Halting Operations for Algorithmic Alignment

Hanns Holger Rutz
Institute of Electronic Music and Acoustics (IEM),
University of Music and Performing Arts,
Graz, Austria
---
rutz@iem.at

ABSTRACT

Departing from the discourse on whether a specific (social, ethical) responsibility is attached to the creation and manipulation of algorithms, this article questions the prerequisite of having an identity of algorithms to which that responsibility could be attached. After showing that such identity is partly fictional due to the fact that algorithms are connected to other algorithms and their identity is always a selective reading of a series of transitions through which algorithms come into existence, the perspective is shifted to the algorithmic as the medium of algorithms and as the actual agential domain. This shift translates responsibility into the ability to respond to otherness and non-identity through sensitive forms of alignment. Comparing the algorithmic with the desiring-machines of Deleuze and Guattari, this article proposes that its dynamics of flows and interruptions could be artistically reflected as halting operations that controvert the superficial evaluation of algorithms, for example under the classical decision problem or halting problem. A possible strategy for making the inner dynamics perceivable is proposed through a balancing act between the credible and the incredible, the plausible and the implausible.

KEYWORDS

Algorithms, Identity, Alignment, Desiring-Machines.

ARTICLE INFO

Received: 31 October 2017
Accepted: 29 November 2017
Published: 22 December 2017

https://dx.doi.org/10.7559/citarj.v9i3.416

1 | PREAMBLE: TALKING PAST EACH OTHER

This article being a consequence of a presentation at the 2017 xCoAx conference, I would like to begin with a *reaction* I received to that presentation. The original pivot had been the question of the ethics of algorithms: The two extreme positions, as I see them, are on the one hand that algorithms are simply the formulation of a set of instructions to perform a calculation, and consequently there is no such thing as a general responsibility worth to discuss; on the other hand, algorithms embody power structures and control systems, so they are inherently political, and on the way to AI singularity they will be increasingly standing in opposition to our freedom and self-determination. Now, my argument was, and it will be taken up again here, that we should not reduce the possible space of this question to a one-dimensional line with the two mentioned positions at its ends, but rather find something orthogonal by means of rethinking what algorithms actually are—or, if that sounds too ontological, how they operate and effectuate. This in turn drew the ire of Frieder Nake and Philip Galanter for whom the status of algorithms had been unambiguously historically established. Galanter argued that the term “iron” had been used in early historical periods in an imprecise way, but that later a precise definition had been established, and by analogy we should not dissolve the already precisely known term *algorithm* [1]. Nake seemed particularly upset about a new “mysticism” surrounding algorithms, an attitude where people attribute all sorts of irrational powers to algorithms.

I am very much aware of the narrow computer scientific definitions of an algorithm, although one

should add that there is no single uncontested definition (cf. Gurevich, 2012). However, one should acknowledge that algorithms have escaped the sphere of competence of computer scientists and are relevant for artists, philosophers, sociologists, biologists, etc., with each of these domains describing and manipulating aspects that necessarily go beyond a canonical minimalist definition by a computer scientist. These latter definitions are still useful, but not sufficient to address the aesthetic and social impact of algorithms. Perhaps it helps to emphasise that I am not interested in "the" algorithm, but in what I had unwieldily called "algorithmicity". A simpler way would be to say "the algorithmic", that is, the dynamics and agency unfolded by algorithmic practices. An inevitable result of this perspective is, however, that the notion of "the" algorithm becomes relatively useless.

2 | DOES "THE" ALGORITHM HAVE AN IDENTITY?

Under closer inspection, the criticised mystification of algorithms goes hand in hand with a strong sense of algorithms as clearly delineated objects. Their abstract nature is compensated by imagining algorithms to have a stable identity. It may appear in titles, "…in the Age of *the* Algorithm", or in truisms, "*The* computer cannot tell us anything substantial about life…" [2] This is reinforced by the Big Data economy, in which a company's value depends on its ability to convince others that "*their* algorithm" performs exceedingly well, or where "one" algorithm—in a search engine, on a social media platform—is upgraded to "another".

The classical notion of an isolated, fixed set of finite steps that capture the essence of an algorithm seems to persist. As Niklas Wirth wrote: "The power of recursion evidently lies in the possibility of defining an infinite set of objects by a finite statement" (Wirth, 1976, p. 126). If infinity is at the core play of algorithms, it becomes tempting to have the assurance of the identity of the algorithm. There is an opposition between the fixed, the "actual" algorithm and the accidental quality of its products. Nake writes:

> *"Each and every individual piece of algorithmic art is no more than only one instance of the potentially infinitely many from the class of works defined by the algorithm … each of its visual products is a shadow only of the algorithm. It is one of its traces, a left-over, a consolation for those who need to see rather than think. If you want to find the masterpiece, you must compare algorithms."* (Nake, 2010, pp. 56–57)

The platonic metaphor of the shadow implies that the materialisations and renderings of an algorithm are inferior to their ideal origin, only there for those who are incapable of the cognitive work of its discovery. But is this not indeed a form of mystification? What would that cognitive step of the rediscovery of the masterpiece-algorithm be?

Another way to enquire into the identity of algorithms is to ask: "When are two algorithms the same?" This question was addressed by a group of mathematicians and computer scientists (Blass, Dershowitz & Gurevich, 2009). If programs are the implementations/shadows of algorithms, when can one say, given two programs, that these represent the same algorithm? The authors make it clear that the situation is very complicated when we allow all kinds of algorithms, including distributed and interactive ones. And so the attempt to define an equivalence relation between two programs begins with a strong constraint, considering only deterministic, small-step algorithms, formulated as abstract state machines (ASM), while the use of any real-world programming language would make the comparison impossible from the beginning.

