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Take Back the Algorithms! A Media Theory of Commonistic Affordance

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Abstract

This essay critiques the 'black-boxing' of many computational processes, which are argued to result in a kind of 'unaffordability' of algorithms. By engaging with current theoretical debates on 'commoning' – signifying a non-profit-oriented, solidarity-based approach to sharing, maintaining, and disseminating knowledge and experience – the essay offers a formulation of commonistic affordance in algorithmic contexts. Through the discussion of widely used computational tools such as the Viola-Jones object detection framework, radical steps towards a 'making affordable' of algorithms are outlined, and the widespread corporate propertisation of computation processes is contrasted with a speculative vision of algorithmic commoning.

Keywords

Commoning, Affordance, Viola–Jones object detection algorithm, Practice-oriented critical media studies

Introduction

Millions of humans are living, communicating, and working in recursively nested body-mind-media-ecosystems, comprised of information, data, and sensor networks, algorithmic systems, communication protocols, media gadgetry, physical infrastructures such as cities, and landscapes co-inhabited by species such as bacteria, plants, and animals. The ubiquitous potentials for interaction, use, and influence unfolding between these entities, their environments, and the structures that they are both actively influencing and being passively influenced by, are often framed by what has, since the late 1970s, been called "affordance" (Evans et al., 2017) – a concept that soon became popular, particularly in fields such as user experience and interaction design. A simple example might serve to illustrate the implications of this transposition of the affordance concept to digital contexts: While a door handle is tangible, realizing its affordances through sensorial experience, many of the critical processes that characterise our interactions with and experiences of algorithmic infrastructures – processes that we are surrounded by and upon which we are becoming increasingly dependent – are increasingly designed to be imperceptible. Not only are these technical processes increasingly embedded within socio-economic contexts, such as those driven by the neoliberal obsession with the maximization of profit, but they are also increasingly designed to be unchangeable. The German media scholar Friedrich Kittler has called this situation "protected mode" (1997);[1] here Kittler is referring to the architecture of modern central processing units (CPUs), where access to CPU memory storage is restricted to internal system applications, so that certain functionalities remain hidden from the user.[2] "Protected mode" as a concept is applicable to all sorts of situations occurring while digital technologies unfold, and where access and agency is restricted for the sake of security and performance optimization. Such protections represent serious obstacles to any efforts at self-deterministically changing the body-mind-media-ecosystems that any individual is living in.

This article therefore begins by arguing for the necessity of granting access to the inner workings of our body-mind-media-ecosystems and their many affordances. This is an urgent matter, especially for configurations in which such systems foster power imbalances, discrimination, and exploitation. The slogan "Take Back the Algorithms!" thus stands for an attempt to transform some of the malicious affordances of our algorithmically driven environments into more equitable ones. This, I argue, can only succeed when done collectively, as a form of commoning – a concept that is used here to signify a non-profit-oriented, solidarity-based approach to sharing, maintaining, and disseminating knowledge and experiences of the algorithms that govern our body-mind-media-ecosystems. I therefore formulate a practice-oriented media theory of commonistic affordance below, which advocates for a broad approach to 'making affordable'. A commonistic affordance, in this sense, is one that enables commoning rather than suppressing it. To design, plan, and realize any commonistic affordances requires efforts to render intentionally concealed, blurred, obfuscated, and protected processes of measurement, counting, control, and surveillance (such as, for example, algorithmically driven facial recognition) visible, understandable, accessible – and thus more affordable. 'Making affordable' is therefore not merely an epistemological endeavour, but an activity that opposes and counteracts attempts of commercial or ideological enclosure. 'Making affordable' is thus not merely an isolated, singular action, but rather involves persistent struggles against power imbalance. Commonistic affordance is a key concept for this undertaking, and attempts to show alternatives to the typically profit-oriented, exploitative, discriminatory ways in which, for example, commercial software might pre-determine its offerings of interactive affordances. Commonistic affordances emphasize accessibility and openness. They offer poetic and utopian potentials for the body-mind-media-ecosystems that we inhabit, and with which we increasingly struggle. In algorithmic contexts, commonistic affordances escalate this potential for utopianism, since any running algorithm might (and should) afford glimpses into the workings, processes, and operativity of a more desirable, a more commonistic, future. This sort of recursive in-world modelling (i.e., the modelling of algorithms by algorithms), that behaves in a non-profit-oriented, non-exploitative manner, and which is instead community-oriented, also indicates the need for a reconsideration of the environmentality of algorithms.[3]

