Media and the transformative potential of AI in the scientific field

Theses on the media conditions of knowledge production in the era of learning algorithms

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The investigation of the epistemic-technical and infrastructural role of media for artificial intelligence (AI) is still a comparatively young field of research, at least if we think primarily – as we are currently accustomed to do – of machine learning (ML) approaches and artificial neural networks especially (ANN).

It has already become common knowledge that equating AI with ML or ANN is problematic for several reasons, but this does not change the fact that the concepts are de facto used more or less synonymously. In a similar way, we can note that the traditional criticism of AI (e.g., there is no such thing as artificial intelligence, corresponding techniques or systems are neither intelligent nor artificial) has not led to a terminological reorientation either. In computer science, for example, one typically speaks of individual models such as convolutional neural networks (CNN) or large language models (LLM), of statistics, or of ML rather than of AI, perhaps because technical details are more important in this academic field than in other contexts. And yet, it remains to be stated that even in computer science many researchers and engineers apparently cannot or do not want to abandon the term. Hence, it is worth asking why it is so persistent. In our opinion, an explanation for this cannot be limited to the fact that we are confronted with a consolidated concept and that the normative power of the factual takes effect here. Rather, the continued use of the term also points to its ideological function, especially in a scientific context. AI is not only a prospering field of research, but also a culturally imparted promise of how humans can grow beyond themselves through the development and application of technologies. It is hard to escape the phantasmatic charge of AI, in view of a historically unprecedented situation in which the gap between its cultural imaginaries and its empirical development in the 'real world' has noticeably narrowed (Ernst/Schröter/Sudmann 2019: 18). Analogously, it is not surprising that the perception and thematization of AI research often seems to be dominated by a rhetoric of outdoing (Humm/Buxmann/Schmidt 2022; Stöcker 2020), while specifically computer science, due to its core responsibility for the development of AI, can meanwhile, depending on the situation, afford itself the luxury of warning against exaggerated expectations of this technology (e.g., Bengio 2022). Nevertheless, it remains to be noted that the concept of AI cannot be reduced to merely serving as an ideology, if one just thinks of the epistemic-technical orientation of computers in comparison to that of humans, for example (Turing 2004 [1948]: 420–422; Rosenblatt 1961: viif., 28). In addition, perhaps the term 'AI' persists so tenaciously because it conveniently offers itself for (critical) reflection, regardless of the state of history.

This position paper discusses some fundamental considerations related to the role of media in practices and methods of the application of AI in different fields of academic research and their potential transformation, with individual (hypo)theses as starting points. This particular approach was chosen due to the specific conditions of our research project. On the one hand, we have to emphasize that, at the time of writing, much of our empirical and historical research still lies ahead of us, which is why the concepts and theses presented here are explorative or tentative. On the other hand, approaching the problems via (tentative) theses also represents an attempt to come to terms with the assumed complexity of the subject matter as well as with the speed of its transformations (just think about how fast, for example, GPT-4 followed GPT-3 and GPT-3.5). Some of the following observations and reflections have already been introduced elsewhere. If this is the case, it is indicated accordingly.

In the context of our project, the term media refers primarily to all technical entities whose function is to perceive, store, process, transmit and present information.[1] Such a working definition may seem relatively broad, but it seems

1 This conceptualization represents a significant extension of Kittler's concept of media technology when he defines it as "transmission, storage, processing of information" (Kittler 1993: 8). Unlike Kittler, we fundamentally understand media as *socio*-technical entities. The labeling of media in our understanding as "infrastructural media" seems useful to us, even though only in a certain sense, if the term is understood rather openly, with a sensibility to the non-fixed status quo of respective entities that constitute and configure an infrastructure. The term "infrastructural media" specifically refers to the systematic and rule-based stabilization and connectivity of media as part of complex chains of operations consisting of people, things and practices (Sudmann

necessary for us in order to capture the heterogeneous spectrum of the infrastructural role of media for the application of AI in different academic fields.

Although the use of AI-based methods already seems to be so normalized that it has even become a casual standard reference in discussions related to the nexus of digital technologies in the sciences (as, for example, in Mößner/Erlach 2022), we argue for addressing the question of 'how AI changes the sciences' as an issue in its own right.

Thesis I

Machine learning presupposes and implies that machines learn with and based on media. Consequently, media also impose their conditions on machine learning practices and applications in different disciplines.

The epistemological and cross-disciplinary relevance of a thesis can be gauged, among other things, by the extent to which it can be countered by an equally important counter-thesis. Against this background, the thesis mentioned here might seem relatively trivial, at least if one proposes a rather broad concept of infrastructural media (as we do and have already briefly sketched). Nevertheless, in relation to the development and application of AI in the scientific field (or elsewhere and beyond), a media obliviousness can be observed that obstructs a thorough epistemological reflection on technologies and their implementations. The indicator of such media obliviousness is not merely the explicit absence of the term 'media' itself, but rather the fact that the general AI discourse lacks a way of thinking about technology that really acknowledges the role of media in its developments and application and that also understands the epistemic influence of media in the reflection on technology. Precisely because the dependence on media can be asserted for every practice, thus also for the application of technology, it is even more important to shed light on this dependence in its specific manifestations and different contexts of application, here in relation to the scientific uses of AI. The latter also includes questioning the nexus as well as the interdependence of different media forms.