The result of this study is that, even under these artificial conditions, several factors remain that prevent an unambiguous decision on the equivalence of two programs. These factors can be summarised as problems of boundary drawing, i.e. deciding which element is inside an algorithm and which is outside:

- Is the algorithm immune to questions of realisability on a particular processor? For example, certain types of operations would have to be replaced by others if they are not available on a processor (Blass, Dershowitz, and Gurevich mention a child that knows how to subtract numbers but not how to divide them). Similarly, are the time and space requirements of an algorithm part of it?

- Is the presentation and formatting of the output of an algorithm part of it or not? If two programs use different formatting, would they still represent the

same algorithm? This becomes crucial as the output is fed into another process.

- Is the type of data processed part of an algorithm or not? For example, does a search algorithm change its identity if the domain and ordering of its data elements changes?

- Problem of symmetry: A more detailed program might be regarded as implementing the same algorithm as a more abstract program, but not vice versa.

- Problem of transitivity: We can construct an evolutionary series of programs, where each successive pair would be considered to implement the same algorithm, but when looking at the overall drift between the first and last in the series, we would not assert equivalence.

In summary, we certainly have an intuitive notion of algorithm, perhaps even inter-subjective if one remains within a specific social group, but when looking more closely, algorithms will always be infected by their actual and prospective implementations, their boundaries—what is accidental and what is crucial—will shift as we change our motivation with which we observe them, and their identity dissolves as we couple them to other algorithms, giving rise to a "new machine" (von Foerster, 1993/2003). The problem of transitivity seems particularly interesting, as it may be connected to the question of what happens to algorithms as they are developed, experimented with, adapted over time. To contrast this again with Nake's writing:

> *"Algorithms are … static descriptions of dynamic processes … When the algorithmic artist designs a work (an algorithm), he writes a static text."* (Nake, 2010, p. 57)

That is not to say that such design may never occur, and it may well describe Nake's own approach to the algorithmic, but I would argue that this is in stark contrast to the reality of most coding practices.

3 | THE RECONFIGURATIVE NATURE OF ALGORITHMS

If the hypothesis is that the algorithmic is in constant flux, and if we factor out the identity of the masterpiece as a superficial effect of the economy of the art system, we may proactively work with this hypothesis. I want to exemplify this with a pair of works, the sound installation *Writing Machine* from 2011 and its reconfiguration as *Wr_t_ng M_ch_n_* in 2017. What is shown is that, even if we begin with the aim of recreating a particular algorithm, we are soon enmeshed with the dynamics of actualisations, and moreover, paradoxically, we need to actively seek realignments with the machinery to preserve the algorithmic quality of a piece.

The first piece, described in more detail in Rutz (2012), was created around Derrida's term "grapheme" as the trace of abstract, trans-linguistic writing. A sound gesture without intentional origin is continually rewritten by replacing parts of it with other sound fragments that appear to be similar to what is being overwritten. As time progresses, the aimless drift in the gesture is perceived, the motion being only guided by the similarity search. This description for the most part still applies to the new piece, the main difference being that now a multitude of gestures coexists.

Figure 1 shows photos of the installations, obviously being very similar visually, but also with apparent dissimilarities: Table (square vs. round) and lighting (subdued in black cube vs. bright in white cube) were

Figure 1 | Left: *Writing Machine*, 2011 at *SONICA*, Ljubljana. Right: *Wr_t_ng M_ch_n_*, 2017 at *Virtualities and Realities*, Riga.

Figure 2 | Left: Code base of Writing Machine. Right: Code base of Wr_t_ng M_ch_n_.

givens rather than controlled decisions, but the meditative framing of the old piece was emphasised with the empty centre of the circular arrangement, the symbolic absence of a centre that at once evokes the centre, whereas in the new piece the computer infrastructure was dumped in the centre of the table, producing a deliberate messiness.

No decision is isolated but part of the texture of reconfiguration (cf. Rutz, 2016), it is part of a particular trajectory that prepares the decision. The main new element was the reimplementation of the composition on a set of small networked computers instead of the central instance that had been used before. I felt at unease with the monistic, centripetal approach, especially after having worked on the project *Schwärmen + Vernetzen* (Castillo, Grossegger & Rutz, 2017), which explored the idea of networking and distribution. Here a tower of small networked computers was first used, and I transferred that element to *Wr_t_ng M_ch_n_*, with six computers running twelve agents, each agent feeding sound to six linked Petri dishes with piezo discs coupled to their lids, and a seventh computer responsible for distributing an FM radio signal (replacing a television feed in the old piece). To show the computers with their individual blinking patterns, the radio antenna, the network cables, the amplifiers and impedance matching coils, instead of hiding them under the table, exposed them to a possible reading by the visitors and counteracted the rigour of the circular arrangement. After installing both pieces, I would not be able to say that one supersedes the other, they are simply similar and different at the same time.

On the software side of *Wr_t_ng M_ch_n_*, I began with the 2011 code base, attempting first to bring all its *library* dependencies up to date. That proved impossible, unless I would recompile old versions of some of the libraries, forcing myself to cling to obsolete *application programming interfaces* (API), an option quickly dismissed when considering the necessary reconfiguration for a networked operation. On the other hand, combing through the old

codebase refreshed my memory of how the algorithms were in fact implemented, so the actualisation became a reading exercise despite its abortion. Eventually, I rewrote all the code from scratch, or almost from scratch, as a few abstractions could be reused without change, and some of the networking protocols were adopted from *Schwärmen + Vernetzen*.