Communities pursuing the self-organized sharing, organizing, and processing of resources – such as energy, information, or material goods – are often called commonist (as they are dealing with commons), while what they are doing together is accordingly called commoning (Dyer-Witheford, 2007; Shantz, 2013; Bollier & Helfrich, 2015). Commoning in the context of media technologies implies a closeness with the Free-and Open-Source-Software (FOSS) movement, as it is based on the idea that software and data are so-called 'digital commons.' While most digital resources are usually owned – or at least controlled – by closed, exploitative, profit-oriented corporate or quasi-corporate entities, digital commons are generated, organized, processed, and shared by an open community of individuals and/or collectives.[4] To secure digital commons and open source projects from commercialization, appropriate non-permissive licensing that prevents their commercial exploitation is crucial. Digital commoning is not only informed by Anarcho-Marxist concepts and a general sense of criticality towards the promises of innovation (in the form of new solutions and new designs), but also needs to be highly self-critical with regards to its own contexts, agencies, biases. It is furthermore necessary to generate moments, scenarios or concrete utopia that are both anticipatory and practice-oriented (Bloch, 1986: 146; Levitas, 1990: 18). Such concrete utopia – one might also call them heterotopia – would allow for the regaining of at least some autonomy from the data extractivism of exploitative, profit-oriented industries and forms of governance. Commoning is thus also about pursuing an ideology that differs from that of the selfish search for ever-growing profit. The implications of these attitudes for algorithmic contexts and the discussion of the affordance concept will be detailed further below.

According to a special report produced by *The Economist*, the top winners after the financial crisis of 2008 are, by and large, companies working with information technology, including Apple, Alphabet, Microsoft, Amazon, and Facebook (Economist, September 17th 2016: 3). Set against such a backdrop, commoning involves taking back or regaining control over information technology, particularly when it comes to matters of freedom of expression, racial discrimination, and various kinds of unjustifiable inequality.[5] The slogan "Take Back the Algorithms!" is therefore inspired by *Take Back the Economy*, a post-capitalist creed co-written by feminist economic geographers Julie Graham and Katherine Gibson (2013), which was itself inspired by "Take Back the Night" – the name of an international non-profit organization which, since the late 1970s, has sought to end all forms of sexual, relationship, and domestic violence, with a particular focus on enabling women to redeem control over their experience of public spaces at night. The present article builds on the spirit of these slogans, not through a gesture towards victimization, but instead through one of empowerment and liberation.[6] As I will argue, to take back algorithms implies programming without always immediately thinking about useful, innovative, efficient or profitable applications. Even more importantly, it means to make algorithms more 'affordable' (in the sense outlined above), so that everybody can access and use them. Ideally, this implies a playful-yet-careful and self-reflective practice that repositions itself continuously, in an effort to detect the hidden affordances of algorithmic eco-systems.

Making Algorithms Affordable

A successful taking back of algorithms from exploitative, profit-oriented organizations and companies requires practices and actions which, metaphorically speaking, would 'make them affordable.' Algorithms are indeed mathematical, symbolic, and abstract structures, but they should not be mistaken for algebraic formulae. The difference is that instructions carried out by algorithms are non-reversible, whereas algebraic formulae are always reversible. Mathematics as such has no real-world effect, while algorithms are vector-dependent; they need time to unfold and thus they embody time and have real-world impacts (Miyazaki, 2016: 129). Algorithms, therefore, are not only already-situated in socio-economic contexts, they also strongly determine what we can say, communicate, know, feel, see, and hear (Mitchell & Hansen, 2010: vii). Therefore, algorithms quite literally put things forth, forward or further. Affordance, in this sense, is the potential and capacity to move forward, to change things. Algorithms, when stored and not-yet-unfolded, have affordances, since they are made of instructions to structure and move hard-, soft- and wetware. Operated by semi-conductor-based chip-architectures, they consist of orders that assign or shift values from one storage location (address) to another. Making algorithms affordable under such considerations implies foremost their liberation from their protectedness and "mute[d] efficacy," as Kittler formulated in the early 1990s (1997: 161). Here, 'making affordable' thus derives a new meaning, namely that of *making something graspable, tangible, usable, movable and shareable*. In this way, the output of algorithms also, quite literally, becomes something that can be paid for.[7]

