Reframing Algorithms

STS perspectives to Healthcare Automation

Edited by
Francesco Miele · Paolo Giardullo

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ISBN 978-3-031-52048-8 ISBN 978-3-031-52049-5 (eBook)
https://doi.org/10.1007/978-3-031-52049-5

Cover Credit: Maram_shutterstock.com

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The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

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In memory of Barbara Czarniawska

Foreword

Digitalization inevitably brings outbursts of both panic and hope—not least within depictions of the future of healthcare. Will chatbots diagnose patients' problems incorrectly by misinterpreting descriptions of their symptoms, or will AI accomplish error-free analyses of serious disorders in next to no time? The editors and contributors of *Algorithmic Healthcare* undertook an analysis of the digitalization of healthcare from the STS perspective by simultaneously focusing on its social, medical, and technological aspects.

The process of digitalization has created many new phenomena, thoroughly analysed by the authors. Among these are platforms (a new way of organizing), social media in their role of contemporary Oracle (there is also a digital company of that name), the workplace health promotion (WPH) programs, or the "health surveillance" apps. The analyses, though rich in theory, never abandon the context of practice, as when describing different uses of algorithms during the Covid-19 pandemic, for instance.

In fact, one of the many strengths of this anthology is its breadth: The reported studies were conducted in several countries, thus highlighting both similarities and dissimilarities in the application of algorithms in a variety of cultural and political contexts. The same can be said of the sites under study, which include political authorities and a variety of workplaces—not only those in the healthcare sectors—and the opinions of patients and potential patients. In doing so, the authors were able to

contradict some common stereotypes—an image of the objects of healthcare "algorithmization" (especially the elderly and the ill) as passive and digitally backward, for example. It turns out that the "objects of care" can be creative, and even actively oppose "care measures" they do not trust. (Perhaps it would help if the programmers realized that the "elderly" users could easily be coevals of Steve Jobs or Bill Gates).

The authors, to borrow a quote from Chapter 4, managed "to stay away from hype and gloom" in their texts. Obviously, studies of actual practices always reveal the negative and positive sides of such practices. The really important question, assumed by all the authors, is, "What level of balance between the two is possible, and how can it be reached?" One conclusion is inevitable: that humans and algorithms must collaborate.

Bruno Latour, whose work is often evoked in the anthology, would, no doubt, be extremely interested in it. And so will many other scholars, both within and outside the STS.

Barbara Czarniawska
University of Gothenburg
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Preface

The making of a book, especially an edited book like this one, is linked to many turning points that all together contributed to a network of heterogeneous actors to properly network. As editors of this book we first experienced some serendipitous events.

It was autumn 2019 when we first approached together the issue of automation and digital technologies from a Science and Technology Studies (STS) perspective. Although we shared the office and some conferences, we did not have the opportunity to actively work together until then. We started our collaboration when we came across the opportunity to contribute to an edited book in Italian about new perspectives in work and organization in front of the so-called fourth industrial revolution. That book gave us the chance to develop the basis for critical analysis of algorithms transposing some issues from media studies, platform studies and organization studies. We were happy about that experience we considered it promising for developing something more structured. During the tougher pandemic times, in 2020–2021, we decided to focus on healthcare and algorithms: We promoted a session for the ESPANET (the European Network for Social Policy Analysis) conference we attended online. That experience was great for many reasons but we want to underline at least two of them that are relevant to the path that brought to this book: first, the hype of algorithms as typical of that period that anticipated the current hype of Artificial Intelligence.

Secondly, we noticed that there was a tendency—and perhaps is still mainstream—to have an institutional approach to technological change and innovation. Chairing experience in ESPANET confirmed some of our impressions and reinforced our idea about how research about algorithms in social sciences is interpreted: researchers appeared as evaluators of the social impact of those technologies or, sometimes, as critical observers of their consequences affecting different social realms. Looking at algorithms in this way implies the assumption of algorithms as distinct entities that enter the arena producing effects. Although it might sound reasonable, as described in the introduction and throughout the book, algorithms can be also interpreted as assemblages thus questioning the pre-given role they might play. This state of affairs definitely made us convinced about the opportunity to investigate algorithmic innovation further recognizing that STS may contribute actively to the debate but, at the same time, being informed from different perspectives and experiences. Last but not least our publisher made this project possible. In parallel to the conference we had the opportunity to set up a dedicated editorial project: Palgrave gave us the chance to build a place for collecting the research experience and the theoretical insights that compose this book. Authors participated with enthusiasm in this book providing insights, and investing time and efforts and we are extremely grateful for this.

