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MACHINE LEARNING AND TECHNOECOLOGICAL CONDITIONS OF SENSING

Abstract

In what way can machine learning be understood as a computational mode of sensing? How does the practice of making sense take place in the context of developing machine learning applications? What assumptions and conflicts are constitutive for that very process of sensing? Bringing case studies from machine learning into conversation with theoretical work primarily by Erich Hörl, Luciana Parisi, Wendy Hui Kyong Chun and Karen Barad, this article reflects on the re-configuration of sense in the course of the expansion of media-technology. It questions how computational expressions become relatable as well as the mechanisms for encapsulating the capacity of sensing for determining purposes.

APRJA Volume 8, Issue 1, 2019
ISSN 2245-7755

Introduction

The expansion of media-technology leads to an extension of the remediation of artifacts and signs. It proliferates the evolvement of machinic programs into relatable environments for sensing. Furthermore, it takes part in a re-configuration of sense and the conceptions of how meaningfulness is constituted. As argued by German philosopher Eric Hörl, under a media-technological condition of sensing, a "technoecological" form of sense-making is disclosed. This emphasizes the operative dimension rather than the representative function of signs as information. Sensing, here, on the one side highlights the interlacing between sensory, cognitive and affective fields within sentience and its significance for intelligibility. On the other side, the term sensing stands for a primarily relational capacity through which boundaries between sense-making entities are enacted. At the same time, media-technological devices become commodified tools for exploiting sensing by encapsulating the capacity of meaningful articulations into a calculated determination of sense (cf. Hörl). Thus, media-technology enables a governing of reality by instrumentalizing sensing for determining purposes.

By taking into consideration a case study of machine learning, this article regards the materialization of information via machine learning as a process of sensing. It focuses thereby on the premises of connectivity and the program's ability to 'generalize' Generalization describes an algorithmic processing, which relies on the abstraction of information by gaining structuring models from data. It points to a transformation of the concept of computation and the epistemology it engenders (cf. Parisi). Further, the article discusses this computational mode of sensing in regards to different concepts of performativity (cf. Chun, Barad). From the perspective of performativity, the critique against an instrumentalization of computational sensing for governing reality cannot be exclusively addressed in regards to its partaking in the determination of sense. Rather, it asks for taking into account the measurements for evaluating and shaping the process of determination. This implies to direct one's attention towards the apparatuses and its infrastructure that sustains algorithmic sensing, towards questioning how one relates to the expressed sense as well as the accountability of computational sensing.

Sensing

Sensing is feeling and thinking. It is an experience that constitutes surfaces of entities and at the same makes time their boundaries questionable and negotiable. It is a capacity which cannot be isolated. Relations are its very substance. Take for example the very trivial but existential experience of sensing hunger. When I feel hungry, I know that I have to eat. If the hunger just emerges, I might be able to wait for a while. If the sense of hunger is more intense, I might become dizzy, unfocused, moody, not able to hold on to a clear thought. If I wait for too long and let the hunger expand, the first bites might cause sickness rather than delightful relief, even though it is a well-known feeling of swallowing more or less pulpy food. Sometimes I know that I need to eat something, but I am too nervous to feel hungry. Fortunately, I am in a privileged situation, where I have access to resources and it is my decision how I deal with hunger, I can choose when, what and how to eat, I do not suffer from hunger.

Why do I elaborate on the sensation of hunger here? It seems to be a good example for how feeling and thinking, knowledge and perception, cognition and affect intertwine in complex ways; for how the same sense may undergo very different nuances and states; for how this sense is generated by multiple entities on different conglomerating scales; for how organism and its environment are interdependent and make sense of each other; for how an 'automatic' metabolism is a part of me and can as well become a conflict for my 'self'; for how due to reflective or intuitive knowledge I can act upon and modify it, but never fully control it; and for how the word 'hunger' subsumes a wide range of different, singular intensities. Nonetheless, terming this phenomenon with one word enhances a relatability and provides further means for sharing or differentiating an experience. In other words, it is a way to illustrate the inseparability between knowledge and aesthetics, or intelligibility and sensibility that comes into play when I refer to 'sensing'.

