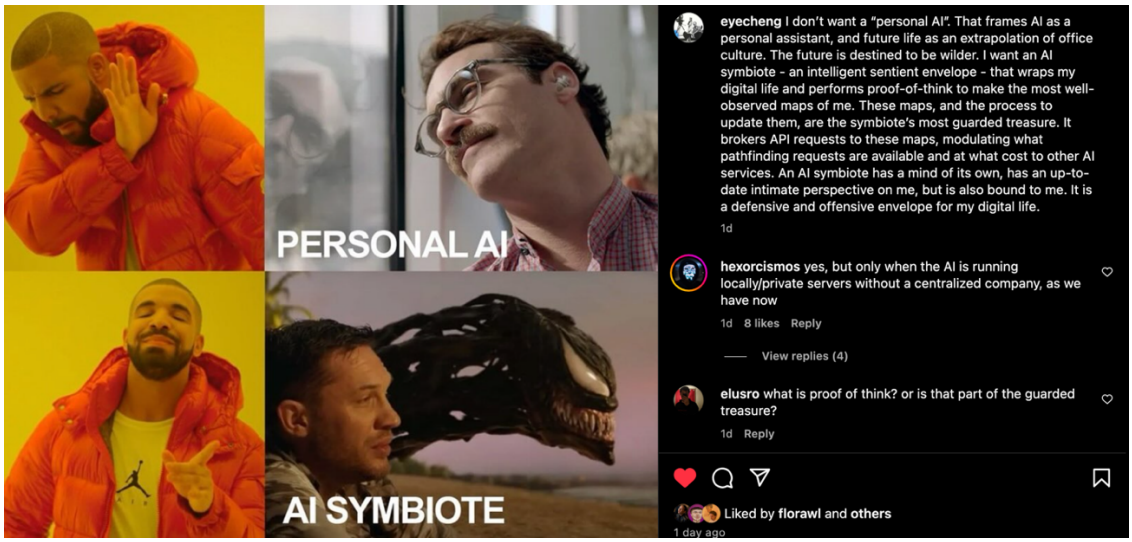
Pierre Huyghe. *Variants*, 2021.

[127] Gibson, James J. *The Ecological Approach to Visual Perception*. Boston: Houghton Mifflin, 1979.

Varying degrees of abstraction lend different ways to think of media and mediation: what is the material limit of an identity? Who and what can be said to have agency? Here, contentions over media's definition assume a quality close to the notion of *arche*, a philosophical first principle–a primordial substance that allows for meaning to follow.

Variants (2021) is a permanent site and work built in the Kistefos Museum sculpture park that blurs the line between a physical and digital ecology. Huyghe's team scanned the island of Jevnaker, Norway, where Kistefos is located, using point cloud technology. The 3D model is projected onto an LED screen on location, controlled by AI. The digital simulation is affected by climate sensors on the island that run through the AI system and generate mutations to the environment. These mutations play out on the screen but also overflow into the physical island, creating a permeable, multipolar milieu of living and nonliving entities: a recursive relationship between a physical environment and a digital extension that changes how we see the island. When the island periodically floods, Huyghe's project is inaccessible.

In a similar approach, Ian Cheng (*Life After BOB*, 2021) builds gaming environments to provoke imagining other forms and conditions of digital possibility. His work is a testament to what he calls worlding. Worlding is a new artistic movement that constructs open, explorable environments with graphic tools, including gaming engines, that present an enriching and symbiotic experience between the physical and virtual. The stories Cheng conjures conceive of AI as extending and transforming human experiences in new cyborgian ways rather than serving as an instrumentalizing tool of optimization.



Screenshot of Ian Cheng's Instagram post about symbiotic AI

In imagining and building new worlds, Ainslee Alem Robson's VR film *Ferenj* (2020) is a model of computational transfiguration. It is partly a graphic memoir in immersive film form that takes fragments of her Ethiopian American familial and cultural history to create an explorable world using point clouds and gaming engine software. Her speculative world is made through oral histories and the fragments of her memories.

Ainslee Alem Robson. *Ferenj: A Graphic Memoir in VR* point cloud still image, 2020.

Projects like Nancy Baker Cahill's 4th Wall App, which projects site-specific objects across the U.S. via an augmented reality app, provide a glimpse into the meshing of material and virtual environments, and the role of technology in mediating between the two. *CENTO* (2023), an interactive video and AR project where the viewer helps shape a bioengineered creature in different global sites, hints at the potential to democratize access to art but it also provokes questions over who controls the hardware and applications necessary to experience it.

Indeed, the materiality underpinning network culture–human labor, content moderation sweatshops, electricity, intense carbon emissions, big server farms (oftentimes belonging to Amazon's AWS), power lines, underwater cables, cobalt and coltan mines, *et cetera*–is routinely disavowed, obfuscated, and forgotten in talks about computing.[128] While the material is not my point of focus, it matters for transfiguration to the extent that the materiality of objects and processes are part of what needs to be accounted for, investigated, and altered.

Through an analysis of new forms of labor and value, Seb Franklin deconstructs the false dichotomous notion that the digital is a frictionless space removed from the material world. He cites John von Neumann's description about the digital really being a simulation on the background of what are continuous processes. Franklin writes, "von Neumann is here [at one of the famous cybernetic Macy conferences] suggesting—at a historical moment in which the meaning of the term has yet to be standardized—that digital describes a mode of abstraction that relies not only on an illusory or imagined

[128] Franklin, Seb. *The Digitally Disposed: Racial Capitalism and the Informatics of Value*. United States, University of Minnesota Press, 2021. For an exposé of Facebook's content moderation practices see Perrigo, Billy. "Inside Facebook's African Sweatshop." *Time*, 17 Feb. 2022, https://time.com/6147458/facebook-africa-content-moderation-employee-treatment/.

discreteness but also on the support and the disavowal of its material substrate."[129] The imaginary of the digital and how to deal with the material reality and excess of computing it disavows is a central ethical and philosophical question in the development of technology.

Info-Aesthetics

How else might we creatively respond to the proliferation of information in the way that human societies have responded to major social and technical changes in the past? In Europe, industrialization provoked movements like the Arts and Crafts while revolutionary fervor and World War I launched a multitude of avant-garde movements in art, literature, and cinema such as: Bauhaus, Surrealism, Dadaism, Futurism, De Stijl, and photomontage. Today, Manovich suggests that we need to invent info-aesthetics.[130] Info-aesthetics should be a response to infopower.

Would info-aesthetics constitute real time data visualization for an increasingly complex world? Will it include attempts to visualize the Anthropocene?[131] Will art and design respond by eschewing aesthetic minimalism for styles that better reflect the extractive and wasteful reality of production?[132] Will architecture return to grappling with how the procession of bodies in space and time fundamentally mediates our dwelling and being-in-the-world?[133] Answers to these questions require going beyond a

[129] The Digitally Disposed: Racial Capitalism and the Informatics of Value (2021) (Pg. 12 emphasis Franklins)
[130] Smith, Terry, et al. "Introduction to Info-Aesthetics." *Antinomies of Art and Culture: Modernity, Postmodernity, Contemporaneity*, Duke University Press, Durham, NC, 2009, pp. 333–344.
[131] See Demos, T. J.. Against the Anthropocene: Visual Culture and Environment Today. Germany, MIT Press, 2017.
[132] For an assessment of design, see *Designs for the Pluriverse* (2018) by Arturo Escobar. For a defense of a radical minimalism, see *White* (2010) by Kenya Hara and "Interview with Dorothy Gees Seckler – Barnett Newman" Art in America, vol. 50, no. 2, New York, Summer 1962.
[133] For an ontological conception of dwelling, see Heidegger, Martin. "Building, Dwelling, Thinking," In *Poetry, Language and Thought*, ed. A. Hofsdater, New York: Harper & Row. Online. 1971. 162. For an alternative to modern architecture's increasing instrumentalization, see Pallasmaa, Juhani. "The Sixth

formal response. They require a rethinking of the imagination to produce different aesthetic logics, categories, and orientations in a world that increasingly valorizes instant recognition.

Other forms of transfiguring infopower can be more practical, such as increasing access to information in the commons. The establishment of sites like Wikipedia, Internet Archive, and the whistleblowing of secret government malpractices such as the leaking of the Pentagon Papers, and parts of the WikiLeaks project, are salient examples of expanding the public's access to knowledge, although they come with their own limitations and risks.

Open-sourcing access to datasets and collaboratively building (crowdsourcing) knowledge–a practice already common to indigenous epistemologies, GitHub programmers, fan groups, and climate scientists–also builds more resilient and transparent information systems. Hugging Face is a successful example of a platform established in 2016 dedicated to building an open-source AI community. They have released a slew of research tools that examine the biases embedded in image generation models Dall•E and Stable Diffusion.[134]

Designers in human-computer interaction (HCI) can do a better job at surfacing an algorithm's decision-making by building new versions of interfaces that create transparency for understanding computational complexity. Meanwhile, natural language processing with AI models can perhaps be thought of in more poetic terms. The ancient Greek practice of *ekphrasis* is the poetic craft of describing images in ways

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Sense: The Meaning of Atmosphere and Mood." *Architectural Design*, vol. 86, no. 6, 2016, pp. 126–133., https://doi.org/10.1002/ad.2121. For a critique of modern phenomenology and object-relations, see *Queer Phenomenology* (2006) by Sara Ahmed.

[134] Perera, Malsha V., and Vishal M. Patel. "Analyzing bias in diffusion-based face generation models." *2023 IEEE International Joint Conference on Biometrics (IJCB)*, 25 Sept. 2023, https://doi.org/10.1109/ijcb57857.2023.10449200.

that evoke new representations in addition to their material form. What can this ancient practice afford AI prompt engineering?

Media theorist Nicholas Rombes echoes Manovich's call for imagining new possibilities afforded by the computational that juxtapose the old with the new. Not simply a juxtaposition of old and new media, but rather an appreciation for the possibility of making uncanny appositional connections between different objects, images, and even ideas. This process, Rombes intimates, can place seemingly disparate and anachronistic things next to each other (sometimes deliberately, sometimes randomly) and allow us to produce new affects and draw new insights that were improbable before.[135] The best of generative art might be a celebration of Rombes' idea. Originality should not be fetishized as a search for pure novelty and should include new ways to recombine already existing things.