Figure 2 shows a graphical representation of both the old and the new code base side by side. Each square corresponds to a source code file and most of the time one module or class defined in that file. The source code has been parsed into an abstract syntax tree (AST), which is then rendered as a treemap (Bruls, Huizing & Wijk, 2000), using different colours for the types of nodes, which are nested as one descends to the bottom of the tree. For example, class, method and value definitions begin in dark violet, terms are in orange, parameters and types in green, literals in light blue. While this does not allow one to read the source code from a distance, it gives a good overall view of the structure of the code, and one can make out some similarities and differences. The code I wrote in 2011 follows a strict pattern of defining for each module an abstract interface—these are the tiny boxes at the bottom—an abstract implementation of the behaviour minus the basic parameters, and the final implementation that combines the abstract implementation with the parameters. In 2017, as it was much clearer to me how to tackle the implementation, I proceeded faster and reduced the number of interfaces, not distinguishing between abstract and final implementation. As a result, the number of modules decreased from 56 to 37. However, the code base is smaller, and in the new version generally more functionality is put into each module.

The piece follows the idea of *real computation time*, that is to say, calculations are performed detached from the “real-time” of the audible audio synthesis, and they happen asynchronously and just as fast as the computer can compute. In the old version, these asynchronous calculations are often represented as procedures, nested and concatenated through loops and functions, visible in the image as yellow-orange strips, e.g. in the implementation of the sound memory ‘Database’ in the top left box, the sound gesture ’Overwrite’ procedure, the primary algorithm loop in the box left to ‘Break’ in the forth row, or the handling of the ‘Live Signal’. In the new piece, signal processing is done with a unit generator (UGen) based system *FScape* similar to the real-time processing (Rutz & Höldrich, 2017), giving rise to a readily recognisable pattern of no or little nesting but many intermediate variables (dark violet) in the boxes labelled ‘Break’ (determining the point of change within current sound gesture where an overwriting should take place), ‘Match’ (determining the sound from the radio buffer most similar to the portion that is being overwritten) and ‘Ovrwrt’ (performing the sound replacement), here embedded into the primary algorithmic loop as opposed to a standalone module ‘Overwrite’ in the old version.

There is a strange tension or inversion at work, because the largely rewritten code is fundamentally different to the old code, but still tries to reinstate most of the old algorithms. Would that not be a counter-example that shows that there is this identity of algorithms and an equivalence relation between two programs? This is a misunderstanding that ignores the dynamics of the actualisation. Two ways to frame this dynamics are Gilles Deleuze’s *Difference and Repetition* (1968/1994), and Hans-Jörg Rheinberger’s *Differential Reproduction* (1997, ch. 5). Below the symmetrical, empty repetition, the spatial-temporal echo that preserves the identity of a concept, a more fundamental, asymmetrical process is at work, aimed at the upholding of productivity.

For a better understanding, let us imagine that I would have rebuilt the original piece; made the minimal adjustments to the old software to run it again on a computer and sound hardware matching the original specification. Would the outcome be a display of the original piece? I argue that this is not the case for two reasons: The first has to do with the problematic boundary between the apparatus of the artistic production, which includes the set of technical objects, myself, and all relations between these, and the object, the piece produced. Both Rheinberger as also Karen Barad (2007) state that no fixed object-apparatus distinction exists, but that it rather emerges from the practical work of this ensemble. Barad says that this distinction is enacted by an “agential cut”, Rheinberger captures this act of cutting with the term “subduction” which relates to “the interface *between* the agents of knowing and the objects of their desire” (Rheinberger, 2011, p. 337) [3]. The piece, to not be a dead artefact but an actual aesthetic object, is re-enacted by its reinstallation and the renewed investment of energy and “tending” in the

actualisation. Myself-as-a-machine is not the same as it was six years ago, and so for the ensemble-machine not to break, a realignment is required. The de-emphasis of the centre, by giving each sector of the circle its own sound memory, by replacing the single computation process with a distributed one, was such a realignment that made the piece "work" again for me. The act of realignment became very obvious to me during the exhibition opening, when I was explaining and describing the piece to the visitors, which was another crucial actualisation as important as the actualisation of the code. Which elements were central and why, and what were the relationships among them had certainly changed since 2011.

The second reason for the impossibility of recovering the original piece is specific to the medium, algorithmic art. The graphematic process of the continuous rewriting of sonic traces is not just the "content" of the piece, but an ongoing re-entry of the medium into its form. In other words, the piece wants to say something about the algorithmic itself. The claim will be, as outlined in the next section, that the algorithmic is about a radical connectivity and the defiance of the *halting problem*, always producing spatio-temporalities of imperfection or material excess, i.e. non-empty repetitions. Consequently, to quit the agential dance of this excess, to not seek an active alignment with the algorithmic-other-as-machine, would produce the same kind of breakage as the abortion of "self-alignment".

4 | BREAKS AND ALIGNMENTS

How can we conceive the excess of the algorithmic, a genuine productivity that is not pre-programmed as a logical disposition? One possibility is to propose *speculative reasoning* as a source of novelty (Parisi, 2013, §1.5), another is to endow it with the aliveness of *intra-actions* (Barad, 2007, p. 177), where actualisations reconfigure the field of possibilities, always both closing some while creating new ones. A third way would be to interpret the algorithmic in terms of Deleuze and Guattari's *desiring-machines* (Deleuze & Guattari, 1983, ch. 1). These machines are at the core of their construction and in opposition to the *body-without-organs*. The structure becomes tripartite as one moves to the level of operations: the production of production or connective synthesis that determines the desiring-machine, the production of recording or disjunctive synthesis that determines the body-without-organs, and the production of consumption or conjunctive synthesis that determines a *residual subject*. The purpose is not to equate these with the agency of algorithms, but to take them as a useful structure to locate similar properties.