In recent years, the inscription of media in machine learning has already been the subject of some studies, also including first attempts for a media-

2021: 281f.; for a slightly different account of infrastructural media, see Schüttpelz 2017).

historical perspective (cf. Sudmann 2017; Engemann/Sudmann 2018; Ernst/Schröter/Sudmann 2019; Tuschling 2022). As has been shown in these contexts, the infrastructural relevance of media can be discussed for entities as diverse as learning data, sensors, software, hardware, platforms, frameworks and many more. The epistemological potential of ANN is particularly evident in the information processing of inherently fuzzy media such as images and language.

The epistemic-technical potential of current AI technology is, of course, especially visible in the field of sequential and generative models. Among other things, the significance of time-based media becomes especially apparent here. This temporal aspect also became evident, when the German-Canadian company TwentyBN back in 2017 trained an ANN to recognize gestures and actions using video data and approaches of transfer learning (Sudmann 2017). Sequence and generative models are, however, also media of self-reflection and because of this capability also interesting from a media studies perspective.

Indeed, as ChatGPT and other systems demonstrate, communication between humans and machines is rapidly evolving and becoming one of the central scenes of the technical performance of AI systems.

Despite existing shortcomings, large language models or sequence models can be seen as another 'game changer' in the development of advanced AI systems. Already the current level of their performance suggests that the intervention of AI in all sciences will proceed faster and more profoundly than the skeptical view would have suggested only a few years ago. However, the growing importance of AI and the hypothesis of its fundamental intervention also raises the question of 'which aspects of scientific practices and methods will be unaffected or hardly changed by AI'.

Especially in this respect, it seems important to us to combine media archaeological approaches for the analysis of algorithmic conditions of information (e.g., Ernst 2021) with media praxeological approaches, especially media ethnography, in order to not explain technology exclusively in technicist terms. The media perspective proposed here does not only concern the socio-technical conditions of AI infrastructures in and of themselves, but equally affects questions about the historical epistemology of AI, as well as the genesis of different forms and models of knowledge.

The fact that ANNs are also called artificial because they are loosely based on the neuroinformatic model of brains (both human and animal) is now widely known and regularly pops up in current debates on the technical performance of AI systems. This might serve to deflate exaggerated ideas and expectations of an artificial general intelligence for which humans continue to be the model, even when AIs in the form of ANNs have been optimizing each other for a while, without humans as a model (even if at present the latter is only in its initial stages, e.g., AlphaGo's successor systems, cf. Silver et al. 2017).

Whether today's AIs embody, among other things, a form of 'alien intelligence' and/or if they are still a form of intelligence closely related to what is characterized as human intelligence, can perhaps not be decided at all, because corresponding assignments are not only worthy of criticism in each case, but they also cannot be reduced to mutually exclusive alternatives.

The claim that AI has to be 'human-centered' challenges us to critically reflect on its anthropocentric logic as well as on its ideological implications. Of course, there are obvious reasons why especially the AI industry or many scientists stress the human-centeredness of their applications. Apparently, one of the strongest potential or at least imagined threats of AI is that humans might get out of the loop and might lose control over the technology (just think of the current call to pause the development of big AI systems more powerful than GPT-4, Future of Life Institute 2023) – that is, of course, a fear that is older than AI and was historically connected to many technologies (especially regarding the question if automation brought about by technology threatens work).

The relation to corresponding dystopian representations in popular media doesn't need detailed explanation here. However, this is precisely why it is important to include the popular techno-imaginations of the culture industry (or media culture, whoever prefers the term) when trying to understand what matters in the development of technology (see thesis VIII below).

Thesis II

The investigation of machine learning methods in the scientific field requires a detailed analysis of the different levels, contexts and the specific functions of media in the creation and formation of AI technologies and their methodological use in research. From a media studies perspective, a distinction must also be made between applications that use AI technologies primarily or exclusively for scientific purposes and those for which this is not the case, since the respective scientific use there is only optional.

Which infrastructural types of media are relevant to the application of AI in general and which are only relevant to a specific field or problem within a single discipline? Finally, which types of AI-related media are crucial for which phases of the research process (e.g., collection or analysis of data)?

Answering these questions seems essential to adequately assess the inter- and transdisciplinary potential of AI's media. Some problems with the differentiations proposed here are obvious: For AI research, the specific domain reference may sometimes be secondary to what the model is capable of doing in general, i.e., in other domains as well; in other cases, the dependence and focus on a single domain is crucial (and intended as such).

