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Ramón Reichert, Mathias Fuchs (eds.)

Rethinking AI: Neural Networks, Biometrics and the New Artificial Intelligence

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Ramón Reichert, Mathias Fuchs, Pablo Abend,
Annika Richterich, Karin Wenz (eds.)
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Digital Culture & Society is a refereed, international journal, fostering discussion about the ways in which digital technologies, platforms and applications reconfigure daily lives and practices. It offers a forum for inquiries into digital media theory, methodologies, and socio-technological developments.
This issue shows: The meaning of AI has undergone drastic changes during the last 60 years of AI discourse(s). What we talk about when saying AI is not what it meant in 1958, when John McCarthy, Marvin Minsky and their colleagues started using the term. Biological information processing is now firmly embedded in commercial applications like the intelligent personal Google Assistant, Facebook's facial recognition algorithm, Deep Face, Amazon's device Alexa or Apple's software feature Siri to mention just a few.

Ramón Reichert (Dr. phil.) works as a European project researcher at the University of Lancaster within the Erasmus+ program. He is the program director of the M.Sc. Data Studies at Danube University Krems, Austria. He is a lecturer at the Department of Communication and Media Research at the University of Fribourg, Switzerland, and a lecturer in Contextual Studies at the School of Humanities and Social Sciences at the University of St. Gallen, Switzerland.
Mathias Fuchs (Dr.) is an artist, musician and media scholar. He has been active as Senior Lecturer at the University of Salford, Visiting Professor at the University of Potsdam, Senior Fellow at the Institute of Advanced Study on Media Cultures of Computer Simulation (MECS) at Leuphana University, Lüneburg (Germany).
Pablo Abend (PhD) is the scientific coordinator of the Research School Locating Media at the University of Siegen. He is interested in geomedia, situated methodologies, participatory culture, and Science and Technology Studies.
Annika Richterich (Dr.) is an assistant professor in Digital Culture at Maastricht University (Netherlands).
Karin Wenz (Dr.) is an assistant professor of Media Culture at Maastricht University, Netherlands, and director of studies of the MA Media Culture.

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Content

III Politics and Media Research

IV Entering the Field

Introduction

Rethinking AI. Neural Networks, Biometrics and the New Artificial Intelligence

Mathias Fuchs & Ramón Reichert

Recently, the long-standing research tradition of *Artificial Intelligence* has undergone a far-reaching re-evaluation. When Herbert Simon in 1956 announced in one of his classes that "[...] over Christmas Allen Newell and I invented a thinking machine" (Gardner 1985: 146) the pioneers of Artificial Intelligence overstated the possibilities of algorithmic problem solving and they underestimated the pragmatic potential of it. They overrated the power of their program by proposing that human thinking can be performed algorithmically and they underestimated it by not being able to foresee what machine learning algorithms would be able to accomplish some 60 years later. Simon and Newell's "thinking machine" was the *Logic Theorist*, a programme that could create logical statements by combining any out of five logical axioms. This was a scientific sensation in the 1950s and was celebrated as evidence-by-machine of Alfred North Whitehead and Bertrand Russel's theoretical exposition in the *Principia Mathematica*. (Russel and Whitehead 1910) Russel and Whitehead demonstrated in an intelligent way that logical theorems could be deduced in an entirely formal manner, i.e. without creative intelligence. Raymond Fancher reports that Russel later admitted, that one of the machine deductions was "more elegant and efficient than his own". (Fancher 1979) Today we have arrived at a state of computational power, that makes automated problem solving of many tasks more efficient than the ones under human conduct. "Elegance" however, seems not to be an issue any longer. The "Winter of Artificial Intelligence" that started in the late 1970s (Crevier 1993: 203) pointed out that machines can perform various tasks that look like human thinking, but that an artificial intelligence that thinks in the way humans think is an impossible thing to accomplish. "Human-level artificial Intelligence? Be serious!" was Nils Nilsson's title for an important paper from 2003. *Google Assistant*, *Deep Face*, *Alexa* and *Siri* all work, and they definitely work well, but they do not tell us how humans think. The current interest in modelling information processing, closely related to the automation of quasi-intelligent behaviour and machine-based learning, is now permeating numerous research and development areas. This affects a wide range of scientific applications, which are highly affected by the regulation and analysis of complex processes. Thus, the interest for artificial neural networks is especially pronounced in fields of practice in which there is little explicit knowledge about the object area to be investigated. This concerns,

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for example, the systematic recognition and processing of patterns (texts, images) which are to be controlled by means of deep learning. The methods of neuroinformatics change large areas of scientific knowledge and have great influence on the knowledge fields of prognosis and diagnostics, classification, simulation and modelling, time series analysis, language development, image processing and pattern recognition.