There are further potential entry points for a definition of 'making affordable.' Making affordable also considers the role of mediation in the sense of filtering. In computational contexts, making affordable additionally invokes circuit-bending as a way of manipulating circuits and changing their taken-for-granted functions without formal training or approval (Hertz & Parikka, 2012: 426). Code-bending as an extension of circuit-bending invades concealed layers of algorithmic governance, often symbolically and literally breaking apart a software system and playing with it without formal expertise, manuals, or a predefined goal (Hertz & Parikka, 2012: 426). Making affordable therefore opposes acts of simplification, reduction, enclosure, and commercialization that are conventionally esteemed in human-computer interaction and other design fields. Popular slogans like "Don't Make Me Think," by the user experience (UX) designer Steve Krug (2000), gestures towards the fact that the ultimate aim in such fields is the elimination of complex openness by making things easier to understand. This is something that frequently occurs by way of black-boxing processes that might disturb or confuse users. Making algorithms affordable then, aims to develop a better understanding by following a different route, namely that of making processes easier in order to then complicate them again, thereby unlocking potential alternatives. Accordingly, 'making' here is also corresponded to a kind of un-making (Gaboury, 2018).

In this sense, the affordances of algorithmic systems are not exhausted by their intended and programmed functions. Instead, they can, potentially, afford much more, such as unexpected glitches, new uses, and different types of users. The mastery of tools, equipment, and media technology often includes the mastery of their malfunctions[8]; making affordable, in this context, means to liberate such systems from the constraints of fully predetermined 'mastery,' and instead enables users to become independent agents in their interactions with the systems in question. Making algorithms affordable, finally, is an activity that involves the ongoing struggle against tendencies to enclose them, to make them privately owned, to increase their value, and then to sell them. Activist and cultural studies scholar Max Haiven describes this sort of theft as "Enclosure 3.0," in which the technological capacities of computation and algorithmic control emerge as a neoliberal form of enclosure that reaches expansively across the globe and intensively into daily life and the "imagination" (2016: 280). To make algorithms affordable is thus to un-make their capitalistic value, while at the same time making them usable and applicable for as many users as possible, such that they become 'common.'

Machine Vision as an Example

Media artist and coder Adam Harvey's series *CV Dazzle* (2010 – ongoing) serves as a good example to further concretize and draw critical attention to both the troubling algorithmic affordances of the contemporary field of computer vision, and to utopian responses to the problematic implications of this technology. *CV Dazzle* concerns processes of automated face-detection executed by algorithmically operating camera-computer systems. The project serves to render otherwise invisible aspects of surveillance technologies graspable, while also exploring alternative designs that are intended to counteract the surveillant gaze and to allow individuals to become self-deterministically invisible. The project webpage[9] describes several make-up techniques that can make a face undetectable for algorithms, operating in correspondence with a so-called cascade classifier that discriminates the data according to pre-coded conditions and rules. These rules are, thankfully, included in the FOSS based *Open Computer Vision (OpenCV)* library, and can therefore be used widely in many different contexts including for artistic and activist purposes. Among many initiatives and software environments that benefit from access to this library, a good example is *Processing*, a popular cross-platform integrated software development environment (IDE) designed to increase the accessibility of coding in art and design.