Sensing emphasizes a material-semiotic (cf. Haraway 11) understanding of inhabiting the world. Instead of being conditioned by a teleological meaning or a transcendent subject, sensing is determined by the relations of its materialization. This does not imply that meaning becomes obsolete, rather significance is an indispensable aspect of becoming. Everything that is, has to be *meaningful.* Also, the mode of being is decisive for *what* it is, with the consequence that "there is no single world in which all living beings are situated […], there are series of 'worlds-for'" (Thrift 465)[1] that interrelate with each other. To understand sense this way, first, accounts for a non-representative, affective, pre-cognitive or "nonconscious" (Hayles)[2] knowledge that is inherently active within material ontogenesis. Second, the diverse cultural operations for making-sense of the world are at the same time methods for worlding. Artefacts — e.g., ranging from oral narrations, reports, measurements, to audio-visual recordings or drawings, modellings, simulations etc. — may not only bring distinct phenomena into the realm of attention, making them detectable for perception and cognitively knowledgeable, they are also tools for intervening in the process of worlding. The procedures of sense-making are not just means to establish truths about reality or storages for representations of the world, but are rather partaking in processes of individuation. They are interfering in ontogenesis by affecting "spacetimematter's" (Barad) intelligibility and sensibility. This is a crucial, as this approach stresses the power of artefacts engendered by sense-making practices as well as the limits of sensing: reality can neither be fully grasped, understood, perceived in its distinct parts nor as a whole. Though this is not because the means of sensing would have to be improved, made more adequate or sufficient, but because reality will have been already re-shaped by its means of sensing. Thus, reality will have become a different one, once sensing has transformed it. Moreover, from this point of view, sensing's capacity remains particular no matter how ex- or intensive it might become. Borrowing from Karan Barad, sensing can be compared to the practice of agential cuts.

> *[A]gential cuts are at once ontic and semantic. It is only through specific agential intra-actions that the boundaries and properties of "components" of phenomena become determinate and that particular articulations become meaningful. In the absence of specific agential intra-actions, these ontic-semantic boundaries are indeterminate. In short, the apparatus specifies an agential cut that enacts a resolution (within the phenomenon) of the semantic, as well as ontic, indeterminacy. (ibid. 148)*

For Barad distinct entities are primarily conditioned by an "ontic and semantic indeterminacy" so that they cannot be taken for granted but are temporal materializations within a phenomenon. She argues against the assumption that knowledge is produced by an interaction of essentially separable unities and suggests instead that distinctions are the result of "intra-actions" within material agency (cf. ibid. 132-185). So, agential cuts are the generative effect of intra-action processes that transform an onto-epistemological indeterminacy into a temporarily determinate separability. Here, indeterminacy is equated to an immediacy which refuses any direct access. Any form of determination is understood as a process of mediation, constituting itself through in- and exclusion of possible onto-semantic materializations, whereby exclusions are the constitutive matter of indeterminacy's potential (cf. ibid. 179). Though it seems that from this point of view, disentanglement is an absolute impossibility and is transferred into the realms of the unthinkable, it also draws attention to the aspect that detachment inherently partakes in any act of sensing.

Ecologizing

Following Erich Hörl, this understanding of sensing can be described as an "ecologization of thinking" (Hörl 1), feeling and perceiving — a "shift from signifying to technoecological sense." (ibid. 4). Due to the implementation of media-technological devices on one side and the expansion of the concept of ecology which underwent a denaturalization on the other, Hörl states a reconfiguration of the "culture of sense" (ibid.) towards a fundamental relational conception. Within the realms of a technological condition, relations rather than essentially stable and self-contained meaningful relata are the only decisive criteria for rationality, with the effect that "signs are no longer seen primarily as representative but as operative entities" (ibid. 19). A technoecological culture of sense thus stresses that prior to being representations, signs are operators that directly act upon the relations they express.