Historically, the expert systems of the 1970s and 1980s, for example, were more or less limited to a particular domain area. At that time, AI systems were not related to a more or less universal knowledge, but strove for selective or specialized knowledge representation. Thus, they stand in sharp contrast to current LLMs, since those models have a universal orientation and competence not only in knowledge representation, but also regarding the fact that they can generate output beyond the central function of knowledge representation, insofar as they are able to generate unexpected results such as creating poems, writing computer programs, solving riddles etc.

Nevertheless, sequence or generative models like ChatGPT are the conditions of possibility for the expert systems of the 21st century. At present, everything seems to boil down to the fine-tuning of the large sequence models (e.g., Lewkowycz et al. 2022). Put simply, you have systems like ChatGPT which can handle general tasks like creating texts regardless of a specific domain, but when it comes to very specialized areas of knowledge, they have trouble coming up with correct or good results. This is where the fine-tuning comes into play. One uses the pre-trained models as a starting point to train them in a second step for a specialized task and/or specialized data in the respective domain area and thus usually has more appropriate results.

In this respect, the relevance of big data is given at various scaling levels of knowledge domains. Contrary to the name, the epistemic relevance of big data does not only result from the amount of data, but from its diversity and ideally also from a qualitative evaluation of this heterogeneity (Kitchin 2014).

Whether it is translation tools, search engines, or dialogue systems based on LLMs – how does epistemologically interested research deal with the fact that the function and use of such systems are not limited to scientific purposes and that they still inevitably inscribe themselves in the practices of scientific thought and knowledge production? It is obvious that the above examples alone point to a specific form of AI-based knowledge production as well as mediation and need to be critically evaluated accordingly. ChatGPT is more than a search engine and yet the system is also, among other tasks, used for this very purpose. Unlike a search engine, however, ChatGPT does not simply generate knowledge depending on appropriate queries; rather, it also provides information about the conditions of knowledge production, including, for example, statements about its limitations and regulations. Moreover, the system is potentially capable of understanding the references of successive queries, of responding to queries, etc.

In this respect, ChatGPT can to some extent also be understood as an application example of Explainable AI. Nevertheless, it is obvious that not only the form of Explainable AI systems – specifically the design of corresponding algorithmic functions – but also the media of their emergence and infrastructural situatedness are quite different in generalistic AI systems like ChatGPT in comparison to more domain-specific systems.

Currently, we can already observe that the differentiation of AI-based epistemic media is increasing. Instead of domain-spanning translation tools, search engines, etc. researchers might increasingly and appropriately use domain-specific applications. These processes potentially have important implications for media policy, which, as the following thesis suggests, are also already becoming apparent.

Thesis III

Research on the research of AI, not only as a media studies enterprise but also as an interdisciplinary project, is confronted with two overlapping challenges: The first one is dealing with the scope and speed in the development of what can be considered rather universal technologies in AI like CNN or LLM, which as such are relevant to different fields of application (in the sciences and beyond) and which typically are developed in fields of computer science. Another challenge in addition to and entangled with the first one is to survey and understand the reaction to and adoption of AI in different disciplines and areas of knowledge, again especially in terms of their scope and speed, but also with regard to their manifold contexts.

Much of the methodological deployment of AI in the sciences, we suggest, consists of the application of machine learning techniques that can be considered conventional from a computer science perspective at the time of their application in other disciplines. Examples would be, for instance, the fundamental importance of how backpropagation is used for many scientific deployments of

ANNs, as well as more specifically, of CNNs, or, more recently, diffusion models as well as LLMs (cf. Chowdhery et al. 2022: 7f.; LeCun/Bengio/Hinton 2015; Schmidhuber 2015). Certain models seem to have established themselves at an increasing rate in recent years (again, think of LLMs), at the same time their validity as 'state of the art' is obviously very limited, if one takes into account the rather short relevance of generative adversarial networks (GANs).

From a meta-theoretical research perspective, just paying attention to these rather universal AI models in computer science is in itself already a very difficult task. Additionally, the complexity of the requirements for understanding corresponding developments increases when they are examined in relation to a specific domain area and placed in relation to its dynamics. Furthermore, the focus on the adaptation of AI technologies leads to more specific challenges, for example, being able to distinguish whether an existing AI technology is primarily being simply applied in a specific field or whether it has also been substantially developed further within the context of the application.

Such dynamics are, of course, a general characteristic of scientific and technological development. Nevertheless, the temporal aspects mentioned here seem to be particularly extreme with respect to current AI advancements. The peculiarity of AI here consists above all in the fact that AI is to be understood not only as an object of the temporal logic of technology development, but potentially, if not solely, as its 'subject'. The mediality and media dependency of AI must accordingly take these temporal dimensions into account (for some general considerations on the temporal aspects of ANN-based AI, cf. Sudmann 2021).

Thesis IV

The outstanding epistemic-technical potential of ANN for the scientific field has (always) mainly been to address and cope with different forms of fuzziness and uncertainty, which includes, e.g., missing information. Accordingly, it is important to explore in more detail how media as input are associated with challenges and problems of uncertainty and fuzziness or generate them in the first place, but also how they contribute to reducing or avoiding uncertainty and fuzziness.