The so-called Viola–Jones object detection framework allows the automatic detection of faces and other visual forms embedded in images (2001). This algorithmic framework has been incorporated into many of the commercial webcams and photographic cameras that were produced around 2010. Significantly, this algorithm is not proprietary, and is available open source, with good documentation. What follows here is a lengthy description of the algorithm's crucial steps and processes. Understanding and following the operations of an algorithm is an important and necessary step for taking it back and making it affordable.

When detecting faces, the Viola–Jones object detection algorithm first uses a list of Haar[10] features such as those illustrated in Figure 1. These visual features are then used as criteria for analyzing approximately five thousand photographs of faces, which create a so-called "cascaded decision tree" provided with the *OpenCV* library. The decision tree, also called a 'classifier,' is the result of a machine learning process that combines adaptive boosting (Adaboost) with a so-called integral image algorithm or summed-area table algorithm, a combination that accelerates and optimizes the process. The creation of this 'classifier' constitutes a type of supervised machine learning, since the training is done on pre-categorized data. Checking a list of Haar features on a single image leads to a value expressing how many of the features matches the list. First, the algorithm verifies all negative examples (non-faces), which results in low numbers. Then, it checks all positive examples (faces), which results in high numbers. A high number thus indicates a high likelihood that an image shows a face. The algorithm now repeats this checking with as many features at different sizes and positions as possible,[11] leading to a set of threshold numbers that ultimately help to decide whether an image is a face or a non-face. The features are then organized so that there is a tree of decisions. This decision tree ensures that the best feature, which detects whether an image is a face or not, is tested first, then the second-best feature is tested, then the third, and so on.

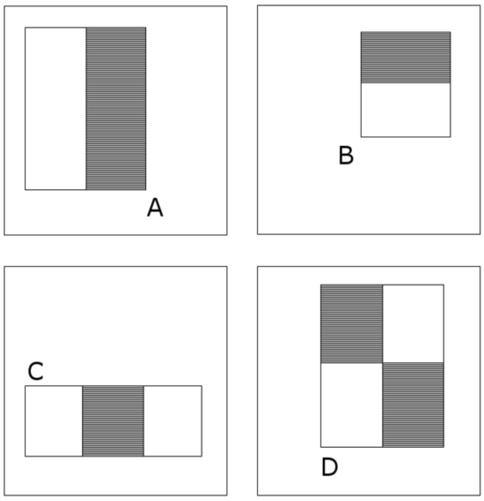

Fig. 1[12]

The Haar features, at least in the most common version of the Viola–Jones face detection algorithm, are based on simple black-white contrasts (see Fig. 1). They are useful for analyzing faces, but their operations are impacted by skin color. The algorithm is therefore a case of programmed racism.[13] It couldn't detect images showing faces that have little or no light-toned elements. This was presumably not only a result of training the classifier – the above described decision-tree – with a biased set of images containing only a few or even no dark-skinned faces, but might have been an amplification effect of the feature selection as such. A lack of white regions in a face leads to failures in the detection. In some cases, this creates an algorithmic bias, as the algorithm is more inclined to detect light-skinned faces, while not being receptive to dark-skinned faces. Computer vision in this case is not neutral or transparent, but has, as mentioned already above, a racialized filter. One might provocatively write: Viola–Jones face detection as computer vision is also a racist vision. As of 2019, the algorithm is still part of *OpenCV*.

In responding to this issue, Harvey's *CV Dazzle* shows playful ways to explore the functionality and limits of the Viola-Jones algorithm. It makes it apparent that computer vision, and algorithmic systems more generally, can yield serious instances of discrimination, racial or otherwise, when not carefully designed. The project explicitly refers to *OpenCV*, so that those who experienced the project in an exhibition, on a webpage, or in a talk can easily learn more about the underlying technology. *CV Dazzle* thus makes the Viola-Jones algorithm affordable not only epistemologically, but also ethico-aesthetically by highlighting its flaws and malfunctions. Foregrounding ethico-aesthetic affordances, in this context, extends a concept by Felix Guattari that involves "speak[ing] of the responsibility of the creative instance with regard to the thing created [...]" (1995: 107; Brunner et al., 2012: 42). Works and projects like *CV Dazzle*, in combination with learning-based tear-downs of relevant algorithmic systems and activist attitudes, will be crucial for taking back algorithms on a step-by-step basis.