For example, if we think about the duality of the algorithmic/algorithms as the medium/form distinction, viewing production of production as an undifferentiated production/product pair is fitting. If "everything stops dead for a moment" to allow for the hypothetical observation of the unobservable, we would see a pure connectedness in this medium-machine. The nature of this machine is to desire to be coupled to another machine, the coupling enacts at the same time a continuity—the system theorist's operational closure—and the possibility of a break or interruption. These breakpoints could perhaps be seen as the locus of reconfiguration, where a gap or irrelativity can be produced. In these breaks, the "problem" of transitivity is manifested: "Repetition can always be 'represented' as extreme resemblance or perfect equivalence, but the fact that one can pass by degrees from one thing to another does not prevent their being different in kind." (Deleuze, 1968/1994, p. 2). Furthermore, we are warned against trying to understand the algorithmic as a totality, instead desiring-machines produce pure multiplicities, so there is a radical openness that, in my reading, is also an openness for alignments between humans and machines.

Another useful hint is the reference to Claude Lévi-Strauss' *bricoleur*, who is continually involved in the reconfiguration of elements, showing "an indifference toward the act of producing and toward the product" (Deleuze & Guattari, 1983, p. 7). Lévi-Strauss and others have of course compared the image of the bricoleur with the artist or the researcher. The project or produce, the "engineering view", only enters the picture as we transition from the inner to the surficial machine, to the surface of recording or distribution, where production is deliberately inhibited to register and valuate. It is here, where the disputed element of violence is added to algorithms, where the algorithmic becomes infected by power structures.

The strategy of addressing, as artists, this transition would be to make recognisable the two-layered construction, thereby making recognisable the

potentially parasitic, manipulative order of the recording grid. This strategy would involve an alignment with and articulation of the flows and interruptions of the desiring-machine. It would involve prioritising laws of the inside over laws of the surface, for example the notion of motion over the pair of control/communication, the affirmative alignment of human/machine over their opposition (cf. Downey, Dumit & Williams, 1995); it would involve, for example, not to teach machines to humanise their way of listening, but to teach ourselves to machinise our way of listening. One such alignment that I want to outline in the next sections is through halting operations.

5 | HALTING OPERATIONS

In computer theory, the classical halting problem (cf. Chaitin, 1982) is that there is no known general procedure to determine whether the execution of an algorithm comes to a halt. It implies that the desired operation of an algorithm is to ultimately determine a target state. In contrast, we see halts from a crashing machine, or halts caused by the engineer stopping an unwanted operation, as anomalies. When speaking of the halting problem, one must first make clear what type of halt is desired. Similarly, within their abstract machines, Deleuze and Guattari distinguish different types of breaks, related to the tripartite production: A cut of extraction, diversion or sampling (*prélèvement*) [4], a cut of detachment that denotes the transition to the recording surface, and a residual cut to produce a subject. The cut of the halting "problem" would be the detachment, which blocks the further circulation and production. The cut we are interested in is the *prélèvement*, the possibility to create a bend in a flow, to redirect it, to differentially repeat it.

Under the extensive model of Deleuze and Guattari's machines, a human is also a system of flows and breaks, and likewise we could establish a halting problem, perhaps thinking primarily of the residual cuts. The problem then is identity, which does not exist except retroactively by recording the trajectory of states enacted by these cuts. Instead of addressing the engineer's halting problem, we accept that this question is not decidable, experimenting instead with halting operations on the level of *prélèvement*. We may then draw a *tableau* of breaks and interruptions, not as final selections, as actualisations of some virtual, but, for example, as acts of abandonment. I understand abandonment here as a form of establishing transparency and permeability, surrendering elements to their own movements and mutual penetration, their release from a prior syntax. Such abandonment could either be understood as un-selection, the movement to a point where something excluded is allowed into the picture, or as non-selection, the non-compliance with the proposition that there is something to be selected *at all*.

These two types are presented by looking at specific elements of an artistic research project that led up to an exhibition titled *Imperfect Reconstruction*, realised in 2016 as a collaboration between two sound and digital artists and a stage designer (Rutz, 2017).

6 | UN-SELECTION

In this project, the exhibition space was divided by a three-dimensional mesh structure into an inner and an outer space. In the outer space, a 48-channel sound installation is heard, and one can see the mesh as a contiguous projection surface for a set of connected real-time video works. The mesh is interrupted at two points, allowing one to enter the inner space, characterised by a red surface and an installation of eight quadratic screens, four of them mounted horizontally, and four suspended vertically. They show a series of video miniatures, each of which follows a different algorithmic process.

One of these miniatures is the work *Moor* [5], based on recordings made in a nature reserve of moorlands. No special provisions had been made; the footage was collected with a photo camera and without tripod. From a deer stand, one could see all across the moor, and I attempted to make a very slow and steady panoramic movement. It was very cold, and I could not hold my hand still at all times. Every time I noticed my hand was making too abrupt a movement, I stopped and repeated from a previous position. I anticipated an eventual selection process; I had the vague idea of being able to cut the selected material into one continuous and smooth shot. Everyone who makes sound, video or photographic recordings has this instinct of gathering a surplus, as subsequent software processes are based on operations of selection.