A provocative response to our research group's question about how AI is changing the sciences might be that the central answer is a foregone conclusion that more or less amounts to the thesis presented here. The epistemic potential of AI's statistical approaches to pattern recognition has been recognized since the 1950s (Sudmann 2018b: 22). But it was only a decade ago when it became apparent how well ANN are able to handle problems of fuzziness, uncertainty as well as missing information, as they have always occurred in diverse sciences: be it the handling of ambivalences in literary texts (e.g., Suissa/Elmalech/Zhitomirsky-Geffet 2022), the reconstruction of damaged or incomplete historical images in the field of art (e.g., Zeng/van der Lubbe/Loog 2019), ambiguities in speech recognition due to noise and other factors (e.g., Qian et al. 2016), facing problems like efficient magnetic resonance imaging in medicine (e.g., Schlemper et al. 2017) or ground water level prediction in geoscience (e.g., Tao et al. 2022).

Dealing with these problems is strongly tied to processing and training with large amounts of data. In this respect, one could say, ANNs represent a new technical-epistemic level of using and exploiting quantities to deal with qualitative research problems. Moreover, ANNs can also be used on a new scale to deal with quantitative problems, specifically with regard to arithmetic and algebra (see e.g., Gérard Biau in conversation with Anna Echterhölter in this volume).

To what extent the ability to deal with problems of fuzziness signifies an epistemic rupture can certainly not be ascribed to an unambiguous date from the outset, but to different historical paths of development as well as specific genealogies that must be reconstructed historically.

Thesis V

The epistemic potential of ANNs – as the (currently) dominant form of AI – is based on the massive parallelism of information processing. The technology can be theorized as quasi-analog or post-digital.

ANNs, as the currently dominant manifestation of AI, are typically negotiated as digital technology. However, this view is at least partially in need of correction, as the following arguments underscore:

> [First], it must be emphasized that the masses of interconnected neurons, activated by an input, fire together simultaneously or in parallel, thus ultimately forming a complex emergent system that abolishes the discrete char-

acter of the elements it consists of (the layers of neurons and their connection) [...]. This extreme or massive parallelism of information processing can indeed count as the essential characteristic of ANN, distinguishing it from the von Neumann architecture of classical digital computers. Due to the described properties, an ANN is therefore a blurred system [in German: "Unschärfesystem"] .. whose operations can be described rather as analog than digital (Sudmann 2018a: 67, own translation).

Secondly, it can be argued that the massive parallelism of neural networks, as currently effectively unfolded in LLMs and other models, among others, is characterized by a quasi-analog fine-grainedness in information processing.

> [A] single artificial neuron is usually either active or not, so in this respect it usually functions according to a binary logic, like the switching states of a digital computer. However, the weighting of activity between neurons, i.e., the strength of their connections, is mostly represented by floating point numbers (positive and negative) in neural networks. And this representation is so finely grained that the corresponding values can be understood as quasi-analog. As a medium of information transmission, ANNs thus do not operate with binary units, such as 0 and 1, but in quasi-analog form (even if the values are still based on a digital substrate) (ibid.: 66f., own translation).

Fine-grainedness in this context is not reduced to generating certain effects of quasi-analog representations, for example when a modern display allows smooth color transitions, and in this way appears analog, i.e., continuous. It is important to note here that the attribute of quasi-analog concerns the technical conditions of information processing, not its mere form of representation. For the time being, the parallelism of neural networks at the lowest level is still determined by the circuit logic of digital computers. For the performance of ANNs this dependence is limiting because of its inefficiency. Subsymbolic AI in the form of ANNs is based on similarity relations of fundamentally continuous quantities, which are currently still digitally approximated. As ironically described elsewhere, they're still 'abusing' digital technology until they are eventually, with some probability, replaced by analog technology (ibid.: 69).

For this very reason, it makes sense to negotiate ANNs not merely as quasi-analog information technology, but also to characterize it literally as a post-digital scenario of the conditions of information and knowledge processing in the 21st century.

In media studies, some of the aspects of connectionist AI addressed here have already been implicitly highlighted by Norbert Bolz in the introduction to the volume *Computer als Medium* (in English: "Computer as medium"), published 1994:

> [The] reorientation of intelligence to simultaneously and parallelly processing nervous systems that statistically process their data at a comparatively low level of precision parts with the dream of a mathesis universalis that philosophy, from Leibniz to Husserl, dreamed of. For the computer is a plausible metaphor for the media spirit [in German: "Mediengeist"] only as long as thinking means calculating and cognition is understood as calculating with digital symbols. Algorithms define a logical world through purely syntactic operations, in which all problems can be solved through serial search routines. The world of emergent AI is quite different. Connectionism is the name for operating in subsymbolic networks where meaning is a function of a system state. Accordingly, storage does not occur in single, precisely addressed, memory locations, but in networks. All regularities in this network are emergent qualities against the background of a chaos of linkages. Thus, in the subsymbolic network of connectionist machines, there is an exact correspondence to the noise in the brain, i.e., to the random firing of neurons. (Bolz 1994: 14, own translation)

While Bolz's reference to the 'chaos of linkages' may be as techno-epistemically inaccurate as the comparison to the 'noise in the brain', the emphasis on the 'emergent qualities' of networks, however, remains crucial in highlighting the suspension of the principle of digital information technology in connectionist systems.