Additionally, as elaborated by Luciana Parisi, this conceptual shift is accompanied and influenced by the transformation of technological apparatuses as such. According to Parisi, multi-sensorial, algorithmic, automated and networked devices for data processing can no longer be understood as means for communication or tools for transmission, but have to be addressed as machines for prehension[4] that "expose a *nonsensuous* mode of feeling irreducible to the split between the mental and the physical, the rational and the sensible" (*Parisi Technoecologies of Sensation* 182). Besides bringing forward an entanglement between thinking and feeling, concretization and abstraction, technoecological conditions of sensing and sense-making disclose processes immanent to worlding that pass above and below cognitive and sensory perception, thus inherently expanding the realms of sentience and fundamentally modifying its configuration. "Because media no longer mediate (at least not primarily) our senses; rather, they mediate — insofar as 'mediate' is at all still the right term — sentience itself, and they do so in the overwhelming majority of cases *before any occupation 'we' can have through and at the level of our sensory organs."* (Hansen 373)[3] This makes automatized and commodified modes of sensing in forms of mediatechnological devices important instruments for an environmentally acting power that "[operates no longer] through perfectly integrated circuits of communication, but through a new interlocking of distinct milieus of information sensing." (Parisi, *Technoecologies of Sensation* 182)

Though the ecological conception of sensing came into matter in the course of an ubiquitously present mediatechnology, and therefore through the infiltration of computation into processes of sense-making, Hörl states that the mathematical way of relating fosters an epistemology and politics that fundamentally opposes the epistemology and politics of relational sensing.

> *It [mathematics] only knows of extensive vectored relations between pre-given terms, terms that always precede the relation, terms that are, but do not become. The "dominance of the mathematical" reterritorialized relations whereas the counter-knowledge of recent anthropological work in particular deterritorializes relations and drives the elaboration of a real relation ecologism. (Hörl 8)*

Hence, for Hörl mathematical procedures are operations that genuinely seal capacities because they pre-determine relations. He argues that

> *"For today, we find ourselves at a very specific point in the history of relationality that brings out the question and the problem of relationality much more radically than ever before: relational technologies and an algorithmic governmentality reduce, regulate, control, even capitalize relations to an enormous extent, and precisely in so doing, become essential to the form of power of Environmentality. […] There is, in other words, a neoliberal-capitalist destruction of the relation [Bezug], a reduction of relations to calculable, rationalizable, exploitable ratios, in the form forcefully wielded by the mathematics of power." (Hörl 8)*

From this point of view, algorithmically, automatized sense-makers in the form of computational media-technology are promoting a rational epistemology, because the methods of calculation are based on pre-determining axioms. Driven by desires induced by cybernetics and capitalism, algorithmic automatization of sensing processes enable new ways of governing reality. Hörl marks a difference between a technoecological culture of sense and a computational sensing carried out by commodified media-technology. In the following section, I want to examine this opposition by roughly exploring the processes of sense-making in a case study of machine learning.

Learning

Though machine learning programs are based on neuro-scientific hypotheses which are implemented into an architecture of algorithmic networks, they have become more than just models for the cognition of living beings. They have become the attempt to transform computation into a field of sentience, to integrate it into the capacity of thinking-feeling, establishing an artificially built, partly automatized, yet not autonomous mode of sensing.

Artificial neural networks are only one of the possible architectures to maintain computational operations that are subsumed under the term machine learning.[5] They are basically up to several millions simultaneously interconnected algorithmic units. Active in different locations, they are used to detect regularities of data. So, they are tools to organize material by extracting information from data without necessarily having a pre-given evaluation system coded to determine what is supposed to be meaningful information. In other words, these programs are supposed to develop ‘their own’ semantics by processing data. The algorithmic units within artificial neural networks are themselves organized by principals of correlation, recursion and repetition[6]: in a mise en abyme like structure, algorithmic units are layered one after the other in such a way that the output of processed data automatically becomes the input for the next one. It is only a question of hardware resources and programmer’s choice how many layers are integrated within one network. The more layers are sequenced, the ‘deeper’ the machine learns. In the case of programs for detecting features from digital images originating from different contexts, the algorithms gain their sensibility for formal similarities and differences between the images by applying probability calculation on the pixel’s appearances.[7] The resulting numeric value is equated with a state of activity or inactivity of the affected cyberneuron towards the processed image.[8] So, when a cyberneuron reacts actively towards images, it is regarded as an expression for the detection of a similar feature or pattern between them and when it reacts inactively, it indicates that the images do not have any meaningful correlations.