The issue of algorithmic bias[14] is not only addressed by artists. In December 2016, a group of computer scientists and software engineers around Ansgar Koene from the University of Nottingham, filed a so-called Project Authorization Request (PAR) for a new IEEE (Institute of Electrical and Electronics Engineers) standard, and formed the "IEEE P7003 Working Group – Standard for Algorithmic Bias Considerations." As formulated there, the standard is planned to provide programmers of algorithms designing autonomous or intelligent systems with certified methods that afford clearly articulated accountability and clarity regarding how algorithms are targeting, assessing, and influencing their users and stakeholders.[15] While this sort of effort in the realm of engineering standards and policies is of course legitimate, we must nevertheless ask how a more community-oriented approach could unfold.

Commonistic Affordance

To be clear: A commonistic affordance operates in the name of commonism. This happens rarely, since we can assume that purposefully designed affordances will operate, most of the time, to make profit. As French Marxist philosopher Henri Lefebvre has noted, the rhythm of capital is one of production and destruction (2004: 55). While capitalists in the early 20th century ultimately controlled the rhythm of factory machines, "vectoralists" (Wark, 2004) are now controlling the algorithms of our body-mind-media-ecosystems. Notably, the term bias is etymologically derived from the French term *biais*, meaning slope, i.e., a path that goes up or down. It thus implies a gradient, a vector. Vectoralists are those who have the means of realizing the value of these vectors, gradients and biases. They control "the vectors along which information is abstracted, just as capitalists control the material means with which goods are produced, and pastoralists the land with which food is produced" (Wark, 2004: para. 29). As the example of *CV Dazzle* beautifully shows, to design *commonistic affordances* that allow us to pursue the idea of taking back algorithms implies reclaiming the accessibility, detecting, amplifying, and playing with the poetic, socio-technical and utopian potentials of the body-mind-media-ecosystems that we live with.

Making an algorithm such as the Viola–Jones object detection 'affordable' implies furthermore what the philosopher Timothy Morton would call a "context explosion" (Morton, 2018: 91); it does not merely involve directing our attention towards the algorithm's biases, alternatives, and playful usages (as a reflective artwork might), but also towards its inner parts, which, again, embody more affordances. These parts are built upon instructions that are, at the lowest level, built-in as micro-instructions on the CPU or GPU-level. Querying the affordances of an algorithm thus leads to the finding that these affordances are recursively intertwined as in a fractal shape. Making algorithms affordable ideally implies working with algorithms on a daily basis: algorithms should not be expensive things we dream of and desire but cannot afford. An important pre-condition for this coming true is that an algorithm, such as the Viola–Jones object detection, is foremost not proprietary, but is instead open source and well documented.

Here, my example shows some flaws: two years after its first description in 2001, the Viola–Jones object detection algorithm was open sourced and included with the *OpenCV* framework (Kruppa et al., 2003). And yet, its license is still, from a commonistic point of view, malfunctional. Although *OpenCV* is open source, its licence is not based on the GNU General Public License, but on a so-called permissive free software license, which does not prohibit an algorithm's commercial application. Even when the code is well documented and fully open sourced, to maintain its commonistic affordance, an insistence on keeping it non-commercial is therefore highly important. Additionally, it is not enough to just re-use the modules, libraries, and demo examples of a set of algorithms, but a genuine desire to know, recognize, and to play with its inner workings and an increased sensitivity for its timing is required. This requires approaches that go beyond a mere rational, abstract, and mostly textual understanding. A more sensorial connection with the object of study is needed here. Cultivating recursive practices and applying media technologies to understand other media technologies might be a first step to increasing our conscious connectivity with and environmentality of our body-mind-media-ecosystems, their algorithms, and affordances. Can we hear computer vision? What would it feel like? What belongs to the environment of a Viola–Jones object detection algorithm? Is the human reading or watching Viola–Jones object detection at work also part of its environment?