The continuing upswing in life sciences, especially neurobiology and brain research, has led to neuroinformatics being instrumental in the development of automated infrastructures *(Internet of Things)*, intelligent sensor networks *(Sensor Information Technology)* and learning environments *(Deep Learning)* and thus exerts a major influence on the digital society, its culture and its social practice. (Shaviro 2014) This has an enormous effect on intelligent sensor networks (robotics and sensor information technology), on learning environments (deep learning) and on digital cultures as a whole but even on the scale of specialised methods and practices like technical computing, decision theory, computer vision, semantic networks, linguistics, multi-sensor technology, knowledge-based systems, automated deduction and reasoning, machine learning, robotics and planning. Theoretical approaches that have been suggested to accomplish this redefine such basic and fundamentally vital operations as *decision making, sensing, network control* and *agency*. An important question for the purpose of this issue is: In which ways are the recent trends of AI deconstructing the limits of the human? (cf. Hayles 2014: 199–210)

In a specific sense, neuroinformatics is of great importance for technical information processing and artificial intelligence and influences large areas of sensory and cognitive data modelling and processing, among others. (Halpern 2014) Within the fields of sensor technology (seeing), semantics and linguistics (language), robotics (manipulation of movement and behaviour) and cognitive science (learning) the (self-)learning algorithms and predictive models of neural information processing not only create epistemic frameworks for the design of multi-agent environments for communication, knowledge transfer, and education, but also create forms of knowledge and power of machine-based intelligence that enable new spaces of action for political and human resources economic processes and decisions. (Keedwell/Narayanan 2005)

The *New Artificial Intelligence* movement has abandoned the cognitivist perspective and now instead relies on the premise that intelligent behaviour should be analysed using synthetically produced equipment and control architectures. (cf. Munakata 2008) In order to explore artificial intelligence, today's researchers build robots that are supposed to show self-regulatory, learning behaviour within complex, and also learning, systems. (cf. Wenger 2014) Using (complete) autonomous agents, New Artifical Intelligence examines certain issues and basic concepts such as "self-sufficiency", "autonomy and situatedness", "embodiment", "adaptivity" and "ecological niches and universality" (cf. Pfeifer/Scheier 1999) involving vast areas of human and social sciences. On the other hand, New AI methods such as machine learning are employed in producing prognostic information on prospective behavioural patterns of web users: "A study publishing this month used machine learning to predict with 80 to 90 percent accuracy whether or not someone will attempt suicide, as far off as two years in the future. Using anonymized electronic health records from two million patients in Tennessee, researchers at Florida State University trained algorithms to learn which combination of factors, from pain medication prescriptions to number of ER visits each year, best predicted an attempt on one's own life." (Molten 2017) Learning algorithms and predictive models create new epistemic conditions for digital biometrics while at the same time also opening spaces of agency for political and economic processes and decisions, which we intend to subject to close scrutiny as part of our special issue. (cf. Stewart 2014: 67–99; Neidich 2014: 264–286)

This issue will also apply a historical perspective through analysing the past occurrences of AI discourses. The meaning of AI has undergone drastic changes during the last 60 years of international cooperation on research and development activities in the domain of intelligent technologies and infrastructures. What we talk about when saying AI is not what it meant in 1958, when John McCarthy, Marvin Minsky and their colleagues started using the term. Biological information processing is now firmly embedded in commercial applications like the intelligent personal *Google Assistant*, Facebook's facial recognition algorithm, *Deep Face*, Amazon's device *Alexa* or Apple's software feature *Siri* to mention just a few. (Manning 2015: 701–707)

In this context, the research design of *Artificial Intelligence* has changed significantly. Today, for example, *Natural Language Processing* (NLP) researchers operate on large portfolios of sample data and collaborate with the research department of the online search engine provider Google. The researchers of the *Artificial Neural Networks* (ANN) use the huge digitized textbooks available online (known as corpora) to statistically analyse linguistic conventions using big data. The "New AI" is no longer concerned with the needs to observe the congruencies or limitations of being compatible with the biological nature of human intelligence: "Old AI crucially depended on the functionalist assumption that intelligent systems, brains or computers, carry out some Turing-equivalent serial symbol processing, and that the symbols processed are a representation of the field of action of that system." (Pickering 1993, 126) Artificial intelligence research has been commonly conceptualised as an attempt to reduce the complexity of human thinking. (cf. Varela 1988: 359–75) The idea was to map the human brain onto a machine for symbol manipulation – the computer. (Minsky 1952; Simon 1996; Hayles 1999)

Already in the early days of what we now call "AI research" McCulloch and Pitts commented on human intelligence and proposed in 1943 that the networking of neurons could be used for pattern recognition purposes (McCulloch/Pitts 1943). Trying to implement cerebral processes on digital computers was the method of choice for the pioneers of artificial intelligence research.