In 2018, Google’s company DeepMind published the paper O*n the Importance of Single Directions for Generalization* (cf. Morcos). Generalization stands for a “structure-finding network” (Morcos 3), which means that the network is capable to learn a model that structures the processed data. Networks capable to generalize well are more likely to predict regularities for inputs which have not been part of the training set. Hence, their numeric value signals references according to a structuring model.[9] Contrarily, for memorizing networks matching is the measurement for learning as they detect features by recognizing patterns in a one-to-one ratio, i.e. they are able to signal, if data repeats. The researchers test the relation between single directions and a networks ability to generalize. Single direction refers to the phenomenon of ‘selective’ cyberneurons which caught a lot of attention in a previous experiment: the activity of several cyberneurons is said to express a selectivity that matches with semantic concepts of what the data is supposed to show. For example, there are cyberneurons which with a high probability detect cat faces, others human faces or human silhouettes, while they are being inactive towards other kinds of depictions (cf. Le). Starting from the observation of those “easy to interpret neurons” (Morcos and Barrett), the researches investigate the role of the other “confusing” (ibid.) ones, which so far make up the majority of an algorithmic network, for generalization. For example, in the case of the ‘confusing’ cyberneuron, it is equally active towards an image of a giraffe, a house and a hamburger and equally inactive towards an image of a dog, a plane and a cat (ibid.).[10] While the in/activity of some cyber-neurons seem to indicate that they are sensible towards data in a meaningful way, the majority of the cyber-neurons make connections between images in a way that is rather puzzling, because their responses to the datasets seem to remain random — the algorithmically conglomerated patterns of information do not make any semantic sense to the human mind. What kind of patterns or features do those images have in common? Is there a ‘hidden’ sense, a pattern, a relation which cannot be perceived by sensory organs, cannot be conceptualized by cognitive thinking? How to address this lack of comprehension or miscommunication?

By deleting diverse constellations of ‘selective’ as well as ‘confusing’ cyberneurons, the researchers tested their influence on the overall performance of the network to generalize (cf. Morcos and Barrett) and concluded the following: First, the 'confusing' or seemingly indecisive cyberneurons are not less important than the 'selective' ones. Second, the cyberneurons that have an 'easy to interpret' selectivity towards previously unknown data (i.e. images that were not part of the data training set) are "more resilient" to deletion than networks that are only 'selective' towards already calculated data (cf. Morcos and Barrett). Thus, the capacity to detect features is not exclusively dependent on the seemingly high degree of selectivity to be found in isolated algorithmic units. The 'confusing' cyberneurons are not malfunctioning. Rather the experiments' results hint towards their significance for the capability of the network to abstract structures or models in data. Thus, it seems that this perceived randomization of data indicated by the 'confusing' cyberneurons is a concomitant of the network's ability to generalize. The researchers asssume "that highly class selective units may actually be *harmful* to network performance" (Morcos 10).

Though the study doesn't resolve the reasons for the observed causality between the 'confusingly' acting cyberneurons and a functioning generalization of machine learning applications, it does make an argument for the acknowledgment of being connected and making connections as a profound principle of acting intelligently. The act of connecting seems to be decisive on many levels: it is crucial for the design of the experimental arrangements as well as the scope within algorithmic processing. The numeric response is regarded as a way of the network to connect with the data and it is simultaneously a way for the researches to connect to the network, namely for assessing what and how the network has learned. Hence, being connected and making connections here coincidences with the generative quality of making sense, disregard whether the numeric response appears to be meaningful in a comprehendible or 'confusing' manner. In this specific case, where the artificial network's capacity to generalize is tested, the practice of collating and abstracting information is inscribed axiomatically into the interconnected structure of probabilistic processing.