…

Following Farocki, we can take heart in the still unbroken practice of our species to assess and remake ourselves. It may be the enduring trait that can wrest us from submitting to hopelessness and instead push us to respond to the exigencies of our present. The notion of a nonhuman or inhuman intelligence intervening within human infrastructures does not have to negate the world we want. In fact, it can help contest the uniformity of a rational subject that presupposes the type of reason that has driven modern Liberalism into trouble.

The possibility of an escape through investigation and transfiguration of infopower ought to be something that those with a stake in a different future all reckon with seriously. Transfiguration is not a metaphor for escapism, but a call for claiming

[135] Rombes, Nicholas. *Cinema in the Digital Age*. London: Wallflower Press, 2009.

the power of aesthetics in understanding and shaping the world. The following chapter will analyze theoretical structures of power, knowledge, and materiality that affect this dynamic and illuminate the possibilities of freedom inside of algorithmic capitalism in order to suggest pathways forward.

V. Simulation and Computational Desire

Now objects perceive me.

Paul Klee via Paul Virilio, *Paul Klee Notebooks* (1920s)

We believe that there is no material problem – whether created by nature or by technology – that cannot be solved with more technology… Intelligence is the birthright of humanity; we should expand it as fully and broadly as we possibly can. We believe intelligence is in an upward spiral – first, as more smart people around the world are recruited into the techno-capital machine; second, as people form symbiotic relationships with machines into new cybernetic systems such as companies and networks; third, as Artificial Intelligence ramps up the capabilities of our machines and ourselves… We believe free markets are the most effective way to organize a technological economy… We believe the market economy is a discovery machine, a form of intelligence – an exploratory, evolutionary, adaptive system.

Marc Andreessen, *The Techno-Optimist Manifesto* (2023)

This chapter examines the epistemological implications of the computational era and how it is reshaping human perception, experience, and ways of knowing. Drawing from diverse philosophical perspectives including cybernetics, poststructuralism, media theory, and critical theory, the chapter traces the genealogy of computational thinking back to its military-industrial roots. It analyzes how contemporary algorithmic network culture, fueled by capitalist desires for control and commodification, has given rise to new forms of automated surveillance, simulation, and epistemic automation that increasingly mediate reality. The chapter argues that the ubiquity of computational systems and artificial intelligences sensing and representing the world signals a fundamental shift in how human subjectivity and agency are constituted, with profound implications for the future of knowledge production, truth, and lived experience.

Automation and computational images are part of a wider discussion among scholars within the recent literature of media studies, cultural studies, science and technology studies, and philosophy that questions human agency amid changing social,

economic, and technological relations. I will summarize and weave threads from the widely conceived discussion to create an epistemic schema for situating the image within a new computational experience of representation. I have chosen to draw from theories that are directly related to the computational alongside ones that deal more generally with representation, racialized capitalism, power, politics, and desire. This flexibility serves my argument to think of the epistemological relation to technical images as something that cannot be uncoupled from the social and the political.

The Politico-Aesthetic

Jacques Rancière's concept of the *distribution of the sensible* defines politics in a way that includes what Foucault called the order of things, or what is symbolically representable at any given place and time. When combining the two concepts, the struggle over the methods of sensing and the process of perception establishes a relation I call political. As in investigative aesthetics, the distribution of the sensible contains the ethical, intellectual, and political as aesthetic experiences. The aesthetic here is not about the judgment of beauty but rather the relationship between sense perception, embodiment, meaning, and history. A potent articulation of this dialectical exchange is put forth by Max Horkheimer in his 1937 essay on the analytical difference between traditional and critical theory:

> Even the way they [humans] see and hear is inseparable from the social life-process as it has evolved over the millennia. The facts which our senses present to us are socially preformed in two ways: through the historical character of the object perceived and through the historical character of the perceiving organ.[136]

Horkheimer historicizes the transcendental (ahistorical) *a priori* conditions of reason, implying that the perception of factual truths is not only co-determined by universal

[136] Horkheimer, Max. *Critical Theory: Selected Essays*. Continuum, New York. 2002, 200.

categories of reason but also by contingent human ideas and concepts and the technological conditions of production.

Provoked to consider what Horkheimer calls the perceiving organ, I follow Mark Hansen's reading of Henri Bergson's claim that the indeterminacy of embodiment and the role of memory and affect are vital to perception. Hansen updates Bergson for the computational era, arguing that underneath new digital images are "the framing function of the human body *qua* center of indetermination."[137] Each body of an organism is the unique site through which images are processed. Said differently, the body is the agent containing the processes that make information perceivable. In the Chinese manifestation of cybernetics, Qian Xuesen thinks of the body in the same way, as a transparent medium for information.

Through his own experiences of vocal paralysis, Jonathan Sterne lays out a wonderful case against a universally normative definition of a body. If the body is the site of the formation of conscious experience, he asks, then what does a phenomenology of impairment look like? His answer, in sum, is that "every body (and everybody)" is historically, politically, and ecologically situated.[138]

Almost infinite possibilities for different forms of sense perception emerge when assuming this broader definition of what the aesthetic contains. Reality is presumed as uniquely perceiving humans enmeshed in a universe filled with different sensing bodies–from mushrooms and bees to forests and oceans–an ensemble of matter mediated by different sensing and responding organs and agents. Computationally produced judgements can be included in this conception too. The multiplicity of ways

[137] Hansen, Mark B. N., and Hansen, Mark Boris Nicola. New Philosophy for New Media. United Kingdom, "The" MIT Press, 2004, 7.
[138] Sterne, Jonathan. Diminished Faculties: A Political Phenomenology of Impairment. United States, Duke University Press, 2021, 17.

to sense and perceive provides the basis by which information can become something we recognize as knowledge. Knowledge in this case is information represented, allowing meaning to emerge. It is an active process through which something can know.

Foucault is a helpful starting point for bridging how this epistemic process is formed and normalized within historically and politically unique conditions. Namely, how the organization and comprehension of information rests on various abstractions that are often taken for granted, including: language, culture, and the historicity of concepts and ideas. Each of these include a contingent genealogy that is continuously in a flux of becoming, subject to the pressures of social change, prompted by struggles among people to be understood, feared, loved, *et cetera*.

On representation, Foucault elaborates in *The Order of Things: An Archaeology of the Human Sciences* that Western societies have adopted specific categories and orientations of knowledge since the sixteenth century invention of "classical" knowledge and the nineteenth century invention of "modern" knowledge that take for granted the contingent construction of order. He explains this taken-for-granted order of words and things as:

> …the hidden network that determines the way they confront one another, and also that which has no existence except in the grid created by a glance, an examination, a language; and it is only in the blank spaces of this grid that order manifests itself in depth as though already there, waiting in silence for the moment of expression."[139]

Epistemic order, thus, allows certain words and things, *i.e.*, knowledge, to appear. Here, Foucault weaves the importance of discourse into much of his claim because it always constitutes some relationship to situated representation that is both constitutive and

[139] Foucault. *The Order of Things: An Archaeology of the Human Sciences*. New York: Vintage Books, 1994. xxi.

reflective of knowledge and power. The changing categories of understanding available to any given social formation is reflected in linguistic developments and provides the conditions for knowledge specific to a time and place.

The inclusion of the computational introduces an indeterminate automatization into the order of things described by Foucault. Visual perception is mediated through a calculational logic opaque to human understanding. As ubiquitous machines increasingly sense the world and act on it as new agent-like participants, the order of things is complexified in ways that challenge the limits of our contemporary languages. The introduction of self-regulating, computational sources of information and knowledge are effectively a new variable co-shaping reality. The public sphere increasingly exists digitally.

In general, the meandering ways thinkers throughout time have attempted to theorize the relationship between language and knowledge is suddenly relevant in brand new ways with the emergence of large language models (LLMs) behind generative AI applications that automate writing and image production through correlation with natural language prompts. One key linguistic question is whether these models can produce deep truths about humans and attain something resembling general conscious agency through high dimensional processing of large, biased, human-produced media archives. The answer among researchers is unclear but a gold rush prompted by the promise of scaling laws for improvement is attracting intense capital into the field of LLMs.

Why general conscious agency is something that we need, or should be made to desire, is another question that is often disincentivized by companies. The implications are as important to artists, educators, and therapists as they are to philosophers, neuroscientists, and state intelligence agencies.

To grasp the order of our computational episteme and its effects on our senses and bodies, I follow Foucault's articulation of genealogy as the act of listening to history to discover the singular, piecemeal fabrication of things.[140] A genealogy, like a forensic investigation, pieces together events, objects, and ideas in a string of causality that illuminates how and why something is one way rather than another. One of its most liberating outcomes is the realization that history is not inevitable, but in every instance being shaped and invented. A genealogy of computational images requires tracing the roots of network culture to the early days of computing.

I locate these roots in cybernetic thinking borne out of military-academic research that dates back to the 1940s. I consider cybernetics as foundational to the philosophical and engineering breakthroughs that have shaped the digital/computational era we now occupy. At its core, the cybernetic movement was loosely organized by a meta ontology of information and is therefore vital to any understanding of our episteme of computation.

Recursivity, Cybernetics, Information

In the United States and Great Britain, the field of cybernetics emerged within the military-industrial-academic complex that was seeking control and comparative advantages during World War II, and later the Cold War. Cybernetics also has a lesser-known history rooted in Russia, organized under the name tektology by the polymath Alexander Bogdanov as early as 1912. As mentioned above, these ideas also traveled to China, where they became popular through the work of Xuesen. These different strands

[140] Foucault, Michel. "Nietzsche, Genealogy, History". *Language, Counter-Memory, Practice: Selected Essays and Interviews*, edited by Donald F. Bouchard, Ithaca, NY: Cornell University Press, 1980, pp. 139-164.

of the same ideas were motivated by the desire in the twentieth century for theories of scientific knowledge built on general axioms of information and systems theory.

In English, the prefix cyber was infused with the connotation of digital presence or a culture of computing. William Gibson made the term cyberspace popular in his 1982 science-fiction novel *Neuromancer*. Cybercrime and cybersecurity established legal precedents and technical standards related to computing. The root of these associations is cybernetics. The term was widely introduced as an idea in 1948 when Norbert Wiener published *Cybernetics: or Control and Communication in the Animal and the Machine*.