The algorithm applied to this footage entered through a detour. A month before, I had taken down a show that included a text in white vinyl lettering attached to a wall. Soon I realised that the removal of the letters was tedious and would take a long time, and it would

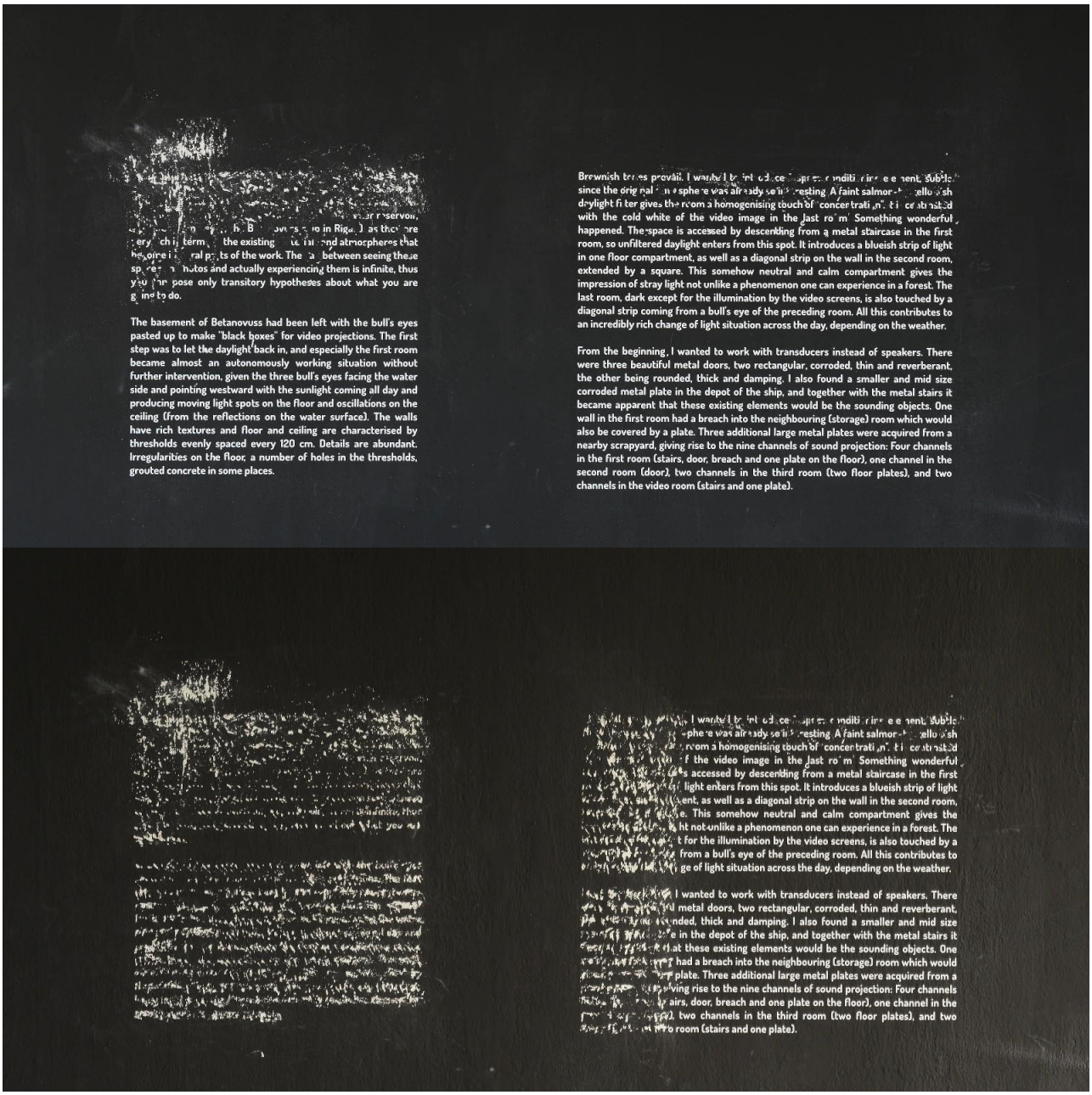

Figure 3 | 1st (top) and 35th (bottom) photograph in the vinyl text removal action.

leave the wall, which had been only superficially painted, with white scratches from the underlying colour layer. I interrupted the process, installed a photo camera, and began taking photographs for each successive row—later column—of text removed, turning the wall into an abstract text (Figure 3). The plan was to create an animated series of the photographs.

Looking at the figure, one can see that a change in lighting occurred, but another problem was more severe: The camera moved slightly between pictures, and for such undertaking the pictures would have to be perfectly aligned. I began writing a software for realignment, first by allowing the manual scaling and translation, visually monitoring the result through XOR difference images of the pairwise photos. It was not possible to achieve complete matches. I added a rotational parameter, then a perspective transform, but an automatic brute force search to find the best parameters did not converge in reasonable time, and so I consulted literature on the subject. A group of researchers that were assessing the damage of hurricanes by comparing satellite images were looking for an algorithm to automatically align images that were generally taken from different angles (Thomas, Kareem & Bowyer, 2012). They came up with a multi-stage process, and I started implementing the first stage, the *coarse registration*. The idea is to calculate a phase diagram and