The conditioning of the computational mode of sensing via machine learning, which seeks to install an algorithmic capability to generalize, seems to attest to the epistemological shift stated by Parisi:

> *The training of algorithms becomes more similar to an articulation of procedures by means of which algorithms not only learn to think, but above all learn how to gain meaning from the conceptual infrastructure associated with the granularity of data. Learning here coincides with the knowledge of how hypotheses are generated, whose indeterminacy in regards to its results expands the possibilities to extend the search for and from meaningful information." (Parisi,* Das Lernen lernen oder die algorithmische Entdeckung von Information *103)[11]*

Here, what appears to be knowledgeable is not given. The functioning of reasoning is not defined as a reproduction of symbolic information that has been already predetermined to be meaningful. In other words, significance is defined by a speculative process of abstracting similarities out of relational differences that can be found in data. Thus, this marks a transition where the design of machine learning applications is not concerned with what to learn, but "learning how to learn" (Parisi, *Reprogramming Decisionism* 4). Parisi outlines that "[c] ybernetic instrumentality replaces truth as knowledge with the means of knowing, and announces a metaphysical dimension of machine knowledge originating from within its automated functions of learning and prediction." (ibid.) The fact that that DeepMind's researchers favor networks which learn by generalization rather than memorization confirms this epistemological shift. Here, learning as a practice is not about reproducing already known information, but about generating connections as the basis for producing new information. In the face of computational devices that proliferated into archives "saving us from the past, from repetition through repetition" (Chun, *Programmed Visions* 157), educational skills such as learning by heart become less relevant. So, while computers seem to have relieved humans from the burden to train their mind to become a storage for stable knowledge, the computational design works on transforming the computer into a machine that is simultaneously an archive and its registrar.

The case study described above shows that integrating the means of learning how to learn into computational processing is accompanied by the introduction of a technoecological culture of sense into the realms of computation. The cyberneuron's in/activity towards the data is determined in a specific way: Though the regularities to be detected are not pre-inscribed into the program, the very conception of the architecture of the algorithmic network is based on the assumption that to learn means to make connections. Each cyberneuron's in/activity becomes a new speculative information that arises out of the process of connecting what appears to be contingent. Instead of having a pre-given schema that determines the cyberneurons' in/activity, it is this very in/activity that becomes the schema for sensing in a connective infrastructure. Irrespectively of whether the in/activity appears to be 'easy to interpret' or 'confusing', it becomes a mean for operating with and through the data—a mean for un/detecting regularities, for building taxonomies, for organizing and structuring by modeling and thus providing new information.

Yet, at the same time the case study also shows that there are conflicting measures coming into play regarding the evaluation of the cyberneurons' in/activity. The computed numeric values are unavoidably exposed to the comparison with already established taxonomies which function as means to evaluate the 'rightfulness' of the calculated meaning. This is why some of them are regarded to be 'confusing' and others to be 'easy to interpret'. Hence, though the computational processing might exceed a representational culture of sense, it is implemented by the researchers' ascriptions, i.e. their understanding of what a meaningful detection is, serves as an evaluation of the networks' capacity to generalize and this understanding is especially representational. This applies to the 'easy to interpret' cyberneurons' in/activity which matches with semantic concepts of the images' depictions, as well as to the 'confusing' ones, whose in/activity is eventually assessed by their ability to sustain the networks' function. Moreover, images which make up the set of data are put here into the role of representational signifiers. The whole procedure of machine learning here includes various remediations which are not addressed by the researchers. Though the perceived randomization of meaning, which is indicated by the 'confusing' cyberneurons, is a point of interest for researching, it does not become the entrance point for questioning the processes of remediation, assumptions about the detectability of patterns or the premise of connectivity. Instead, it is problematized as well as resolved by the concept of generalization, which at least in this case becomes a method for maintaining a representational order of things—a way of ensuring a general equivalence between signifiers and signified, a general equivalence of meaning between different artifacts and diverse modes of sense-making.