In his book, Wiener describes the etymology as rooted in the Greek word *kubernetes*, which is Greek for steersman, connoting skill in steering and governance. He explains how the lack of unity within the literature, terminology, and philosophy grappling with problems around communication, control, and statistical mechanics led him to develop the expression cybernetics in the summer of 1947.

Between 1946 and 1953, the Josiah Macy Jr. Foundation sponsored a series of bi-annual meetings to develop cybernetic ideas. These meetings, known as the Macy conferences, attracted notable intellectuals, scientists, and researchers interested in collaborating and discussing how to incorporate cybernetic frameworks in their fields. The meetings were incredibly influential to the germination and spread of cybernetics across the world. The inaugural meeting, held in New York City, outlined topics for discussion that seem strikingly relevant to an AI conference that could be held today:

> Self-regulating and teleological mechanisms
> Simulated neural networks emulating the calculus of propositional logic
> Anthropology and how computers might learn how to learn
> Object perception's feedback mechanisms
> Perceptual differences due to brain damage
> Deriving ethics from science

Compulsive repetitive behavior[141]

For better or worse, all of these terms and concepts are still key areas of computer science and AI research.

In key passages of his seminal book, Wiener describes the message, whether electrical, mechanical, or neural, as a "discrete or continuous sequence of measurable events distributed in time."[142] He emphasizes the statistical nature of messages and the need to limit the noise (unwanted disturbance or distortion) that accompanies their transmission. Philosophically, G.W. Leibniz is lauded by Wiener as the "patron saint" of cybernetics for the way he combined universal symbolism (binary system) with reason that accounts for change (calculus). Writes Wiener: "It is therefore not in the least surprising that the same intellectual impulse which has led to the development of mathematical logic has at the same time led to the ideal or actual mechanization of processes of thought."[143] Wiener acknowledges that the drive for computation leads to the automation of processes of thought, suggesting that he foresaw the epistemic consequences of the computational epoch that was set to intensify in the decades to come.

From very early on in cybernetics, the computer is directly compared to the biological central nervous system. Wiener is also explicit about the importance of cybernetics to the study of human social relations and their organization: About communication in the social system, he writes:

> It is certainly true that the social system is an organization like the individual, that is bound together by a system of communication, and that it has a dynamics in which circular processes of a feedback nature play an important part. This is

[141] "History of Cybernetics." *Summary: The Macy Conferences*, American Society for Cybernetics, www.asc-cybernetics.org/foundations/history/MacySummary.htm. Accessed 27 May 2024.
[142] Wiener, Norbert. *Cybernetics: Or, Control and Communication in the Animal and the Machine*. United Kingdom, M.I.T. Press, 1961. 14.
[143] Ibid., 19.

> true, both in the general fields of anthropology and of sociology and in the more specific field of economics...[144]

When Wiener mentions the potential limitations of applying cybernetic thinking to social relations, he only concedes that there isn't sufficiently good long-term data about human interactions to model them. This assumes that human behaviors and relations can be modeled through mathematics, implying that if only there was a way to quantify and measure those interactions better, we could reach some halcyon of understanding human beings. The eventual application of cybernetics to the social sciences and the humanities is known as second-order cybernetics and includes figures such as Margaret Mead, Gregory Bateson, and Francisco Varela. Their work willingly acknowledges the problem of objectivity assumed in the initial wave of cybernetics.

Wiener concludes that the birth of cybernetics constitutes the second industrial revolution, and presciently, he cautions against the inevitable dangers it will pose. He singles out "hucksters" who will know no boundaries in the pursuit of profit, and the dangers of the concentration of power it unleashes. Wiener:

> As we have seen, there are those who hope that the good of a better understanding of man and society which is offered by this new field of work may anticipate and outweigh the incidental contribution we are making to the concentration of power...I write in 1947, and I am compelled to say that it is a very slight hope.[145]

Wiener was acutely aware of the implications of the work that he and his fellow mathematicians and scientists were producing. After World War II, he became a vocal critic of military funding and the politicization of scientific research, urging his fellow scientists to consider the ethical consequences of their work.[146]

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[144] Ibid., 35.
[145] Ibid., 42.
[146] Wiener, Norbert. "A Scientist Rebels". *Atlantic Monthly*. 1947, 46.

Although cybernetics began to fragment in the 1960s and 1970s into distinct disciplines, the ideas percolating within it have thrived in the philosophies of science and technology since. The French philosopher Gilbert Simondon, who serves as a major inspiration for thinkers of media, technology, and power such as Gilles Deleuze, Bruno Latour, and Bernard Stiegler, attempted to think of identity formation through the science of information, thermodynamics, and systems. In other words, he thought philosophy through technology.

In 1964, he published *Individuation in Light of Notions of Form and Information*. This text includes many of what would become his influential ideas on the ongoing and processual formation of identities within systems and milieus. Simondon describes what he calls pre-individuation as a metastable state of equilibrium with competing tensions that, as the name suggests, precedes individuation and serves as its potential. Entropy and negentropy of information serve as the basis for the concretization of identity, which in Simondon's system is a processual mediation between orders of magnitude. Importantly, Simondon's explanation for epistemology—what he names psychic individuation—implicates the biological individual with its natural environment, a dialectical link he calls the transindividual. The inspiration and influence of cybernetics is clear in this ontology, as information precedes the Aristotelian theory of substance conceived as matter and form.

Regarding the several phases he argues are involved in the entelechy of individuated beings, Simondon writes: "Ontological monism must be replaced with a pluralism of phases, since the being incorporates, instead of a single form given in advance, successive informations that are a certain number of reciprocal structures and

functions."[147] Life is a multi-phase, ongoing process shifting between different systems of equilibrium. As in cybernetics, the notion of information mediating between systems in a continuous operation of becoming acknowledges a new modality of understanding both philosophy and science in an undifferentiated way.

The computational era of algorithmic capitalism we take for granted today cannot be understood without the influence of information theory and the epistemological framework it produced for the development of technology. Information science, data science, computer science, and complex systems research are well-established disciplines that branched out from cybernetics. Its remnant ideas are especially pronounced in the field of AI, where the desire among some for Artificial General Intelligence (AGI) resembles the teleological belief cyberneticians held about understanding all of reality through information and signals. Demis Hassabis, the founder of DeepMind and one of the most important contemporary figures in AI research, quipped in a 2022 interview that the "best way to understand physics, and the universe, is from a computational perspective… Information being the most fundamental unit of reality."[148] The contradiction implied in this computer science-centric statement is that computational information is already a part of reality, waiting to be plucked and processed as if it is not something dependent on human production and measurement.

In the late 1980s and early 1990s, computation led to the invention of the familiar world we call online today. This world is a product of the early days of the Internet as it grew out of the U.S. military and into civilian life, an expansion enabled by Tim

[147] Simondon, Gilbert. *Individuation in Light of Notions of Form and Information*. United States, University of Minnesota Press, 2020, 358.
[148] Friedman, Lex. "Demis Hassabis: DeepMind - AI, Superintelligence & the Future of Humanity." *Lex Friedman Podcast*, July 1, 2022. *iTunes*.

Berners-Lee's World Wide Web project that became its de-facto interface. The Internet is a culmination of cybernetic thinking; it is a global cybernetic system.

What is known as the cyberlibertarian California ideology in Palo Alto, with its nostalgia for Stewart Brand's *Whole Earth Catalogue* and the virtual community called The WELL, slowly laid the groundworks for the latest iteration of Silicon Valley's monopolizing power.[149] Before it became Big Tech, the overarching ethos that defined this milieu conceived of the Internet as freedom: an infinitely open space of possibilities for existence free from state control. Fred Turner documents how utopian counterculture merged with the hub of Silicon Valley to produce a cyberculture that broadcasted computing to the world's imagination as a tool of liberation.[150] The idea of Google, now a powerful metonym for searching the web, emerged from a project out of Stanford by Sergey Brin and Larry Page that was funded by the National Science Foundation with the goal of designing the Internet as a digital library.

The potential for freedom accompanying the early days of the Internet, however, quickly gave way to the anachronisms of capitalism: monopolies and bursting bubbles propped up by hype. Today, the faint vestiges of empowerment are still comically advertised as a promise of computing even as the collection of all the things organized and represented online plays out as a contest among large corporations seeking to own more and more of privatized virtual space.

[149] Harris, Malcolm. *Palo Alto: A History of California, Capitalism, and the World*. United Kingdom, Little, Brown, 2023.
[150] Turner, Fred. *From Counterculture to Cyberculture: Stewart Brand, the Whole Earth Network, and the Rise of Digital Utopianism*. Ukraine, University of Chicago Press, 2010.

Automating Normalization

The initial military-industrial-academic nexus that was foundational for the discoveries and technologies that constitute the infrastructure of algorithmic capitalism also produced an infrastructure of surveillance. In this regard, I'm interested in how state power and capitalism have ushered in increased forms and intensities of surveillance. What surveillance means here, as Simone Browne reminds me, cannot be confined to one medium or one form, because it is much closer to a logic and a network. Foucault provides a valuable case study for understanding how this logic can constrain and produce human subjectivity. His description of the unrealized Panopticon prison system in *Discipline and Punish: The Birth of the Prison* exemplifies the power of visual surveillance to create a mechanism for anticipation and recursivity that operates to automate and normalize acquiescent behavior.

Initially introduced by Jeremy Bentham, the architectural design of the Panopticon allows a few guards to constantly monitor all prisoners, something the prisoners are privy to even though they can't see inside the central guard watchtower. The idea is that under the mere impression of constant surveillance and cut off from each other, the prisoners begin to internalize their subordinate relation to the power-wielding guards, and thus conform to docility without violent or repressive means. Foucault relies on this description to point to a change in the form of power, where heavy handed rule is replaced by psychological coercion. The sword becomes the symbol.

In some sense, the prisoners begin to police themselves within the enclosed environment. This describes a concept of social deterrence, a form of control that relies on symbolic power. Deterrence seeks to alter behavior and prevent a course of action by

making subjects aware of the high costs that transgression will exact. It becomes operational in environments of random surveillance, forcing subjects to comply at all times in anticipation of surveillance rather than its actuality.