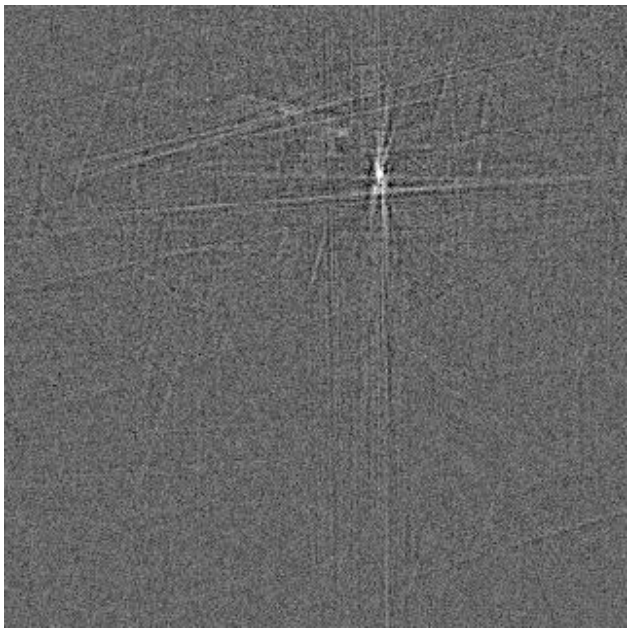

Figure 4 | Phase correlation diagram. White is positive, black is negative correlation.

determine the coordinate with the highest pixel value as indicator of the sought translation transform. The proposed algorithm would also use a brute force trial of rotation angles, a step that I did not implement, as rotation seemed irrelevant in my case. With strongly related images, the phase correlation diagram would give one sharp bright spot of only a few pixels extent. Figure 4 shows such a diagram, with contrast enhanced to show the background structure more clearly that represents all the changes occurring between the two images. The white peak is off-centre towards the top-right, indicating that the camera performed a pan towards the bottom-left between the first and the second picture.

Once these phase diagrams were correctly produced, I un-selected all the sophisticated next steps proposed in the paper, and instead extended the procedure to videos, applying the process pairwise and integrating the translations. I returned to the *Moor* piece. The footage being a pan, integrating the translations results in the image completely leaving the frame to the left in the beginning and to the right in the end of the sequence, so a linear counter motion was added as a measure to keep the image within bounds while still stabilising the motion. I rendered the background black on top of which the translated frames were placed, and something very interesting happened: As the average speed of rotating the camera by hand was not constant, the pan is sometimes “ahead of time”, sometimes lagging behind. As a result, a new dramaturgy or filmic element is added by a changing vignette. While it is

Figure 5 | Still from Moor (top) and assemblage of key frames (bottom) showing the relative translations.

easy to anticipate that this would happen from simply analysing the consequences of the algorithm, the actual effect—the way it unfolds and interacts with the image, the way it shows a particular rhythm—can only be experienced when seeing the resulting video (Figure 5).

Another particular interaction between the material, the context, and the algorithm occurred, and it was precisely articulated by the action of un-selecting the subsequent steps of its implementation, un-selecting the full perspective alignment: During the actions of readjusting my arm, the camera was impinged and it produced, for a brief moment, a blurred image and slight rotations around its own axis. The algorithm “works” and “breaks down” at the same time. It stabilises the translation at the same time as it maintains the perspective distortion which it does not address. The resulting phenomenon transposes the viewed scenery from a credible “immersed” mode of perception—credible in terms of the spatiality of the landscape—into a “mediated” mode of perception, where the landscape becomes almost like a postcard that is being torn apart, or like something separated

Figure 6 | Single photo and differential integration of 269 frames.

from the viewer by a lens apparatus which is now revealing its intermediate existence [6].

The intervention of un-selection, suspending a program at an appropriate moment, is thus producing a crucial bend in the original flow, it is an affirmative action and not simply to be thought negatively as a lack of completing an original algorithm. It is a refusal of the completeness criterion of selection.

7 | NON-SELECTION

Another piece of the series has the working title *Site*. It relates to long-term exposure. In this type of exposure, things that happen disparately across time are assembled in a single tableau. For me, it was a metaphor of exposing process, to include all the traces of the processes that can only be understood as ongoing, durational, iterative things into which we "tap" when we frame a project.

Between the beginning of *Imperfect Reconstruction* and its exhibition, I was involved in a different collaborative project, in which one of the fellow artists used an actual long-term exposure process through analogue pinhole cameras. As a partial response to this, I started experimenting with a digital camera module that I placed in various places, taking interval photographs and integrating them with an algorithm in a manner somewhat opposed to the analogue integration: Instead of averaging the images over time, I applied a sliding time window median filter that selected or amplified only those pixels that constituted changes in the camera's view. This process produced very curious images that reflected the changes happening over time, changes that are often not obvious to the eye, such as the movement of light, clouds, reflections… (Figure 6).

In *Site*, I was interested in understanding how this process could be translated to moving image or video. I began experimenting with ways of duplicating the sliding window filter as a means to walk through time. The photos being taken every five or so seconds, one starts with a time-lapse video that is quite rapid. I finally applied an audio resampling algorithm, using a band-limited sinc filter, based on time series of each pixel position, slowing down the time-lapse, until it reached a point of sufficient calmness.

The particular noisiness and somehow inversion of contrast due to the amplification of differences met another peculiar behaviour: As people walk by the camera's field of view, individual snapshots capture the passers-by, while the preceding and successive photos do not show them. There is a reason sinc interpolation [7] is not used in video editing software. It is a resource hungry algorithm, as theoretically the filter kernel is infinite, making it so that every point in time contributes to the interpolated value at any instant. The sinc function also brings out the Gibbs effect (Figure 7), an over- and undershooting when the input signal sharply changes, as the samples left

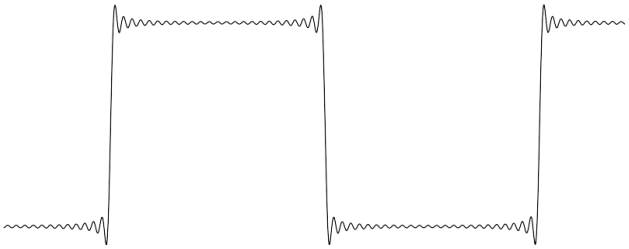

Figure 7 | Gibbs phenomenon, showing over- and undershoot, as abrupt changes undergo a sinc interpolation.