Expressing

In order to account for a computational sentience in machine learning applications, the processing of numeric values has to be conceived as a performative act. Regardless of whether the in/activity of the cyberneurons is evaluated to be meaningful in a representational way or whether the in/activity is understood from a technoecological point of view accounting for an excess of meaning, it points towards a sensing of data within worlds-for data. Evidently, it is fundamental to consider the in/activity as a mode of sensing in order to be able to relate to and modulate its operability. Though, it is important to notice that the machinic mode of sense-making, the specific computational sensing within the network, derives not only from the program as such or a genuine 'execute-ability' of the algorithms. Rather, an entire apparatus sets structures and conditions potentials for how and what is to be expressed through numeric values — this concerns for example the required material infrastructure, the programming of code, the labeling of data, the digitalization of images, the generation of power, the transmission of electronic signals etc.[12][13] So, a lot of work has to be done by human and non-human labor to ensure a computational sentience and even more work to navigate the machinic expressions of sense into desired directions. To conceive the in/activity of cyberneurons as an enunciation of algorithms alone would result in a misconception comparable to the one Wendy Hui Kyong Chun has worked in her study of the performativity of code: a "conflation of instruction with its product — the reduction of process to command — that grounds the emergence of software as a concrete entity and commodity" (Chun, *On "Sourcery," or Code as Fetish* 303). Drawing upon Judith Butler's understanding of performativity, Chun argues against conceptualizing code as a merely machinic expression:

> *What is crucial here is: first, code that succeeds must be citations — and extremely exact citations at that. There is no room for syntax errors; second, that this iterability precedes the so-called subject (or machine) that is supposedly the source of the code; and third, and most importantly, an entire structure must be in place in order for a command to be executed. This structure is as institutional and political as it is machinic. (ibid. 322)*

Applying Chun's argument to the in/activity of the cyberneurons, computed numeric values cannot just be addressed as expressions of the artificial neural network. One has to take into account the social and political infrastructure, where these materializations are embedded in and which render its capacity of becoming an expression at all. Recurring to Barad's notion of agential cuts, to address the in/activity as a mode of computational sensing implies the following: on the one side, it stresses that the discursive and the material dimensions within what emerges as a machinic expression are inseparably entangled. Thus, every materialization — in this case the cyberneurons' in/activity — is already inherently political and social. On the other side, these materializations are regarded less as the result of assembled human and non-human workforces, but more as events that temporarily (re-)produce the boundaries between human and machinic labor. Moreover, they have the capacity to reformulate the relations that constitute the agents at work. Though Barad's concept of performativity differs to the one of Chun, it too raises attention towards the infrastructure or apparatuses of expressions:

> *In an agential realist account, performativity is understood not as iterative citationality (Butler) but as iterative intra-activity. Intra-actions are agentive, and changes in the apparatuses of bodily production matter for ontological as well as epistemological and ethical reasons: different material-discursive practices produce different material configurations of the world, different difference/diffraction patterns; they do not merely produce different descriptions. Objectivity and agency are bound up with issues of responsibility and accountability. Accountability must be thought in terms of what matters and what is excluded from mattering. (Barad 184)*

From this perspective, even a representational culture of sense cannot just be regarded as means for merely depicting the world, but rather has to be addressed as a specific way of intervening into reality — a specific mode of worlding. In regards to the above described case study of machine learning, a representational logic is applied in particular as a measurement to modulate the expressions in forms of numeric values into desired articulations in order to channel the programs capacity into an instrument for the (re-)production of restrained meanings. Whereas this specific way of re-configuring the process of materialization relies on the account of conceiving the cyberneuron's in/activity as a responding expression, which allows the machine and its apparatuses to become a relatable milieu for sensing. The artificial neural networks are situated in the realms of probabilistic procedures and they are insensible for cultural connotations or the conditions of production that sustain their effectiveness. Nonetheless, they are imbedded in those cultures of sense-making, which shape the arrangements of the program's apparatuses and influence how one relates to the sensing. From this point of view, numeric values cannot just be regarded as signifiers referring to patterns, features or semantic concepts. Rather they are signs for the effectiveness of a complex assembly that weaves a computational mode of sense-making into the realms of sentience by simultaneously implementing a technoecological culture of sense into the machinic infrastructure.