The ecological approach of the New AI has its greatest impact by showing how it is possible "to learn to recognize objects and events without having any formal representation of them stored within the system." (Pickering 1993, 127) The New Artificial Intelligence movement has abandoned the cognitivist perspective and now instead relies on the premise that intelligent behaviour should be analysed using synthetically produced equipment and control architectures (cf. Munakata 2008).

Kate Crawford (Microsoft Research) has recently warned against the impact that current AI research might have, in a noteworthy lecture titled: *AI and the Rise of Fascism*. Crawford analysed the risks and potential of AI research and asked for a critical approach in regard to new forms of data-driven governmentality: "Just as we are reaching a crucial inflection point in the deployment of AI into everyday life, we are seeing the rise of white nationalism and right-wing authoritarianism in Europe, the US and beyond. How do we protect our communities – and particularly already vulnerable and marginalized groups – from the potential uses of these systems for surveillance, harassment, detainment or deportation?" (Crawford 2017)

Following Crawford's critical assessment, this issue of the *Digital Culture & Society* journal deals with the impact of AI in knowledge areas such as *computational technology, social sciences, philosophy, game studies* and *the humanities* in general. It can be assumed that the large-data research in the fields of advanced technology, humanities and social sciences is responsible for the reorganization of power relations in the digital society.

Subdisciplines of traditional computer sciences, in particular *Artificial Intelligence, Neuroinformatics, Evolutionary Computation*, *Robotics* and *Computer Vision* once more gain attention. Biological information processing is firmly embedded in commercial applications like the intelligent personal *Google Assistant*, Facebook's facial recognition algorithm, *Deep Face*, Amazon's device *Alexa* or Apple's software feature *Siri* (a speech interpretation and recognition interface) to mention just a few. In 2016 *Google, Facebook, Amazon, IBM* and *Microsoft* founded what they call a *Partnership on AI*. (Hern 2016) This indicates a move from academic research institutions to company research clusters. In this context we were interested in receiving contributions on the aspects of the history of institutional and private research in AI. We invited articles that observe the history of the notion of "artificial intelligence" and articles that are able to point out how specific academic and commercial fields (e.g. game design, aviation industry, transport industry etc.) interpret and use the notion of AI.

The work on Artificial Intelligence is expected to yield better results than competing models of computer science and computational neuroscience in the challenging applications of predictive modelling of knowledge, classifying pattern recognition, and fault tolerant learning. Artificial neural networks are used in applied computer science and mathematics because they allow alternative formalizations of computability. Today, neural networks are used for optical *(Image Clas-*

sification) and acoustic *(Speech Recognition)* pattern recognition and in robotics. In the military field, neural networks are used in automatic image analysis for target recognition. Against the background of these trends and upheavals, we not only question the cultural, social and political significance of today's dominant biological information processing, but also the historical dimension of the mutual influence of biology, cybernetics and early computer science since the mid-20th century training of research centres and networks. (Hauptmann/Neidich 2010)

Against this background, the special issue *Rethinking AI* explores and critically reflects the hype of neuroinformatics in AI discourses and the potential and limits of critique in the age of computational intelligence. (Johnston 2008) Digital societies increasingly depend on smart learning environments that are technologically inscribed. Our special issue is asking for the role and value of open processes in learning environments. Therefore, we invited contributions that are historical and comparative or critically reflective about the biological impact on social processes, individual behaviour and technical infrastructure in a post-digital and post-human environment (e. g. artificial neural networks, fuzzy systems, genetic algorithms, evolutionary computation, deep learning, prognostics and predictive modelling, computer vision). We had put together texts that discuss empirical findings from studies that approach the relationships between *neurobiology, brain research, computational intelligence, biopolitics, psychological research* and the *new AI* movement. Against this background, we (1) want to examine the scientific-historical, epistemological, and media-theoretical dimensions of New AI in order (2) to focus on their historical and performative dimensions, which provide a ground breaking foundation for understanding the basic requirements of the data society.