Thus, if one seeks to examine the impact of AI technologies on the sciences, one cannot avoid taking seriously the fundamental algorithmic specificity of the technology. And this means that the question of the transformations of the sciences by AI is, from a technical-pragmatic point of view, only to a limited extent a problem of digital technology. Therefore, it might not be sufficient to describe AI technologies only with notions taken from the theory of digital media or to insert their histories into the histories of digital media. Other theoretical and historical traditions might be important too. The same, by the way, might be the case in quantum computing, in which also a partial return to analog forms of information processing can be observed (or described as such, cf. Schröter/Ernst/Warnke 2022).

Thesis VI

The diagnosis of an AI revolution is ubiquitous. Given the historical examples for supposed technological or specifically media-technological revolutions, such rhetoric should be treated with caution. It is likely that, as in all historical examples, discontinuities and continuities coexist in complex manners that cannot be predicted beforehand.

As the last few years of the boom in machine learning have reminded us once again, it is rarely one event that establishes a caesura; rather, it is a series of events that establish an order of a before and after, or mark a longer process of change as such. The rhetoric of 'revolution' is, more often than not, a rhetoric of AI imaginaries (see Thesis VIII) used in entertainment and advertising, rather than a useful description of real developments. Nevertheless, sometimes specific events have a profound relevance for the further development of technology (see Sudmann 2018b related to the recent history of ANNs).

Since AI is obviously a technology that processes information, questions of media history and media historiography apply (cf. Schröter/Schwering 2014). We want to highlight three aspects:

Continuity and Discontinuity: As in all media history formulations, clear linear successions and rhetorics of 'before' and 'after' ('revolution') should be discarded in favor of multifactored and multilayered descriptions – 'series' as Foucault (1972: 4, 7f.) put it (cf. Schröter 2014: 13–22). In some series some things change slower or faster, where in others certain aspects stay the same.

Accelerations and Brakes: Brian Winston (1998: 1–19) has argued that on the one hand "supervening social necessities" accelerate the development and distribution of new media, while on the other hand a "law of the suppression of radical potential" applies, which tames radical changes made possible by new media technologies (e.g., copyright laws that impede the potentialities for lossless reproduction in digital media).

Retrospective construction: As Glaubitz et al. (2011) have argued, media history of a certain media technology is always triggered at first by a high 'level of recognition'. Some technology becomes visible, commercially successful and perhaps scandalized – and then the process of retro-construction starts. The research focuses on 'emergence events' where it all began and also looks for the lines of development that begin with these events.

All these mechanisms operate in the historical development and historiographical description of AI systems too. Regarding the role of AI in different scientific disciplines it is to be expected that they may have different weightings, distributions and forms. To develop a more precise picture in this regard is one task of our research project.

Thesis VII

Due to their predictive capabilities, it is important to examine approaches of ANN, in a broader sense, as technologies of speculation. In this respect, however, they also challenge us to reflect on our own speculative thinking; the critique of AI and its epistemic applications must therefore also include the 'meta-theoretical' reflection.

Even beyond its culture-industrial imagination, AI has always provoked speculation about its future limits, risks, potentials, and ambivalences. Recent developments and achievements of ANNs have added a crucial new aspect to this view especially: Instead of speculating about AI, people have started speculating with AI. But the semantics of speculation implies uncertainty. One must recall, at this point, that ANNs have been used for the speculative business of stock market prediction since the late 1980s and 1990s (cf. Wong/Bodnovich/Selvi 1995; Vui et al. 2013). However, the risky bet on big business in the stock market and the uncertainties associated with it are at odds with what is socially desired for the scientific application of ANNs as predictive technologies, namely to be able to use it to control and master the future, especially in highly sensitive areas such as medicine or climatology (cf. Halpern/Mitchell 2023). This epistemically almost indispensable claim highlights the need to relate the critical analysis of predictive systems as a technology of controlling the future(s) to the present, taking into account empirical technology development as well as the realm of imaginaries.

Nevertheless, speculation as a critical practice remains necessarily and essentially related to the future. Critical analysis of current conditions is always in the service of the premise and claim that the world could (and should) be different than it currently is. Contemporary AI systems such as ChatGPT can now themselves be interrogated for utopian imagining of their future as well as for critiquing society, which is why we must seriously consider that the political infrastructures of societies to come will also increasingly depend on the deployment of learning algorithms. In any case, recent AI and the critical moment of speculation it mediates should in turn be used to critically reflect on our own cognitive processes and approaches. The institutions and designs of the sciences which are necessarily related to the future, must, precisely for this reason, also offer speculative thinking, as a critical practice of the present, and not (alone) of the future, as well as an appropriate space to unfold.