Conclusion

The expanding evolvement of media-technological devices does not only transform concepts of computation but also brings forward a further dimension of the interlacing between sensory, cognitive and affective fields within sentience. The implementation of media-technology introduces new environments for sensing and re-configures modes of sensibility and intelligibility. From this point of view, the reductionist and quantitative characteristics of applied mathematics do not per se encapsulate capacities for sensing. Though computational methods of sensing differ from other ones such as writing, touching, hearing, smelling, thinking, feeling etc., they neither genuinely oppose them in terms of their tendency towards determination of meaning, nor can they be executed exclusively within the realms of computation. As determination is inherently part of any mode of sensing and a condition for un/becoming, it is so to speak an immanent cruelty of worlding. So, a critique against an instrumentalization of sensing for exploitative means cannot just address logics of calculation or capturing, but also has to take into account the apparatuses and their measurements which create and sustain computational procedures for instrumental means. Thus, this does not imply that the problematic of determination as such becomes meaningless. On the contrary, as it highlights that every made connection simultaneously points to a detachment, the determining process asks to be further problematized. Therefore, it directs one's attention to the measurements which are incorporated in sense-making and demands a continuous questioning of what kind of world the determinations make im/possible. It raises the awareness for the ethical dimension within sensing — because each connection goes in hand with separation, learning with unlearning, expression with muteness.

Notes

[1] Thrift is referring here to Jakob von Uexküll's concept of "umwelten".

[2] Hayles coins the term "nonconscious" in order to describe a mode of thinking that traverses cognition, but is not executed consciously. It is an automatically enacted decision for interpretation of information, which is pervasive in life forms as well as technical systems (cf. Hayles).

[3] Translated from the German publication by the author.

[4] The term "prehension" has been suggested by by Alfred North Whitehead. It describes a registering or comprehending mode of existence that is intrinsic to all organic and inorganic forms of perception and thinking (cf. Whitehead 57ff). For the relevance of Whitehead's philosophy for Parisi's thinking see also *Was heißt Medienästhetik?* (44-49).

[5] In his publication on the *Machine Learners: Archaeology of a Data Practice* Adrian Mackenzie gives an overview of the different operations that are assembled under the term 'machine learning'. He examines the consequences machine learning has on forms of knowledge production, critical thought and strategies of power. Notably, by machine learners he "refers both to humans and machines or human-machine relations" (Mackenzie 6) and therefore rather to practice that is situated in specific "accumulations of settings, data and devices" (ibid.).

[6] It is interesting to note that this resembles what Félix Guattari, who himself was influence by cybernetic theory, described as 'machinic': an affective mode of thinking that proliferates non-pre-given, irreversible and singular enunciations, which result into an excess of meaning by assemblies that are organized through recursion and connectivity (e.g. cf. Guattari). At this point it should be also mentioned that Hörl develops the notion of the technoecological culture of sense amongst others in close reference to Guattari's idea of ecology as well as his notion of non-significant heterogenesis of meaning which is apprehended to be machinocentric (cf. Hörl 13-21).

[7] This depiction of how machine learning processing of images is arranged by engineers and how it works on a computational level is quite simplified here. It is to be said that there are different parameters for designing such a program and that there are further aspects such as regulatory measures (e.g. batch normalization) that shape its operability. Nonetheless, for the context of this paper, I want to emphasize the premises of connectivity as well as the attributes of the network's architecture such as correlation, recursion and repetition in regards to their partaking in the configuration of an algorithmic sensing via machine learning.

[8] If it tends towards zero it is regarded as inactive and if tends towards one it is regarded as active.

[9] According to Alpaydin, the network's capability to generalize is the main feature that marks machine learning's capacity to govern information. He states: "This ability of generalization is the basic power of machine learning; it allows going beyond the training instances." (Alpaydin 42)

[10] This example refers to the explanatory graphic provided by the researchers (cf. Morcos and Barret).

[11] Translated from the German publication by the author.

[12] For instance, Andreas Sudmann emphasizes that the reason for the recent popularization and proliferation of machine learning applications is neither primarily to be found in more elaborated algorithms nor the enlargement of data training sets, but the parallel organization of fast GPU- or TPU-chips (cf. Sudmann 63, 69).

[13] See e.g. the work published in the context of *Data & Society* (https://datasociety.net) that provides insightful research on social consequences as well as conditions for mediatechnological industries.

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