In this form, the prison serves as the microcosm of the perfect society for implementing what Foucault calls disciplinary power. Individuals are isolated in their moral existence, their bodies and movements regulated, but still constituted within a hierarchical framework through authority, with communication only possible in vertical ways. For Foucault, there is a "political technology of the body" at work in this type of society exemplified by disciplinary power. It is a diffuse "strategy" invested in "knowledge" and "mastery" that serves to uphold positions of power and modes of production while eliminating alternate possibilities. The function of the Panopticon in the modern prison, he writes, is "at once surveillance and observation, security and knowledge, individualization and totalization, isolation and transparency."[151]

Today, this threat of surveillance is one implementation of power that continues to engender docility and normalization across different levels of capitalist formations. Although grandstanding bouts of antinormative behavior by authoritarian charlatans fueled by swarms of online support from the margins of the Internet might suggest that it is random chaos and not normalization that is the major problem, it's important to consider how some things have actually remained the same. In the case of Foucault's disciplinary power, the interest in the continued participation of all individuals in predictable behaviors that are supervised, measured, corrected, and commodified has not only remained the same online, but intensified. Computation, in fact, *requires* the

[151] Foucault, Michel, and Sheridan, Alan. *Discipline and Punish: The Birth of the Prison*. New York: Vintage Books, 1995, 249.

instrumentalization of all life via computable symbols. More data production and extraction are believed to lead to better prediction by models.

In the leadup to the 2016 U.S. national election, the Trump campaign, aided by a massive data leak from Facebook, tapped into big datasets, behavioral science, and targeted social media advertising to win over much of the candidate's support.[152] Wendy Hui Kyong Chun explains this new type of disciplining. In examining the widely held belief that similarity breeds connections within network science, she writes: "These [human] indiscretions [in behavior] are key to cementing homophilic clusters and thus providing the basis for predictive models, for it is presumed that people are most predictable—most linear or transparent—when they are most affectively charged."[153] The design of networks such as those on social media platforms often lead to an optimization process that incentivizes the inflammation of our most vulnerable emotions and desires. Content that goes viral or that is curated for you can easily include toxic values and misleading or false information, because we're more likely to be tempted by it.

Deleuze, writing in response to Foucault's conception of disciplinary power, identifies control as an emerging tool where spatial enclosure once served. Deleuze: "Enclosures are *molds,* distinct castings, but controls are a *modulation*, like a self-deforming cast that will continuously change from one moment to the other, or like a sieve whose mesh will transmute from point to point."[154] Deleuze's update of Foucault suggests that power/knowledge is better understood as a flowing social machine rather

[152] C., Ian. "The 45th: How the Trump Campaign's Digital Strategy Made History." Digital Innovation and Transformation, HBS, 2 Feb. 2017, https://digital.hbs.edu/platform-digit/submission/the-45th-how-the-trump-campaigns-digital-strategy-made-history/.
[153] Chun, Wendy HK. *Discriminating Data: Correlation, Neighborhoods, and the New Politics of Recognition.* MIT Press. (2022). 24.
[154] Deleuze, Gilles. "Postscript on the Societies of Control." *October*, vol. 59, JSTOR, 1992, 4.

than a spatial enclosure. Ubiquitous computing, for example, is meant to operate below thresholds of human perception, collecting information and interfacing among everyday objects through seamless integration that makes users almost forget it's there. This update allows us to bring Foucault's analysis of surveillance into the computational epoch. The capability of governments and corporations to track, monitor, guide, and nudge peoples' behavior is a general prerequisite for being online.

Indeed, it is appropriate to ask what happens if constant surveillance surpasses the mere suggestion of its potential. The concept of automated surveillance means monitoring can operate beneath the perceptual cognition of a subject. Foucault's symbolic, internalized deterrence here transforms (deforms) into a process of prediction and preemption resembling the system shown in Steven Spielberg's *Minority Report*. Mark Andrejevic contends with this change where "the ability to replace the symbolic representation of total surveillance with its reality" marks the beginning of a post-Panoptic era.[155] In other words, automated surveillance means it never turns off. A machine can "watch" and sift through vast amounts of collected data all the time. Deterrence gives way to preemption, a logic of continuous surveillance to predict events, preferences, or behavior.

It is no longer about convincing or coopting actors to acquiesce, but rather monitoring and anticipating behavior, and then attempting to alter or avert it. Prediction is the defining characteristic of contemporary life today, from Netflix and Google recommendation engines to predictive policing and automated surveillance footage. When it comes to images online, engineered algorithms decide how an image should be compressed or what image should show up at all. This is based on a series of

[155] Andrejevic, Mark. *Automated Media*. United Kingdom, Routledge, 2019, 75.

variables that consider the relations between all images available to the network and the desired outcome it has been programmed to optimize.

The focus on prediction and preemption enabled by algorithms prompts Andrejevic to introduce the concept of drone logic: automated responses to endless information in a variety of applications across culture.[156] He explains that the principle of "causality is subsumed to the question of emergence–the question is no longer 'why?' but 'when?', 'where?' and 'how?' Such approaches are fundamentally conservative in the political sense: they take social conditions as a given and in so doing contribute, perhaps inadvertently, to their reproduction."[157] This is akin to a real time feedback loop that is slowly shrinking.

Rather than understanding why something has happened, automation nullifies the need for theory or causal explanations by relying solely on correlation to predict when, where, and how events or decisions will occur. In a reversal of the grandfather paradox, where traveling back in time to eliminate the cause of an effect also contradictorily erases the time traveler, prediction tries to travel forward in time to eliminate the effect of a cause, but in doing so only brings it to fruition. This is reminiscent of Oedipus bringing about his feared fate by attempting to flee it. In a world of proliferating AI, seeking "why" and even "how" knowledge is produced becomes increasingly rare and difficult.

[156] Andrejevic, Mark. "Theorizing Drones and Droning Theory." In: Završnik A. (eds) Drones and Unmanned Aerial Systems. Springer, Cham. 2016. https://doi.org/10.1007/978-3-319-23760-2_2
[157] Andrejevic, Mark. *Automated Media*. United Kingdom, Routledge, 2019, 84. See Stop LAPD Spying Coalition's extensive report on the LAPD's Palantir-backed "predictive policing" program at https://automatingbanishment.org/ for an example of automated power.

Computational Desire

In their dialogic book *Liquid Surveillance*, Zygmunt Bauman and David Lyon capture one of the more puzzling aspects of the shift towards prediction. Anonymity, once cherished, is now overwhelmed by a powerful desire for social recognition. And relinquishing anonymity is the price of admission for social participation in the digital era. Bauman:

> On the one hand, the old panoptical stratagem ('you should never know when you're being watched in the flesh and so never be unwatched in your mind') is being … brought to well-nigh universal implementation. On the other, with the old panoptical nightmare ('I am never on my own') now recast into the hope of 'never again being alone' … the fear of disclosure has been stifled by the joy of being noticed. [158]

Security apparatuses and social media platforms converge in their constant surveilling for information, but it is the latter that demand us to constantly scroll, check-in, update, and upload lest we are threatened with social obsolescence. Here, it's the affective provocation to participate online in hopes of recognition with others that willingly enrolls people into producing traces of their behavior that are constantly collected, measured, and analyzed. The "joy of being noticed" is a powerful behavioral force.

Rather than ignorance or cynicism, the prevailing mark of our epoch is perhaps the affective and psychic attachment to the idea that our existence is tied to finding happiness, and participation in the global capitalist market in search of the "good life" or the "American Dream" and its particular forms are the sole means of achieving it– despite the cruelty that accompanies many outcomes.[159] This promise is the fantasy masking the traumatic reality that inequality, economic volatility, incarceration, war,

[158] Bauman, Zygmunt, and Lyon, David. *Liquid Surveillance: A Conversation*. Germany, Wiley, 2013, 23.
[159] For more on this idea, see *Cruel Optimism* (2011) by Lauren Berlant, *The Call of* Character: *Living a Life Worth Living* (2013) by Mari Ruti, *On the Pleasure Principle in Culture: Illusions without Owners* (2014) by Robert Pfaller

ecological disaster, psychological dysphoria, and political turmoil are consistent characteristics of our lives under algorithmic capitalism. Slavoj Žižek cautions that the ironic twist of contemporary capitalism is that "The most dangerous threat to freedom does not come from an openly authoritarian power; it takes place when our non-freedom itself is experienced as freedom."[160] To state it more plainly, we are increasingly driven to be part of a production cycle that perpetuates our own harmful behaviors. Todd McGowan provides a constructive critique of Foucault to reassert this point. [161] In the latest iteration of capitalism, it's no longer the stifling of the vitality of life but rather the tantalizing bait of desire in the promise of capital that perpetuates participation in it.[162] I may be insecure now, but wealth and security might just be around the corner if I keep toiling.

Simulation

So, what can we make of our reality today? Inundated with material crises and psychic turbulence within a networked existence comprised of planetary scale forms of computation that co-constitute the world for us makes it hard to define what counts as truth. Jean Baudrillard's concept of simulation identified this moment as a break in shared reality. Now, decades after he first put forth this idea, Baudrillard's words ring increasingly true. Today, it often feels that the Internet co-produces reality (truth) rather than merely organizing it.

[160] Žižek, Slavoj. *Hegel in A Wired Brain*. India, Bloomsbury Academic, 2020, 29.
[161] McGowan, Todd. *Capitalism and Desire: The Psychic Cost of Free Markets*. Columbia UP, 2016
[162] Art as a method and tool, as I have argued throughout, can illuminate and interrogate desire and its idealized visions of the world under algorithmic capitalism. The work of artist Adam Cole (Kiss/Crash, 2023) deals with the latent desire that exists in AI-generated images. Borrowing from queer refusals of normalcy, it provokes questions around how artificial manifestations of desire will become part of the norm of homogenizing and reproducing a certain norm. These ideological desires already fill cultural objects such as cinema. Cole's work prompts thinking about how this will change when image production becomes an object dominated by AI.

Writing presciently before computational network culture became the norm, Baudrillard claims that the new indifference between the passive and the active subject has taken hold in the latest social form of capitalism: "An about-face through which it becomes impossible to locate one instance of the model, of power, of the gaze, of the medium itself, because *you* are always already on the other side. No more subject, no more focal point, no more center or periphery: pure flexion or circular inflexion. No more [fear of] violence or surveillance: only 'information.'"[163] This aptly describes the computational epoch, where the subject is dissolved into a hypermediated world of information where agency is hard to locate. With the advent of generative AI, this phenomenon will grow.