In his contribution, Lev Manovich discusses important challenges for Cultural Analytics research. In his survey on key texts and propositions from 1830 on until the present he examines the fundamental paradigms of data visualization, unsupervised machine learning, and supervised machine learning. He wants to clarify that the observation and analysis of culture means to be able to map and measure three fundamental characteristics: diversity, structures, and dynamics. Clemens Apprich's contribution presents the idea of a "psychoanalysis of things" and applies it to artificial intelligence and machine learning. His approach reveals some of the hidden layers within the current AI debate and hints towards a central mechanism in the psycho-economy of our socio-technological world. At a time, when algorithms, in the form of artificial neural networks, operate more and more as secret agents, the question of "Who speaks?" achieves high relevance. This question, situated at the centre of a psychoanalysis of paranoia, becomes central for the analysis of AI in Digital Cultures. Tiina Männistö-Funk & Tanja Sihvonen analyse the attempts at making speaking machines commercially successful on various occasions. They investigate how speech producing devices such as the actual digital assistants that operate our current technological systems fit into their historical context. Franz Krämer's article is about Educational AI. It is not only governments and the traditional educational institutions, but increasingly also companies, especially big technology firms like *Facebook, Google, Amazon* or *Microsoft,* that appear to see unlimited potential in educational AI, and steadily elevate their sponsorship and investments. His text approaches the phenomenon from a view that sees the educational relevance of AI as rooted in AI's characteristics as software. Software can be described – as another author of this Journal's issue has famously stated - as "our interface to the world, to others, to our memory and our imagination – a universal engine on which the world runs" (Manovich 2013) AI systems and the notion of educationally applied AI can be viewed as a result of social, economic, political and cultural production processes, including practices, structures and discourses interlinking education, educational technology and the notion of AI. Oscar Schwartz investigates how two competing visions of machine intelligence put forward by Alan Turing and J. C. R. Licklider have informed experiments in computational creativity, from early attempts at computer-generated art and poetry in the 1960s, up to recent experiments that utilise Machine Learning to generate paintings and music. Sebastian Vehlken's leading hypothesis argues that Swarm Robotics create a multifold "spatial intelligence", ranging from the dynamic morphologies of such collectives via their robust self-organization in changing environments to representations of these environments as distributed 4D-sensor systems. Johannes Bruder elaborates on deliberations of "post-enlightened cognition". His article explores links between cognitive neuroscience, psychology and artificial intelligence research. Bruder demonstrates how the design of machine learning algorithms is entangled with research on creativity and pathology in cognitive neuroscience and psychology through an interest in "episodic memory" and various forms of "spontaneous thought". Spontaneous thought, long time stigmatised as a sign of distraction or even potentially pathological, achieves a new valuation. Recent research in cognitive neuroscience conceptualises spontaneous thought as serving the purpose of creative problem solving and therefore builds upon earlier discussions around the links between creativity and pathology. Benjamin Gregg starts from the worrying observation that there is no consensually held scientific understanding of intelligence. He states that the term "intelligence" is no less indeterminate in the sphere of artificial intelligence than in general theoretical thought. This is obviously no hindrance to using the term "AI", because technical applications and biotechnical developments do not wait for scientific clarity and definitional precision. The near future, he proposes, will bring significant advances in technical and biotechnical areas, including the genetic enhancement of human intelligence (HI) as well as artificial intelligence (AI). Gregg shows how developments in both areas will challenge human communities in various ways and why the danger of AI is distinctly political. Andreas Sudmann investigates the media-political dimension of modern AI technology. The main focus of his paper is centred around the political implications of AI's technological infrastructure, especially with regard to the machine learning approach that since around 2006 has been called Deep Learning (also known as the simulation of Artificial Neural Networks). Sonia Fizek's contribution is about the automated state of play. She attempts to review and critically rethink anthropocentric rules of games. Two aspects guide her investigation: Firstly, she is interested in self-playing game worlds, self-acting characters and non-human agents traversing multiplayer spaces. These automated actors and environments are more than a merely technological enhancement of gaming. Secondly, based on a decentralised post-humanist reading, we might have to rethink digital games and play. This serves also for a critical reflection of games AI, which due to the fictional character of video games, often plays by very different rules than the so-called "true" AI. Catherine Griffiths writes about the visual tactics toward an "ethical debugging". Her critical study of artificially intelligent algorithms, strategies from the fields of critical code studies and data visualisation are combined to propose a methodology for computational visualisation. She argues that computational visualisation seeks to elucidate the complexity and obfuscation at the heart of artificial intelligence systems. This is the source for ethical dilemmas, that are a consequence of the use of machine learning algorithms in socially sensitive spaces, such as in determining criminal sentencing, job performance, or access to welfare. The paper of Monica Monin is concerned with the ways in which present day artists are engaging with artificial intelligence, specifically material practices that endeavour to use these technologies and their potential non-human agencies as collaborators with differential objectives to commercial fields.

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