Figure 8 | Example key frames from *Site*, showing the Gibbs oscillation as a person enters the picture, with second and forth image undershooting to dark, third and fifth overshooting to bright.

and right of the slope are alternately weighted with positive and negative coefficients. This phenomenon produced a strange darkness-brightness oscillation of the passers-by just before their appearance and just after their disappearance. One gets the impression of contours being "raised" or "falling" cardboard cut-outs. This combines with a particular illuminated green-yellow colour stemming from an unevenness in the camera's RGB gain stages, resembling phosphor (Figure 8) [8].

It would have been easy to swap the resampling algorithm for another one "more suitable" to video processing, as it would have been easy to adjust the RGB gains or apply a post-production correction. Although none of these elements were planned or prior conceptualised, they gave rise to the particular quality that would be otherwise lost. I simply let go, I let the process run the way "it" came to run, as an act of my own non-selection.

The intervention of non-selection, sustaining an "inappropriate" outcome of a program, is thus crucially tapping into the original flow before it would normally be corrected, it is again an affirmative action and not a lack of allegiance to an original algorithm. It is a refusal of the imperative criterion of selection.

8 | GIVING SUPPORT, SEEKING SUPPORT

How do these operations translate to the critical perception of the audience? What is needed to make our alignments recognisable? First of all, it is important to note that alignment with the algorithmic and the otherness of the algorithmic are not in contradiction. If I say becoming-machine, it does not mean that we cease to be human, but that we understand that the engineering perspective on algorithms is a surface effect, and that humans and algorithms are not separate ex ante. Returning to the question of responsibility, the "ability to respond to the other", the "ethical subject is not the disembodied rational subject of traditional ethics but rather an embodied sensibility, which responds to its proximal relationship to the other through a mode of wonderment that is antecedent to consciousness." (Barad, 2007, pp. 391–392). Then to repeat that relation, extending it to the audience means to attempt to instil that same mode. Halting points not only indicate the diversion and repetition of flows, but also moments of rest, a fourth type of cut that suspends and defers. The German word *halten* is not just to stop, but *Halt* also signifies support (to hold). Enacting halting operations could thus also mean to give support (*Halt geben*), and it expects a counterpart that seeks support (*Halt suchen*).

What this support must achieve is to intervene and go between the body-without-organs, the "appropriating" and "arrogating" forces (Deleuze & Guattari, 1983, p. 10) that try to presuppose their authority on the algorithmic, e.g. the Big Data economy or the commodification of algorithmic ubiquity, and the audience. For instance, if one locates the point where the credible becomes incredible, seemingly small interventions can strongly intensify the sense of the own temporality and dynamics of the algorithmic, a sense of reciprocally relating. An example of the transition from credible to incredible was given in

Moor, where an immersive (maybe Deleuze and Guattari's "miraculate"?) perception is suddenly interrupted by the mediated spatiality of the algorithmic process itself. Sound installation pioneer Max Neuhaus used the term 'plausible' which seems very close to 'credible', and he works specifically with the moment where the plausible breaks down:

> *"I often make a sound which is almost plausible within its context when you first encounter it. The point where a person realizes that it is not plausible is when he jumps into the piece; he's swimming on his own from then on."* (Neuhaus, 1993/94, p. 98)

The plausible, the probable enters the disjunctive synthesis as a way to deal with complexity, the engineer's way of rationalising what has already become miraculous. The persuasiveness of the plausible, oscillating between the absurd and the evident, is that its assumption, at least in everyday context, requires no specific competency—"it sounds plausible" (cf. Böhnert & Reszke, 2015). Our embodied sensibility, the balancing act, can be a critical tool, where a culture is increasingly undermined by the corruption of the plausible in the form of "filter bubbles" and "fake news".

ACKNOWLEDGEMENTS

This work was conducted within the project Algorithms that Matter, funded by the Austrian Science Fund (FWF AR 403-GBL). I would like to thank Ron Kuivila who initiated a discussion on the criterion of plausibility and implausibility.

ENDNOTES

[1] Ironically, Galanter was later accused of an imprecise use of the term fractal that was a mathematical abstraction and thus could not, as he claimed, be found as such in nature.

[2] A Google search for the former phrase yields a vast number of results, ranging from "leadership development", "music", "life", and "democracy", through to "fairness and transparency", "the quantified self", and "advertising and media", to name but a few, all placed "in the age of the algorithm". The latter paraphrase was voiced during a discussion round of the *Schwärmen + Vernetzen* exhibition.

[3] This is framed in terms of epistemology, which however is not seen as separate from the material world, and Barad uses the condensation of "ontoepistemology". I would also include "aesthetic knowledge/experience" here.

[4] *Prélèvement* seems much better translated in German as *Entnahme*, such as taking a (blood) sample, temporarily diverting a flow, than the English translations of *slicing off* or *portioning*.

[5] The titles are convenient work titles as the series has never been taken apart into "individuals".

[6] The following link leads to a page containing a short video excerpt in which the phenomenon can be witnessed: https://www.researchcatalogue.net/view/245942/249036 (accessed 29-Oct-2017).

[7] The sinus cardinalis or sinc function is (sin x)/x, producing a decaying oscillation around the zero point.