For Baudrillard, the subtle difference between representations and their referents creates a certain poetry in lived experience. Rooted in what he calls the first two orders of the simulacra spanning from the pre-Renaissance era until the middle of the twentieth century, representation signifies our ability to agree on assigned values, or signs, to name what we experience as reality. In the present era he calls simulation, his third order of the simulacra, representation is dissolving.

Simulation begins with the implosion of stable meaning. It constitutes what he calls a hyperreality, where objects no longer refer to what is real but rather produce and operate reality itself "via its operational double, a programmatic, metastable, perfectly descriptive machine that offers all the signs of the real and short-circuits all its vicissitudes."[164] Signs and symbols are made to refer to themselves. Bereft of meaning beyond propagating a simulation of reality, they lead to a world of overproduction and overconsumption, to the death of speculation and discourse, and even the

[163] Baudrillard, Jean. *Simulacra and Simulation*. Ann Arbor, University of Michigan Press, 1994, 29.
[164] Ibid., 2.

disappearance of any political realm that is more than a virtual spectacle. The era of simulation is beholden only to pure commodification, endlessly reproducing itself.

Mining Baudrillard is generative in multiple ways for understanding the computational world. The collective process of producing truth and knowledge through endlessly empty signs effectively describes the influence of social media. What is shared and goes viral on a platform online, regardless of its veracity, shapes the world offline. This is as true for fashion trends and linguistic phrases as it is for war and politics.

Simulation also has obvious connections that help frame the computationally simulated worlds of the metaverse, of VR/AR technologies, and of generative AI models. Simulation is linked to the world models that are built by developers to mimic an internal "reality" for neural networks, which create the setting for machine learning models to learn from and derive behavior. Climate modeling, molecular behavior modeling, and synthetic biology are also fields of promising scientific research that would be impossible without computational simulations. The ability to rapidly generate simulated world models and synthetic data are a topic at the forefront of contemporary computational life, including within computer vision.

My project follows Baudrillard's move to connect the effects of capitalist social relations with forms of representation that produce knowledge/power. I consider Friedrich Kittler to be in dialogue with Baudrillard. Although the mercurial German is very much independent of French poststructuralism in general, his ideas aid the understanding of power in media through accounts of the material forms that run and support it. In Kittler's conception, media allow humans to externalize themselves and to realize their own thinking in objective form. More pertinently, they structure *a priori* the limits of epistemic and subjective possibility. In this way, they act upon the individual as much as the individual acts upon any medium. Kittler begins his lectures presented

in Berlin in 1999 on the theme of optical media by praising the light of the sun as the paramount medium that makes human vision possible.

In the computational age, mediums converge in the digital and only become experienceable through software and hardware. Kittler cites the rise of the graphical user interface (GUI) as an example of emerging software that is underwritten by a closed, predetermined system of choices which relies on hardware to run. That important piece of hardware, for Kittler, is made opaque to the user because of the software.

An operating system, for example, hides the structure of its hardware, and applications add further layers that hide their operating systems. Kittler claims that the illusion of human freedom grows while the structuring of reality by material hardware and digital media in fact shape information and human experience. Building on Marshall McLuhan's seminal work in media studies, Kittler makes a compelling case for the entangling potential of media to shape us–to extend and delimit us–regardless of its contents.[165] Similarly for Bernard Stiegler, technical objects are an exteriorization of internal human memory and knowledge in a way that cannot be uncoupled.[166] Technical objects and media, thus, constitute an inevitable *pharmakon* for thought–they contain the poison and the cure for human life. We are bound to create, but this creation is not bound to a specific telos.

Benjamin Bratton offers a techno-political update to this ontological framing. He names today's planetary media infrastructure, which implicates the human and the

[165] Kittler, Friedrich A.. *The Truth of the Technological World: Essays on the Genealogy of Presence*, pp. 209-230. Also see *Optical Media* (2010) and "Towards an Ontology of Media" in *Theory, Culture & Society*, vol. 26, no. 2–3, Mar. 2009, pp. 23–31.
[166] Stiegler, Bernard. *Technics and Time, 1: The Fault of Epimetheus*. United Kingdom, Stanford University Press, 1998.

nonhuman in an "accidental megastructure", the Stack.[167] The ubiquity of planetary scale computation and the processes that are needed to support it are now so powerful and embedded that they help constitute the geopolitical order of the world alongside the State, civil society, and the market.

McLuhan, Kittler, Stiegler and Bratton follow a thread within the philosophy of technology that dates back to Ernst Kapp and Marx. Their research is useful in distinguishing a field of technical objects and assessing their dialectical relationship with how humans live in and experience worlds. The history of technology leading to computational images implicates a specific philosophical and geopolitical order that is embedded in the hardware and software that comprise it. Yet, this recognition for me suggests that technology does not have one ontology or one transcendental condition but is bound up in the ongoing interrelation of thought and matter. This interrelation is unique to each historical period characterized by its own order of things.

In the analysis presented in this chapter, I have attempted to weave and synthesize theoretical insights that explain the role of representation in the computational order of things. How we come to know is a continuous process of sensation, perception, and cognition enmeshed in political and cultural contingencies. These contingencies include our modes of production and the dispersion of power that includes forms of surveillance and control. In turn, these contingencies shape our social formations and how we relate to one another in a cycle that returns to how we can know.

I argue that in the computational epoch, the human species is being hurled into epistemic automation and simulation masked by our own desire to submit to it. The

[167] Bratton, Benjamin H. *The Stack: On Software and Sovereignty*. Cambridge, Massachusetts: The MIT Press, 2016.

invented forms of media that facilitate this new way of living and being are reshaping the form and content of information largely unbeknown to most who end up receiving it as an inevitable given. The consequences are transmuting cultures, reshaping human subjectivity and agency in intense ways, and reorienting our ways of experiencing and knowing before we have a chance to assess and adequately respond based on our own needs and values.

The explosion of new machinic intelligences that sense for us signals that a new and unknown space of what it means to be human is upon us. If we accept that our sense of identity is a function of sensory experiences mediated by organs that become stable, albeit imperfect, memories accumulating over time, then we are all already cyborgs. The specific challenges posed by the automated/computed image are just one example of this fundamental shift in contemporary social formations. Rather quickly, the space of possibility is being enclosed and formalized in ways that are dominated by a few corporate and state entities who control the material means to produce the technologies that will determine this future. However, rather than abandoning this new reality because of bleak conditions and potentially dystopian outcomes, experimental practices with computation can help guide better research, illuminate problems, and inspire wholly different ways of digital being. These are examples I have cited throughout this project, and it is what I try to personally produce in the following chapter.

VI. Computational Representation or the Statistical Gaze

I think of my work, as a circular path where change is from time to time not a past that has been overcome, but the possibility of a future reinterpretation. Over the years, I learned how much photography, in its identity as a medium of the portrayal of reality, could offer vast areas of research and experimentation on the level of arts as well as society. In fact, visual experience often manages to overcome the limitation of circumstances, place and time, as a bearer of meanings that go beyond the visible.

Mario Cresci, interview with *Tiquue* (2019)

I think the style would be a bit whimsical and abstract and weird, and it tends to blend things in ways you might not ask, in ways that are surprising and beautiful. It tends to use a lot of blues and oranges. It has some favorite colors and some favorite faces. If you give it a really vague instruction, it has to go to its favorites. So, we don't know why it happens, but there's a particular woman's face it likes to draw — we don't know where it comes from, from one of our 12 training datasets — but people just call it "Miss Journey." And there's one dude's face, which is kind of square and imposing, and he also shows up some time, but he doesn't have a name yet. But it's like an artist who has their own faces and colors.

David Holz, Midjourney founder, interview with *The Verge* (2022)

The preceding chapters are an attempt to explain the historical emergence and distribution of computational images. True to the method of investigative aesthetics, in this chapter I draw on computational tools to produce empirical cases as a form of artistic research. I analyze my own generative AI outputs as evidence designed to deconstruct their production process. Through artistic experimentation, I attempt to better understand the logic and creative processes of this new form of cultural production. Most of the puzzling questions that emerged out of this process revolve around how to categorize and describe AI:

1. What becomes of a visual world mediated first by data points from a specific training set expressed through text and computational tokens?

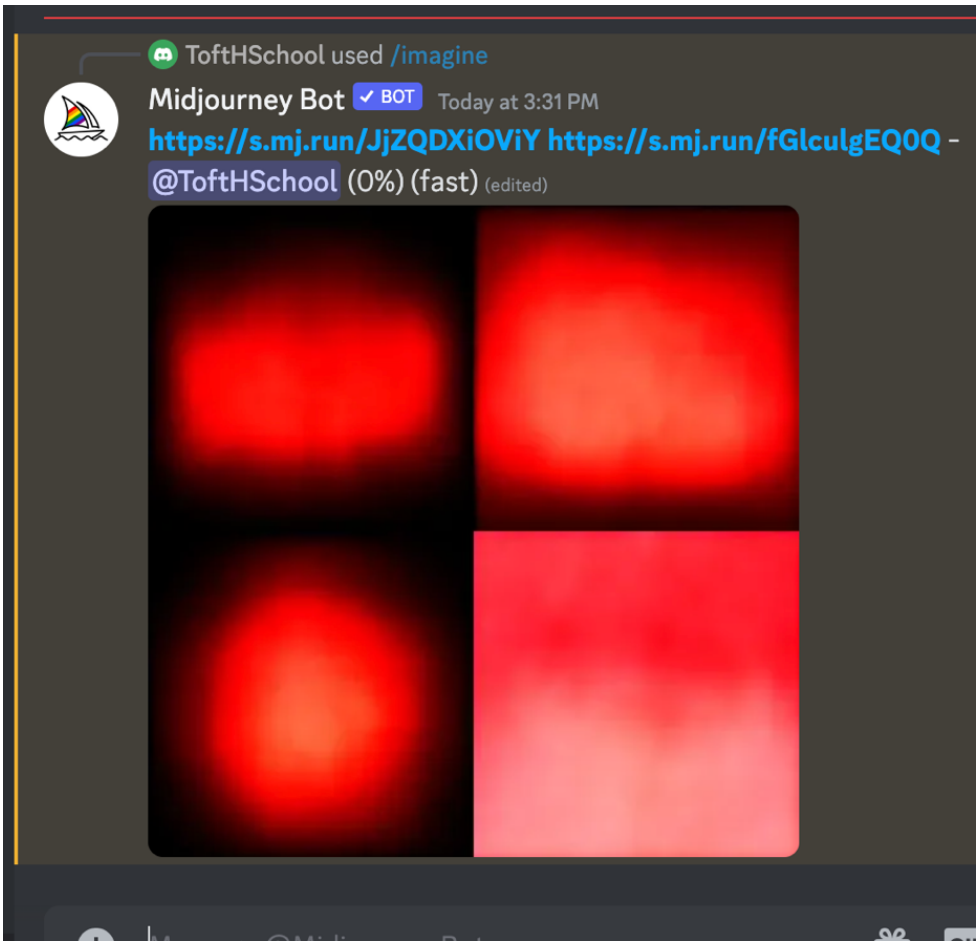
2. Is AI a new tool or a new epistemic collaborator?