Thesis VIII

The analysis of the scientific uses of AI should also include the analysis of their (culture-industrial) imaginations.

One of the central problems of the scientific engagement with AI is that there is hardly any group of technologies that is so charged with partly crazy imaginations (on the notion of cultural imagination; see its use in Ernst/Schröter/Sudmann 2019). In particular, popular media, like motion pictures, since the late 1960s have been full of – often exaggerated – ideas about what AI and (not always clearly separated from them) robots should be able to do.

These ideas can have both a utopian and (this is the more common case) dystopian inclination. We cannot and will not go into these ideas and their various forms in detail here, but several theoretical and methodological demands follow from this for the scientific study of AI: First, one has to ask why at certain times and contexts certain imaginaries are attached to a technology like 'AI' – to which needs does 'AI' respond, which social deficiency and/or deficiency caused by previous media finds expression in these imaginaries (on utopias regarding computers in general, cf. Winkler 1997). Secondly, we can investigate what role such imaginaries have played as 'Leitbilder' (Dierkes/Hoffmann/Marz 1992) or 'diegetic prototypes' (Kirby 2010) in the actual development of technology. Thirdly, in doing so, we must also historically separate ideological and simply absurd imaginaries from those that have played a constructive role, which is only possible through historical retrospection.

The discourse about the role of AI in the sciences is also permeated by such 'AI'. The ideas of what should be possible with AI, which have increased into the utopian, can be a reason for starting to use AI-based methods in the first place. Manufacturers of such systems do well to quote these utopias in their advertising, for example, in order to increase the attractiveness of their products for scientific buyers. What do different scientific disciplines, certain research domains or even individual scientists expect from the use of AI? What guiding principles are associated with it? What is imagined under the term 'AI' in the first place? These are questions that must play a central role in a research design on the role of AI in the sciences.

Thesis IX

The principle of ANN is its universalistic orientation, determined by the phantasmatic imagination that has always characterized AI technologies: to overcome problems of difference.

Connectionist AI can be understood as a universal machine sui generis. Information processing with artificial neural networks is Turing-complete, i.e., we are dealing with machines that can simulate or program other machines (Siegelmann/Sontag 1992: 440f.). They share the universalistic principle that already characterizes the digital computer according to the serial Von Neumann architecture: to be able to scan and simulate all individual media as well as to process a certain input independent of its specific meaning and socio-cultural codes, and so on. This universalist feature, however, characterizes not only the epistemic conditions of technology, but also its telos.

In practice, especially in scientific applications, the specificity of the learning material is of course immensely important, for example with regard to inscriptions of discriminating biases.

Part of the practical perspective is to note that by no means all those who are driving the development of machine learning are pursuing the goal of AGI. Yann LeCun and many other experts constantly emphasize how far current technology development still falls short of the status quo of whatever is considered to be 'human intelligence' (cf. LeCun 2022; Shanahan 2023). And yet, leading companies and scientists are more or less explicitly committed to the goal of AGI (cf. Altman 2023). This goal is not simply identical to simulating human intelligence, but consists first and foremost of developing an AI system that, similar to humans,

I. can cope with a heterogenous range of problems and tasks, and
II. generally speaking, has to fulfill as few preconditions as possible, e.g., avoids having to learn the solution of a problem in a time-consuming way, amongst other things by accessing a lot of data or by specific procedures of processing these data.

Already at the end of the 1980s, Seymour Papert criticized that both symbolic-ruled and connectionist AI are "engaged in a search for mechanisms with a universal application" (Papert 1988: 2). Papert's critique is perhaps more relevant than ever today, given the supposed universalistic capabilities of technologies like LLMs.

Nevertheless, we might be able to better deal with problems of difference, but they persist, especially with regard to AI models that seek or seem to overcome them (like the concept of a universal language translator). A very important aspect in this respect is the inevitability of algorithmic biases for every learning model. In current discussions of algorithmic discrimination, it is often forgotten that every learning for a certain task (like learning languages) inevitably produces 'costs', and hence any machine learning process that claims to be universal (i.e., is capable of dealing with all challenges of difference) must necessarily remain phantasmatic, which is also true, in a very fundamental way, for the relationship between humans and machines (cf. Ernst/Schröter/Sudmann 2019).

List of references

Altman, Sam (2023): "Planning for AGI and beyond.", February 24, 2023 (https://openai.com/blog/planning-for-agi-and-beyond).

Bengio, Yoshua (2022): "Superintelligence: Futurology vs. Science.", January 24, 2022 (https://yoshuabengio.org/2022/01/24/superintelligence-futurology-vs-science/).

Bolz, Norbert (1994): "Computer als Medium – Einleitung." In: Norbert Bolz/Friedrich A. Kittler/Christoph Tholen (eds.), Computer als Medium, München: Fink, pp. 9–16.