Environmentality is a concept borrowed again from philosopher Timothy Morton, who in the context of climate change defines it as a "becoming aware of something that is just functioning, yet now we have global warming and pollution. We are aware of it, because some kind of malfunction is taking place" (Morton, 2012: 97). Remembering the concept of affordance as being developed originally in the context of an "ecological approach to visual perception" (Gibson, 1986), which was then famously turned into a design concept (Norman, 1988), indicates a taking-back of its environmental aspects, which have been forgotten in the time between. As described earlier, works like *CV Dazzle*, for example, can give us clues as to the malfunctioning of rather new sorts of environments (compared to those of buildings, landscapes, atmosphere, climate, etc.), namely those of algorithms, which are, increasingly, intermingling with every other type of environment.

CV Dazzle increases our environmentality, our awareness, of something that commonly remains unnoticed. Making an algorithm affordable in this sense means not to regard it as a closed black box, but instead to try to learn about its inner workings by connecting it with an "experimenter," thus creating feedbacked couplings with it, as the early cybernetician Ross Ashby had already envisioned in the 1950s (1956: 87). Exploring the affordances of a method, an algorithm, or a digital technique also involves exploring the full spectrum between what you are and what an algorithm is, and what you and what this algorithm seem to be: what is Viola–Jones object detection and what does it seem to be? Where are the limits of Viola–Jones object detection as an entity? Do the images – the data – processed and learned influence the behavior and effectivity of Viola–Jones object detection? Yes, certainly. Is its racism a feature or a bug? Was it intentional, or more a result of a general tendency linked with the cultural and epistemic backgrounds of Paul Viola and Michael Jones? More context explosion: What kind of entity is performing the algorithm? The CPU? The monitor? Our consciousness? Our affecto-somatic body? The operating system? The semiconductor minerals inside the CPU? To take back algorithms is not merely a way of asking questions and making things more complicated; it is also an offer for further affordances and malfunctions to emerge. Whether these affordances are planned or not is insubstantial. More important is whether they enable more solidarity and commoning, rather than more competition, and whether they might lead to new insights regarding how we can live together in a self-determined fashion and share things, resources, knowledge, and affects. Entangled with this concretely utopian approach is also the aspiration of organizing movements such as commonism in ways that are inseparable from experimentation, design, and an acknowledgement of its reciprocity to body-mind-media-ecosystems (Lovink & Rossiter, 2018: 171).

Thinking in ways that are concretely oriented towards utopian goals while also being media-theoretically informed about commonistic affordances also implies that we need to think about more solidarity with algorithms, which might be considered as something akin to companions or co-species. 'Solidarity' is etymologically related to the Latin term *solidus*, and refers to a kind of non-hollow whole, a solid, a body. Solidarity in the 18th century was redefined as *solidarité*, signifying a joining together of people with shared interests and mutual responsibility. Solidarity as it is meant here, and also to be consistent, is not – or should not pursue – the enclosing of things into a body, but rather the pursuit of a situation in which a body becomes porous, full of holes, and connections. Sharing interests together, being mutually responsible for one another, and thus making things affordable for each other implies an understanding that we are all linked together, also in case of malfunction.

Increasing solidarity with machinic eco-systems – even if it is merely meant metaphorically – implies generally more inter-growing between human, machinic, organic, and other sorts of ecosystems. We need more environmentality not only including our organic co-habitants, but extending to all kinds of non-human and non-organic technological-entities chirping, screeching, wiggling, shaking, jiggling or rocking and in more technical terms signalling in the informational-energy-fields that we are surrounded by. This means not merely an exploration of their structures, software, hardware, and in-between layers, as mentioned earlier, but also an opening of ourselves. We need to become more aware of our porosity (about our holes and connections) and at the same time become more porous – more open in affective, psycho-technological and perceptive meanings. This is not meant in the sense of a Silicon Valley-inspired "radical openness" that has become integral to contemporary capitalism, but in the sense of an even more radical opening of new channels to our cognition and perceptions of algorithmic systems; this is an openness that includes algorithms' malfunctions and that is always oriented towards learning new things about commoning, as part of a multiple, poly-structural body-mind-media-ecosystem. Ultimately, this also implies a sort of increased and technologically augmented, technically mediated, computerized engagement with all types of energy fluctuations (bioelectric, electromagnetic, thermal, kinetic, gravitational, nuclear etc.), which should be linked to docking stations on our bodies and into our thinking. Simply spoken: it involves a playful exploration of alternative, sometimes poetically dysfunctional, sensor-actor couplings, installations, or configurations. Most importantly, in doing all these things, we should never forget to counter-act against movements that might again enclose all these things opened before.