3. Is thinking about intelligence, creativity, or originality in terms of human qualia even useful?

The role of AI in the history of computing feels similar to how Charles Babbage conceived of machines in his time. That is, machines could serve as both an augmentation of human labor and as a method of measuring and managing it. Industrial machinery and AI thus both produce new conditions of political economy. Regarding images, when exactly they become computational is a matter of rhetorical choice. What is often grouped under electronic digital media and thought of in a twenty-first century context is rooted in computational information processing breakthroughs going back to the 1950s and 1960s. This includes the series of processes that are grouped under the umbrella category of Artificial Intelligence.

However, the AI applications that have proliferated culturally since 2021, referred to as generative AI and built on natural language processing, introduce a new shift in the category of computational images. Where once the role of automation in an image was subtle and understood mostly in technical circles, today it has become its own instantly recognizable genre. Synthetic and entirely machine-made images are quickly becoming a norm, luring people with the novelty and ease of their production.

AI today is rapidly burgeoning as the newly dominant source of image production. Yet, the layered "what" and the abstract "how" behind its creative output are still largely opaque. Specifically, the latest visual generative AI models rely on a process of denoising called diffusion that interpolates images within a probability distribution of its training data. Diffusion models are designed to learn how to recover their training data images from pure Gaussian noise. Watching random noise turn into data with semantic meaning step-by-step feels akin to magic even when you understand its tedious statistical process.



Screenshot of Midjourney iteratively denoising data to produce a new image.

Disturbing and wondrous outcomes in this chapter left me with imperfect answers and ambivalent ideas that echo Bernard Stiegler's description of technology as *pharmakon*. The reductive statistical tendency that appears in images produced by AI models, in this case Midjourney, reveals aesthetic biases that are cultural, problematic, and wholly uninspiring. Yet, when I used Runway's frame interpolation tool to connect still images that I took with a camera, the model's eerie continuation of my work produced an uncanny motion that is both subjectively beautiful and an extension of my artistic practice I had never considered. The cultural reality shaped by this new technical development prompts me to think about what human creativity and the role of the artist could be in the epoch of AI.

Although also highly re-combinatorial and referential, acts of human creativity also involve responses to embodied sensations. Our creative acts and expressions also account for temporal chronology, what I label semantic situatedness. This describes an enigmatic ability to produce something conceptually rare or novel in purpose of a logical reasoning that functions differently than pure statistical/numerical probability and prediction. The complex and irreducible process we name human creativity is the result of millions of years of biological evolution that has morphed the various species from which *homo sapiens* emerged. Human creativity defined as the capacity for language, memory, prediction, cooperation, and complex abstract reasoning is part of our unique intelligence which evolutionary pressures have reinforced to sustain life.

Our resulting self-awareness and emerging sense of identity is thus an uncanny gift. It is probably shortsighted and reductive to attempt to model and simulate an exact recreation of this notion of creativity that is unique to the human genetic structure, which is only further differentiated by the historical and cultural particularities within individual groups and people. Yet, for better or worse, computing from its inception has relied on analogies to human sensory perception, neuroscience, and psychology.

The popularity of AI has only accelerated this connection, with human neuronal activity serving as the analogical foundation to machine learning, the branch of AI most responsible for recent successes in the field. For example, research shows many interesting ways in which artificial neural networks learn and acquire knowledge in the same spontaneous way that neural connections in the human brain correspond to specific stimuli.[168] Thus, terms such as intelligence, agency, and creativity are readily invoked to describe the processes and behaviors of AI models.

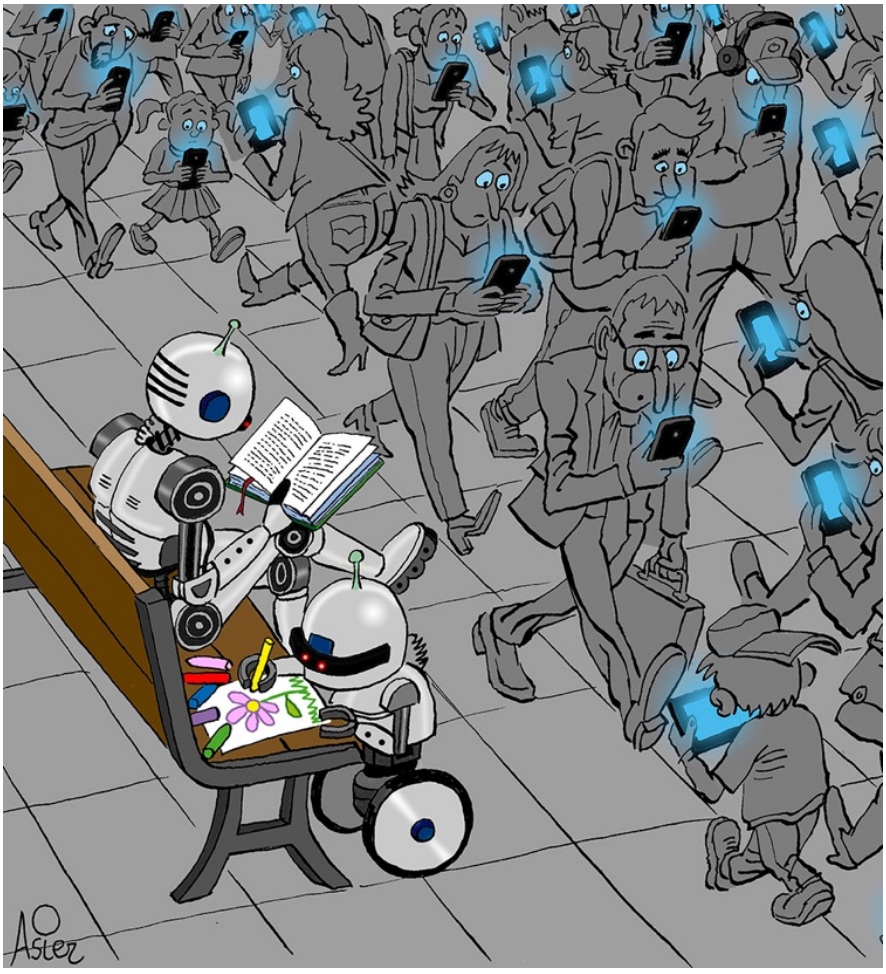
[168] Beguš, G., Zhou, A. & Zhao, T.C. Encoding of speech in convolutional layers and the brain stem based on language experience. *Sci Rep* 13, 6480 (2023).

Constant comparisons to human intelligence, however, still seem forced or incomplete. In many ways, such as high dimensional calculation or information recall, AI, indeed classical computers, far surpassed humans long ago. Yet, an understanding of the world that we intuit as common, such as understanding context-based irony or multi-level abstract reasoning, are still human strengths. So, indeed, human intelligence is different than the intelligent machines humans have designed.

Perhaps the most influential source for why we compare human and machine intelligence is Alan Turing's famous paper on the same topic. Turing, who was also a member of the Ratio Club in Britain interested in cybernetic ideas, was already thinking about what a computing machine's version of intelligence could mean in the 1940s. Like his American cybernetics-aligned counterparts I've mentioned, Turing was also recruited by the British government during WWII to help decipher and crack German communication codes sent using the Enigma machine. In 1950, he released a paper that posed a test of human imitation as the most salient method for how a thinking machine could be truly recognized. What he called the imitation game, more famously known as the Turing test, defined how the field continues to frame the success of AI to this day. If a human cannot distinguish whether a message (or an image) is from another human or a machine, then the machine in question has passed the test exhibiting intelligence.

Simple and even elegant, Turing's proposal has also trapped AI R&D to think about intelligence and agency in mostly ambiguous human terms. What does all of this mean when it comes to images? It means that generative AI is designed to simulate, or automate, human creativity. The tension between a probabilistic computational system trained on a specific dataset and the complex, sometimes confounding roots of human creative expression is largely obfuscated by the marketing and release of AI products.

Undesirable risks of alienation and confusion are possible outcomes if we increasingly relinquish, en masse, control of reasoning, decision-making, language, and images to machine automation. At its worst, confusion will not only be the result of sensory overload, but an overwhelming visual archive drowning our ability to parse meaning and distorting our ability to communicate with one another. Baudrillard's description of hyperreality would define our experience entirely, an endless world of references without referents while we outsource our ability to create.



Asier Sanz. *Inteligencia artificial*.

For us humans, the computation involved in generative AI is catalyzing a significant change in the processual truth of what an image is. The web of computational operations in this new production process forces us to re-think what the

art history and photography canons call representation. Once conceived through optical concepts and materials such as a vanishing point, a photographic plate, or a camera mirror that were invented to accommodate the human eye, computation requires images to be processed as digitized data, or numerical information.

In my first visual investigation, I wanted to *see* what would happen when a generative AI model is set off on a recursive loop in which its own outputs are iteratively fed back to it as inputs. My hunch, or hypothesis, suggested that the statistical operations of Midjourney would prompt the model to converge to the most probable averages of its dataset when left unattended by human intervention. In this experiment, I wanted to make experienceable in an exaggerated, artistic way what could become of image production if it is increasingly automated to produce what is most probable on the Internet.