Chowdhery, Aakanksha/Narang, Sharan/Devlin, Jacob/Bosma, Maarten/Mishra, Gaurav/Roberts, Adam/Barham, Paul/et al. (2022): PaLM: Scaling Language Modeling with Pathways, arXiv Preprint (https://doi.org/10.48550/arXiv.2204.02311).

Dierkes, Meinolf/Hoffmann, Ute/Marz, Lutz (1992): Leitbild und Technik – zur Entstehung und Steuerung technischer Innovationen, Berlin: edition sigma.

Engemann, Christoph/Sudmann, Andreas (eds.) (2018): Machine Learning – Medien, Infrastrukturen und Technologien der Künstlichen Intelligenz, Bielefeld: transcript.

Ernst, Christoph/Schröter, Jens/Sudmann, Andreas (2019): "AI and the Imagination to Overcome Difference." In: spheres. Journal for Digital Cultures

5 (https://spheres-journal.org/contribution/ai-and-the-imagination-to-overcome-difference/.
Ernst, Wolfgang (2021): "Existing in Discrete States: On the Techno-Aesthetics of Algorithmic Being-in-Time." In: Theory, Culture & Society 38/7-8, pp. 13–31.
Foucault, Michel (1972): The Archaeology of Knowledge, New York: Pantheon Books.
Future of Life Institute (2023): "Pause Giant AI Experiments: An Open Letter.", March 22, 2023 (https://futureoflife.org/open-letter/pause-giant-ai-experiments/).
Glaubitz, Nicola/Groscurth, Henning/Hoffmann, Katja/Schäfer, Jörgen/Schröter, Jens/Schwering, Gregor/Venus, Jochen (2011): Eine Theorie der Medienumbrüche. 1900/2000, Siegen: universi.
Halpern, Orit/Mitchell, Robert (2023): The Smartness Mandate, Cambridge and London: The MIT Press.
Humm, Bernhard G./Buxmann, Peter/Schmidt, Jan C. (2022): "Grundlagen und Anwendungen von KI." In: Carl Friedrich Gethmann/Peter Buxmann/Julia Distelrath/Bernhard G. Humm/Stephan Lingner/Verena Nitsch/Jan C. Schmidt/Indra Spiecker genannt Döhmann (eds.), Künstliche Intelligenz in der Forschung: Neue Möglichkeiten und Herausforderungen für die Wissenschaft, Berlin/Heidelberg: Springer, pp. 13–42.
Kirby, David (2010): "The Future is Now: Diegetic Prototypes and the Role of Popular Films in Generating Real-world Technological Development." In: Social Studies of Science 40/1, pp. 41–70.
Kitchin, Rob (2014): "Big Data, new epistemologies and paradigm Shifts." In: Big Data & Society 1/1 (https://doi.org/10.1177/2053951714528481).
Kittler, Friedrich A. (1993): Draculas Vermächtnis. Technische Schriften, Leipzig: Reclam.
LeCun, Yann (2022): A Path Towards Autonomous Machine Intelligence, OpenReview Preprint (https://openreview.net/pdf?id=BZ5a1r-kVsf).
LeCun, Yann/Bengio, Yoshua/Hinton, Geoffrey (2015): "Deep Learning." In: Nature 521, pp. 436–444.
Lewkowycz, Aitor/Andreassen, Anders/Dohan, David /Dyer, Ethan/Michalewski, Henryk/Ramasesh, Vinay/Slone, Ambrose/et al. (2022): Solving Quantitative Reasoning Problems with Language Models, arXiv Preprint (https://doi.org/10.48550/arXiv.2206.14858).

Mößner, Nicola/Erlach, Klaus (eds.) (2022): Kalibrierung der Wissenschaft. Auswirkungen der Digitalisierung auf die wissenschaftliche Erkenntnis, Bielefeld: transcript.

Papert, Seymour (1988): "One AI or Many?" In: Daedalus 117/1, pp. 1–14.

Qian, Yanmin/Bi, Mengxiao/Tan, Tian/Yu, Kai (2016): "Very Deep Convolutional Neural Networks for Noise Robust Speech Recognition." In: IEEE/ACM Transactions on Audio, Speech, and Language Processing 24/12, pp. 2263–2276.

Rosenblatt, Frank (1961): Principles of Neurodynamics: Perceptrons and the Theory of Brain Mechanisms, AD0256582, Buffalo, NY: Cornell Aeronautical Laboratory.

Schlemper, Jo/Caballero, Jose/Hajnal, Joseph V./Price, Anthony/Rueckert, Daniel (2017): "A Deep Cascade of Convolutional Neural Networks for MR Image Reconstruction." In: Information Processing in Medical Imaging. 25th International Conference (IPMI 2017), Boone, NC, USA, pp. 647–658.

Schmidhuber, Jürgen (2015): "Deep Learning in Neural Networks: An Overview." In: Neural Networks 61, pp. 85–117.