Exploring algorithmically automated decision-making processes on all scales of our media culture, media scholar Florian Sprenger ingeniously remarks that, "[a]lthough we might still be able to identify individual decisions, we will always be too late to the scene, because their sheer number and speed exceeds our capacities" (2015: 113). Still, since the increased connectivity between machinic systems, from which humans are excluded, is unavoidable, it is critical that we ensure that it is never "too late" to reconnect. Algorithms are usually perceptually beyond reach; making them 'affordable' is therefore crucial. For understanding the commonistic affordances of an algorithm you need to play or co-operate with it and never leave again. Increasing solidarity with machinic affordances through commoning also implies responsibility, active careful engagement, and continued self-criticality. If you make something affordable, you are responsible for it. This includes an attentiveness to the neo-liberalist tendency to further enclose things in order to make profit. Competition and growth are tolerated, but only as long as the rhizome or tumor is benign, and as long as it serves the idea of mutual, even symbiotic, solidarity, living, and sharing together in a manner in which all members of a community can live – even if such a goal is reached only after a long series of conflicts and discussions. Potentials for such agonistics are of course always intended (Mouffe, 2013).

Ultimately, discussion regarding commonistic affordance is never final. This article is a non-solution. Commonistic affordance can never be fully articulated as it unfolds along recursive trajectories. Affordances afford affordances in a never-ending *différance* of concrete utopia. Commonistic affordances (of algorithms) are a hopeful signal towards a future short-circuited with our now.

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Notes

[1] Its German original was published in 1991.
[2] This is an idea that we connect more generally to the "invisibility of design," as formulated by Lucius Burckhardt already in the late 1970s (2017).
[3] Environmentality is a useful concept here in that it can describe the wider implications of commonistic affordances, as discussed in more detail below.
[4] A commendable FOSS community is the p5.js community. See https://p5js.org/community/
[5] I will unpack some of these aspects further below.
[6] Historically regarded, it should be remembered that geometry, arithmetics, music, and astronomy, together with rhetorics, logics, and dialectics, where the seven fields of the liberal arts taught at universities in Western Europe since at least five hundred years ago, and that aspects of power and control linked to mathematics gained momentum not until the dawn of statistics as an applied science strongly linked to the rise of statehood and theories of governance in the 18th century. Notably, the term statistics etymologically is rooted in New Latin *statisticum* meaning "of the state."
[7] While framed primarily in epistemological rather than economical terms, 'making affordable' in this case also reminds one that epistemology and economy are always intertwined.
[8] See, for example, Morton, 2012 for a similar idea. I will take up this concept further below again.
[9] https://cvdazzle.com
[10] Named after the mathematician Alfréd Haar.
[11] In the case of the classifier included in the *OpenCV* library, there were 6,000 features. See (Viola & Jones, 2001: I–515)
[12] This image has been released into the public domain by its author, Prmorgan at English Wikipedia. This applies worldwide:
https://en.wikipedia.org/wiki/File:Prm_VJ_fig1_featureTypesWithAlpha.png
[13] See, for example, Chun, 2009, McGlotten, 2016 and Noble, 2018 for the relations between race, technology, data and algorithms.

[14] See, for example, the *Algorithmic Justice League* by Joy Buolamwini, or ORCAA, founded by above mentioned mathematician Cathy O'Neil, which is a consulting company that helps companies and organizations audit their algorithmic risks.
[15] See http://sites.ieee.org/sagroups-7003/files/2017/03/P7003_PAR_Detail.pdf

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