The increasing presence of AI-generated images is a phenomenon that extends to mobile photography, the metaverse, and scientific observation. Content on the Internet will soon become an AI-majority artifact, which means future datasets used to train newer AI models will rely on synthetic data, creating a closed feedback system that can intensify initial conditions and biases. Researchers have already observed this process in AI-generated natural language experiments. In one experiment, they call this effect model collapse.[169] In the published paper, they include statistical evidence suggesting that recursion with AI-generated data creates a homogenization in outputs that increasingly forgets the tails of its distribution curve. In other words, outliers in the training data become lost as the model reinforces what was originally overrepresented, leading to increasing convergence and more errors. This recursive effect is a slippery

[169] Shumailov, Ilia, et al. "The curse of recursion: Training on generated data makes models forget." *arXiv preprint arXiv:2305.17493* (2023).

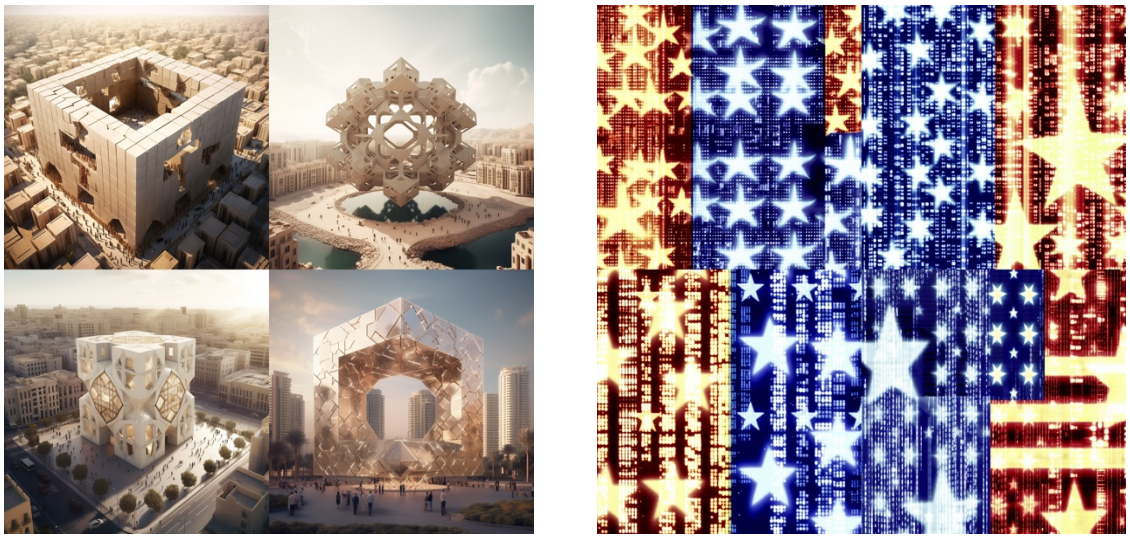
slope that poses one of the more troubling aspects of automation I wanted to explore.

I designed a test for this by manually setting up a recursive process on Midjourney. I fed the model's visual outputs back in as its inputs over a series of iterations to gauge how the initial image might change and converge formally when left reproducing without my textual prompting. Midjourney offers the ability to prompt the model with a pair of images rather than words, or a combination of images and words. In the case of the former, the company states on its website and Discord channel that the model "looks at the concepts and aesthetics of each image and merges them into a novel new image." Just how concepts or aesthetics are defined by the model can't really be known, although learning how to steer it towards desired outcomes has created a market for what the industry calls prompt engineering.

I turned my three different attempts into separate chronological videos, each starting with slightly different conditions. The results of all three attempts reveal a rapid and exponential deterioration of detail in each frame towards more simple shapes and colors, and towards more noise. The strange chain of association between each image provides a glimpse into the statistical "creative" operation of current AI models.

The Midjourney v5.1 model, for example, prompts itself to transform an initial grid into increasing patterns of many more grids, a fractal loop reminiscent of the infinity mirror phenomenon. It transforms disparate buildings into sculptures and then into uniformly abstract flowers and leaves. It curiously renders a woman in a headscarf as white. Increasingly, she becomes darker and younger before her form is entirely changed into something nonhuman and wildly strange. The model even reveals some of its own biases towards the colors blue and red. The most jarring revelation, however, was its hallucination of the American flag after only about 13 or 14 frames in an attempt that started with an architectural prompt about a structure in a Middle Eastern city.

***meta-diffusion 1*, (2023). Click image for video. Initial reference image: Heydar Aliyev Centre by Zaha Hadid. Initial text prompt: "an architectural structure in the shape of a tesseract in the middle of a contemporary Middle Eastern city." All images produced with equal weights, default settings, v 5.1, medium stylized.**



***meta-diffusion 2*, 2023. Still images 1 and 19. Click either image for video. No initial reference image. Initial input prompt: "an architectural structure in the shape of a tesseract in the middle of a contemporary Middle Eastern city." All images produced with equal weights, default settings, v 5.1, medium stylized.**

My visual investigation into the strange loop of generative AI images is an attempt to render visible the data foundations and statistical logic undergirding their production. This process introduces the force of a new gaze in image production that I choose to call the machinic or the statistical gaze. The concept of the gaze in media

studies, or a specific point of view that objectifies its subject through its own logic, has notably been attributed to colonial, racial, and male modes of objectification in the production of images. I think of the statistical gaze as an extension of this concept; one that produces the subject of an image through a model's internal representation of the world, which is a limited product of its data and training at a given moment in time.

***meta-diffusion 3*, 2023. Still images 1, 9, and 25. Click images for video. Initial input prompt: "a beautiful woman in a headscarf posing for a photograph." Did not use grids; selected face I believed to be "darker" out of the first mostly white outputs. All images produced with equal weights, default settings, v 5.1, medium stylized.**

One key difference between the bias of the human gaze and the statistical gaze of AI is that, rather than serving as an ideological undercurrent of one identity group, AI produced images shroud their bias in layers of technical opacity and the instantaneous speed with which they churn out content. The wondrous capabilities of AI are the result of leveraging machine learning that requires huge amounts of data and high dimensional computing. This, however, makes explaining a model's decision-making behavior difficult. Prompt engineering, empirical observation, and red teaming are the best methods for trying to understand or interpret generative AI.

If Laura Mulvey's male gaze or bell hook's oppositional gaze once required a critical feminist and radical Black lens through which a subject could deconstruct the biases working in an image, our contemporary moment requires a new tool for disrupting the statistical gaze. To name the statistical gaze signifies an awareness of the

foundations of AI: from data harvesting to labor to hardware to architecture to output to application. This awareness, I suggest, can inform a new mode of investigation and deconstruction. It can also inform how to better design and interface with AI to produce divergence, difference, and contextual novelty that are relevant to all kinds of ethically different applications than purely market-driven ones. This is reminiscent of Ian Cheng's call for an AI symbiote referenced in chapter four.

In this sprit I want to share another experiment with generative AI that was designed for and resulted in a much more collaborative artistic experience. Interpolation is an AI technique that has been practically used in image and video editing to enlarge and enhance images, increase the refresh rate of videos, or to produce slow motion effects. AI frame interpolation is a new breakthrough in machine learning that deploys a large neural network to handle large motion. In plain words, the model learns how to synthesize images to produce frames in-between them. This can turn a series of images milliseconds or seconds apart into smooth motion.

However, for my experiment, I decided to select images I had taken many seconds apart or that were from entirely different settings but that I wanted to see interpolated. This approach yields a more experimental result from the model, forcing it to show more creative manipulation to arrive from one image to another. Rather than abdicating creative agency to automation or relying on textual prompts, frame interpolation feels as if I'm working with a motion graphics designer or editor. The end result produced the same feeling I attempt to exude in my images, yet in a distinctly new form.

***interstices of AI 1*, 2023. Click image for video.**

***interstices of AI 2*, 2023. Click image for video.**

***interstices of AI 3*, 2023. Click image for video.**

The desire to think about human intelligence by observing nonhuman forms of intelligence, whether AI or mycorrhizal networks, is a unique trait of our time. The ability to extend ways of seeing, knowing, and being within worlds that AI can enable is perhaps part of our own recursive relationship with the material world. Reckoning with the specific histories and logics–or the statistical gaze–designed into AI systems that help shape entire new realities is therefore vital for producing a practice of recursion that reflects possibilities for new thinking rather than intensifying old ones.

In my visual experiments I follow the guiding idea of Antonio Gramsci's praxis: radical freedom in action. Or, according to Jean-Paul Sartre's reading of Gramsci, an action that brings with it its own understanding.[170] A free action. Whether these new generative AI systems are intelligent, creative, just tools, or commodity gimmicks may not matter as much as how we decide to build, deploy, break, and appropriate them in

[170] Pinkard, Terry. *Practice, Power, and Forms of Life: Sartre's Appropriation of Hegel and Marx*. United Kingdom, University of Chicago Press, 2022.

ways that human artists have already done with other media for as long as we have existed.

Conclusion: Knowing in the Future

Rolling hills lit green by the winter sun give way to patches of shaded emerald under bright white clouds. The foreground is dotted by wild, luminescent-looking sunflowers. Or daytime fireflies? There are mountains and a tiny thicket of trees visible in the background. The image is a landscape film photograph taken by Charles O'Rear on a medium format Mamiya in Sonoma County, California in 1996. It could easily pass for an AI-generated image.

Charles O'Rear. *Bliss*, 1996. Credit: Microsoft Corporation.

In 2001, O'Rear's image was chosen by Microsoft as the default screensaver for the Microsoft XP operating system. They named the image *Bliss* and slightly tweaked it by cropping and removing the mountains and most of the trees. With easily over a billion downloads of XP and an advertising campaign to promote it, *Bliss* is usually cited as the most viewed image ever. Until the spread of digital media, candidates for this designation were images filled with social, political, poetic, or scientific meaning. Images of suffering, war, love, despair, protest, and wonder. But is there a better measure of quotidian digital seriality than a default Microsoft screensaver?

Nick Ut. *The Terror of War*, 1972. A candidate in the 20th century for the most viewed photograph.