Schröter, Jens (2014): 3D. History, Theory and Aesthetics of the Transplane Image, New York, London, New Dehli and Sydney: Bloomsbury.

Schröter, Jens/Ernst, Christoph/Warnke, Martin (2022): "Quantum Computing and the History of the Analog/Digital-Distinction" In: Grey Room 86, pp. 28–49.

Schröter, Jens/Schwering, Gregor (2014): "Modelle des Medienwandels und der Mediengeschichtsschreibung." In: Jens Schröter (ed.), Handbuch Medienwissenschaft, Stuttgart and Weimar: Metzler, pp. 179–190.

Shanahan, Murray (2023): Talking About Large Language Models, arXiv Preprint (https://doi.org/10.48550/arXiv.2212.03551).

Siegelmann, Hava T./Sontag, Eduardo D. (1992): "On the Computational Power of Neural Nets." In: Proceedings of the Fifth Annual Workshop on Computational Learning Theory, New York, NY, USA, pp. 440–449.

Silver, David/Schrittwieser, Julian/Simonyan, Karen /Antonoglou, Ioannis/Huang, Aja /Guez, Arthur/Hubert, Thomas /et al. (2017): "Mastering the Game of Go Without Human Knowledge." In: Nature 550, pp. 354–359.

Stöcker, Christian (2020): "Der Forschungs-Turbo.", February 23, 2020 (https://www.spiegel.de/wissenschaft/mensch/beschleunigte-wissenschaft-der-forschungs-turbo-a-b828d49e-4d5c-414b-8315-0ef2c5ce0a30).

Sudmann, Andreas (2017): "Auch Maschinen können intuitives Wissen sammeln", October 27, 2017, (https://www.nzz.ch/digital/das-intuitive-wissen-der-maschinen-ld.1324264).
Sudmann, Andreas (2018a): "Szenarien des Postdigitalen: Deep Learning als MedienRevolution." In: Christoph Engemann/Andreas Sudmann (eds.), Machine Learning – Medien, Infrastrukturen und Technologien der Künstlichen Intelligenz, Bielefeld: transcript, pp. 55–74.
Sudmann, Andreas (2018b): "Zur Einführung. Medien, Infrastrukturen und Technologien des maschinellen Lernens." In: Christoph Engemann/Andreas Sudmann (eds.), Machine Learning – Medien, Infrastrukturen und Technologien der Künstlichen Intelligenz, Bielefeld: transcript, pp. 9–23.
Sudmann, Andreas (2021): "Artificial Neural Networks, Postdigital Infrastructures and the Politics of Temporality." In: Axel Volmar/Kyle Stine (eds.), Media Infrastructures and the Politics of Digital Time, Amsterdam: Amsterdam University Press, pp. 279–294.
Suissa, Omri/Elmalech, Avshalom/Zhitomirsky-Geffet, Maayan (2022): "Text Analysis Using Deep Neural Networks in Digital Humanities and Information Science." In: Journal of the Association for Information Science and Technology 73/2, pp. 268–287.
Tao, Hai/Hameed, Mohammed Majeed/Marhoon, Haydar Abdulameer/Zounemat-Kermani, Mohammad/Heddam, Salim/Kim, Sungwon/Sulaiman, Sadeq Oleiwi/et al. (2022): "Groundwater level prediction using machine learning models: A comprehensive review." In: Neurocomputing 489, pp. 271–308.
Turing, Alan (2004 [1948]): "Intelligent Machinery." In: B. Jack Copeland (ed.), The Essential Turing. Seminal Writings in Computing, Logic, Philosophy, Artificial Intelligence, and Artificial Life plus The Secrets of Enigma, Oxford: Clarendon Press, pp. 410–432.
Tuschling, Anna (2022): "Vom Bildstimulus zur Emotion AI: Zur Sichtbarkeit und Unsichtbarkeit technischer Affektbilder." In: MLN 137/3, pp. 443–465.
Vui, Chang Sim/Soon, Gan Kim/On, Chin Kim/Alfred, Rayner/Anthony, Patricia (2013): "A review of stock market prediction with Artificial neural network (ANN)." In: 2013 IEEE International Conference on Control System, Computing and Engineering (ICCSCE), Penang, Malaysia, pp. 477–482.
Winkler, Hartmut (1997): Docuverse. Zur Medientheorie der Computer, München: Klaus Boer.

Winston, Brian (1998): Media Technology and Society. A History: From Telegraph to the Internet, London and New York: Routledge.

Wong, Bo K./Bodnovich, Thomas A./Selvi, Yakup (1995): "A Bibliography of Neural Network Business Applications Research: 1988–September 1994." In: Expert Systems 12/3, pp. 253–261.

Zeng, Yuan/van der Lubbe, Jan C. A./Loog, Marco (2019): "Multi-Scale Convolutional Neural Network for Pixel-Wise Reconstruction of Van Gogh's Drawings." In: Machine Vision and Applications 30/7, pp. 1229–1241.