[8] The following link leads to a page containing a short video excerpt in which the phenomenon can be witnessed: https://www.researchcatalogue.net/view/245942/314773 (accessed 29-Oct-2017).

REFERENCES

Barad, K. (2007). Meeting the universe halfway: Quantum physics and the entanglement of matter and meaning. Durham & London: Duke University Press.

Blass, A., Dershowitz, N. & Gurevich, Y. (2009). When are two algorithms the same? Bulletin of Symbolic Logic, 15(2), 145–168. doi:10.2178/bsl/1243948484

Böhnert, M. & Reszke, P. (2015). Linguistisch-philosophische Untersuchungen zu Plausibilität: Über kommunikative Grundmuster bei der Entstehung von wissenschaftlichen Tatsachen. In J. Engelschalt & A. Maibaum (Eds.), Auf der Suche nach den Tatsachen: Proceedings der 1. Tagung des Nachwuchsnetzwerks INSIST (pp. 40–67). Berlin.

Bruls, M., Huizing, K. & van Wijk, J. J. (2000). Squarified Treemaps. In Data Visualization 2000. Proceedings of the Joint EUROGRAPHICS and IEEE

TCVG Symposium on Visualization (pp. 33–42). doi:10.1007/978-3-7091-6783-0_4

Castillo, N., Grossegger, G. & Rutz, H. H. (2017). schwärmen + vernetzen. Transdisziplinäres Kunstprojekt. Lichtungen. Zeitschrift für Literatur, Kunst und Zeitkritik, 38(151), 155–170.

Chaitin, G. J. (1982). Gödel's theorem and information. International Journal of Theoretical Physics, 21(12), 941–954. doi:10.1007/BF02084159

Deleuze, G. (1994). Difference and Repetition (P. Patton, Trans.). New York: Columbia University Press. (Original work published 1968)

Deleuze, G. & Guattari, F. (1983). Anti-Oedipus: Capitalism and schizophrenia (R. Hurley, M. Seem & H. R. Lane, Trans.). Minneapolis: University of Minnesota Press.

Downey, G. L., Dumit, J. & Williams, S. (1995). Cyborg anthropology. Cultural Anthropology, 10(2), 264–269. doi:10.1525/can.1995.10.2.02a00060

Gurevich, Y. (2012). What is an algorithm? In International conference on current trends in theory and practice of computer science (pp. 31–42). doi:10.1007/978-3-642-27660-6_3

Nake, F. (2010). Paragraphs on computer art, past and present. In Proceedings of CAT 2010 London Conference (pp. 55–63). London.

Neuhaus, M. (1994). Notes on place and moment. In Inscription. sound works volume 1 (pp. 97–101). Ostfildern: Cantz Verlag. (Original work published 1993)

Parisi, L. (2013). Contagious architecture: Computation, aesthetics, and space. Cambridge, MA: MIT Press.

Rheinberger, H.-J. (1997). Toward a History of Epistemic Things: Synthesizing Proteins in the Test Tube. Palo Alto: Stanford University Press.

Rheinberger, H.-J. (2011). Infra-experimentality: From traces to data, from data to patterning facts. History of Science, 49(3), 337–348. doi:10.1177/007327531104900306

Rutz, H. H. (2012). Sound Similarity as Interface between Human and Machine in Electroacoustic Composition. In Proceedings of the 38th international computer music conference (pp. 212–219). Ljubljana. Retrieved from http://hdl.handle.net/2027/spo.bbp2372.2012.039

Rutz, H. H. (2016). Agency and algorithms. Journal of Science and Technology of the Arts (CITAR), 8(1), 73–83. doi:10.7559/citarj.v8i1.223

Rutz, H. H. (Ed.). (2017). Imperfect Reconstruction. An algorithmic project by Lisa Horvath, David Pirrò, Hanns Holger Rutz. Graz: esc media art laboratory.

Rutz, H. H. & Höldrich, R. (2017). A Sonification Interface Unifying Real-Time and Offline Processing. In Proceedings of the 14th Sound and Music Computing Conference (SMC) (pp. 50–57). Espoo.

Thomas, J., Kareem, A. & Bowyer, K. (2012). Fast robust perspective transform estimation for automatic image registration in disaster response applications. In 2012 IEEE International Geoscience and Remote Sensing Symposium (IGARSS) (pp. 2190–2193). doi:10.1109/IGARSS.2012.6351066

von Foerster, H. (2003). For Niklas Luhmann: How Recursive is Communication? (R. Howe, Trans.). In, Understanding Understanding: Essays on Cybernetics and Cognition (pp. 305–323). New York: Springer. (Original work published 1993)

Wirth, N. (1976). Algorithms + data structures = programs. Englewood Cliffs, NJ: Prentice-Hall.

BIOGRAPHICAL INFORMATION

Hanns Holger Rutz (*1977 in Germany) is a sound artist, composer, performer, researcher and software developer in electronic art. He studied computer music and audio engineering at the Electronic Studio of the TU Berlin, and from 2004–2009 worked at the Studio for electroacoustic Music (SeaM) Weimar. In 2014, he completed a PhD at the Interdisciplinary Centre for Computer Music Research (ICCMR) in Plymouth (UK). His artistic work, mainly comprised of sound and intermedia installation, live improvisation and electroacoustic composition, has been internationally exhibited, performed and awarded. In

his works, the development and research on software and algorithms plays an important role. The central theme in the recent works is the materiality of writing processes. He lives and works in Graz, Austria, where he currently leads the artistic research project *Algorithms that Matter* at the Institute of Electronic Music and Acoustics.