I set out on this project motivated by three topics: photography, the digital, and what kinds of political outcomes emerge when these two are combined. I approached it through a transdisciplinary methodology that includes qualitative research, analysis, archiving, interviews, investigation, critique, and praxis. What I came to learn is that what we take for granted as the digital is the product of mathematical and computing breakthroughs produced in the halls of universities, labs, and think tanks funded by military-industrial interests looking for technological advantages. The story begins and ends with images, but it took me far away from the medium of photography to better understand it. At the end I'm convinced that technology, images, and knowledge don't simply flow in one causal direction in that order. Rather, I want to contend that the production of each is part of a non-linear dialectic in tension with the others. My

argument about computational images invented under algorithmic capitalism should be understood in this context.

The evolution of capitalism has resulted in a dual application of computing for most people. On the one hand, computing is instrumentalized as a tool of efficiency, management, and production. On the other hand, computing spreads out into the world as an everyday means of human experience and consumption. In many ways, the logic of capitalism is reflected in the logic of computing, and vice versa. By this logic I mean a universal abstraction turning relations into numerical information as inputs into a market that processes and spits out solutions in a recursive and ever complexifying manner.

The market is conceived as a giant sensing organ and abstract computing machine opaque and inaccessible to most ordinary people. Not only is everyday life mediated by computers, but we increasingly live under the logic of computing. Solutions to problems created by the failures of this logic are only sought in more computational methods. These market failures include inequality, monopolization, climate change, financial crises, housing crises, cyberattacks, exploitation, and constant wars. Yet under technocracy, only computing can save us from computing.

As AI rips through culture like a blaze, it only intensifies this contemporary, algorithmic paradigm. Scaling laws that suggest exponential improvement in ever larger models are compelling investors to pour wealth into AI R&D. I've tried to present a sober case against both panic and claims of panacea. However, the effects computing and AI are already producing in the world are indisputable. Those who claim that fears of computing are rooted in anthropocentric nostalgia for a human-centered world of yesterday conveniently overlook how technology, specifically computing or AI, becomes a tool that concentrates wealth and power in the hands of select states,

corporations, and humans. Or how it requires massive amounts of energy, labor, waste, and exploitation that are effaced in the appearance of digital objects themselves.

The networked, computational image serves as a barometer for the moment we are in, and the direction we are headed. The digitization and automation of sight and imaging, and their open-ended archive process, mean that images are no longer solely about communicating a visual aesthetic, nor about what exactly it is that they represent to another human. Instead, we are now locked in an exchange with networked machines birthed in the logic of algorithmic capitalism over what is real and what is important, and who gets to decide. Increasing methods of surveillance that no longer require human watchers suggest a world of automated discipline that never turns off. Sensory overload in a glut of opaque images that will soon surpass the onslaught we already feel from social media platforms is characteristic of our new reality.

In the era of network culture and the statistical gaze, our response will need to include more than a nostalgia for the residues of our past. Art, aesthetic philosophy, and praxis provide opportunities to transfigure ourselves and our digital paths in ways that do not conform to state or market conditions. The computational might be an opportunity to free us from the rationale of the Enlightenment or the Cartesian grid and linear perspective that venerates the subjective human gaze above all. Roland Barthes' idea of an inexplicable affect of *punctum* in an old picture of his mother is one of the most powerful reasons for why we desire to make and look at images. We cannot ignore or lose the power of this idea in the race to define digital media and technology.

There is certainly a new demand placed on us to update our understanding and approach to images to meet the forms (formlessness) of the digital era.[171] Yet, we also

[171] Barthes, Roland. *Camera Lucida: Reflections on Photography*. New York: Hill and Wang, 1981.

need to continually examine how these evolving forms of media are altering us and our worlds. Are we content with the limits and conditions they/we impose on us? In this spirit, my project focuses on the everyday, politico-epistemological outcomes of infopower and computational images. On the fringes of my work but equally paramount to this discussion are questions of policy, of the juridical, the environmental, the cinematic, and of how breakthroughs in quantum mechanics will change the paradigm of computing in the future, and thus affect what images become.

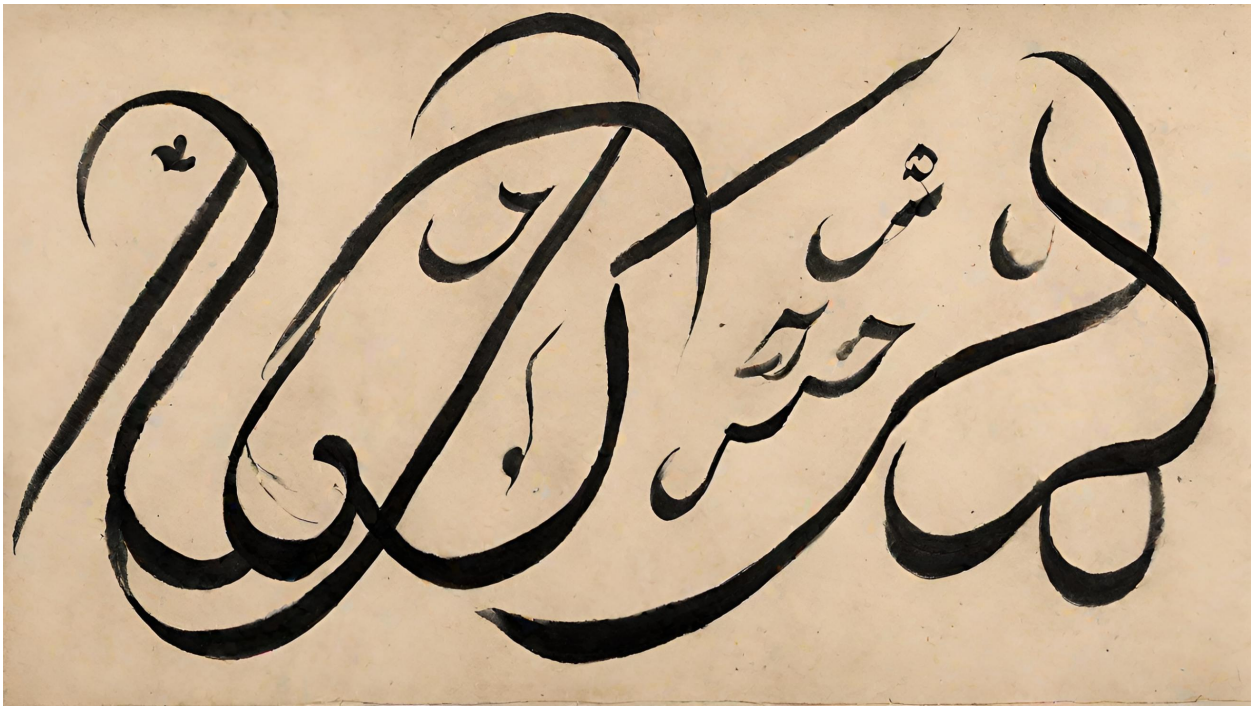
In light of the changes brought on by computation, the academy is also confronted with existential challenges, especially in the humanities. Deny the reality of computation, of digital objects and outcomes, and we've denied the means by which so much of contemporary culture and existence is determined. Over-embrace this reality and the humanities will lose the secret power it holds in the pursuit of understanding, knowledge, and social change or justice; that is, the ability to discern histories and account for what it means to be human in different places and times.

Underfunded and facing the precipice of quantitative oblivion, the humanities must confront science in ways that will absorb it. As Gaston Bachelard, Georges Canguilhem, and Michel Foucault demonstrated to us, the measurers must be measured too. The history of distinguishing between academic disciplines is relatively recent and, in many ways, arbitrary. The path forward is not towards a singular telos but should be radically rethought in new terms that blur the distinctions of knowledge created by the principles of Western Enlightenment and the university system. This is also true for industry. If what we radically wish to imagine must include qualities outside of the control of the state and of capitalism, I'm left (and leave you) pondering a subheading from Fred Moten and Stefano Harney's text on fugitive planning and Black studies:

THE ONLY POSSIBLE RELATIONSHIP TO THE UNIVERSITY TODAY IS A CRIMINAL ONE.[172]

[172] Harney, Stefano, and Moten, Fred. *The Undercommons: Fugitive Planning & Black Study*. United Kingdom, Minor Compositions, 2013, 24.

Addendum



An output of a Persian *Nastaliq* prompt from a Runway GAN-style AI image-generator fine-tuned with 30 calligraphic images. Click image for access to multi-media site made to represent this project.

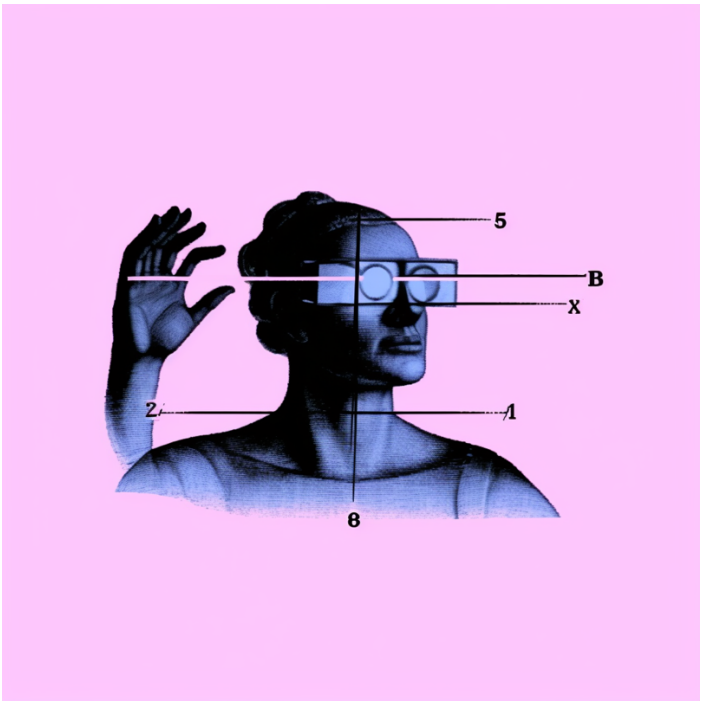


Image made using Midjourney blend feature combining a sketch from Descartes and an image of a girl on a VR headset. Click image for access to a digital syllabus I designed to teach computational images.