Special thanks go to those who helped us in the review process of the chapter we collected for this book. We gathered an excellent ensemble of colleagues who served as reviewers, definitely contributing to improving the rigour and the clarity of the single chapters. Therefore we thank them all: Simone Arnaldi, Attila Bruni, Bruno Cattero, Claudio Coletta, Giada Danesi, Ulla Forseth, Alessandro Gandini, Alina Geampana, Rui Hou, Baki Kakici, Benjamin Marent, Sergio Minniti, David Moats, Francesco Nunes, Ivana Pais, and Alexandra Vinson.

The book could not be anything else than a collective effort and we are proud of having initiated such an endeavour.

Trieste, Italy — Francesco Miele
Padova, Italy — Paolo Giardullo
April 2024

Acknowledgements

This foreword is posthumous, as Barbara Czarniawska passed away on April 7, 2024, while the book was in the course of publication. Barbara leaves a significant human and intellectual void, given her importance for the development of the STS community and for the individual paths of many of the authors who contributed to the writing of the book. It is for these reasons that having her foreword on this book is an even greater honour for us.

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CHAPTER 1

The Encounters of Science and Technology Studies with Algorithms in the Analysis of Healthcare

Francesco Miele and Paolo Giardullo

In a blog post published on the digital media platform Mashable, journalist Sacha Lekach offered twelve ways that algorithms, called "the mysterious lines of code", can "increasingly control our lives—and our futures".[1] The examples she gave concerned digital platforms with services that we can buy or use for free online or on our smartphones. Although we may immediately think about an algorithm as something connected to digital technologies in our daily lives, the term dates back

[1] See Lekach, S. (2020, September 3). *12 unexpected ways algorithms control your life*. Mashable. https://mashable.com/article/how-algorithms-control-your-life

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F. Miele and P. Giardullo (eds.), *Reframing Algorithms*,
https://doi.org/10.1007/978-3-031-52049-5_1

about 900 years and comes from the Latin word *algoritmi*, a Latinisation of Al-Khwarizmi, the most widely read mathematician in Europe in the late Middle Ages. During the twentieth century algorithms have been widely applied. For example, Blest and Fitzgerald (1988) described a way to create sports competition fixtures as an algorithm, while the use of algorithms in the creation of timetables for school classes or for managing production flows has an even longer history (Dempster et al., 1975; Giffler & Thompson, 1960).

As Lekach's post hints, algorithms have entered the public discourse only recently, creating strong positive expectations that have contributed to attracting material and symbolic resources to the development of a new generation of algorithms, as well as generating anxiety and fear (Ames & Mazzotti, 2023). Rather than being restricted to a specific domain, algorithms now play a role in shaping our everyday routines, mediating information access and cultural consumption, mapping people's preferences and showing which are the most prevalent at a certain time, providing suggestions about how to act in the future and nudging some behaviours while discouraging others. Contemporary algorithms embedded in computers, digital platforms, mobile apps and wearable devices are developed through complex programming sessions, rely on different infrastructures for data collection and offer outputs through several screens and devices after elaboration. We refer to these technological components of daily life as *algorithmic technologies*, which can be defined as input–output computing systems "able to render decisions without human intervention and/or structure the possible field of action by harnessing specific data" (Issar and Aneesh, 2022).

The overlap between algorithms and technological innovation probably forms the base of the growing interest shown by science and technology studies (STS) in the former. Since their birth, STS, intended as an interdisciplinary field of studies, has explored how the development and use of technological applications are entangled with other social processes in law, politics, public policy, ethics and culture. Consistent with these key research interests, over the last few years, STS scholars have offered significant works to the theorisation and empirical analysis of the social and material processes through which algorithmic technologies are programmed and incorporated into our societies.

The extensive use and continuous development of algorithmic technologies in high-stakes areas, including education, employment, credit scoring, entertainment, cultural consumption, intimate relations and

healthcare, have stimulated the theoretical reflections and research experiences of a wide group of STS scholars from various disciplines of the social sciences, such as media, labour and cultural studies and organisational analysis. Over the last few years, imaginative theoretical constructs such as "algorithmically infused society" (Wagner et al., 2021), the "public relevance of algorithms" (Gillespie, 2014), "algorithmic fairness" (Wang et al., 2022), "algorithmic authority" (Carlson, 2018; Lupton & Jutel, 2015) or "algorithmic governance" (Coletta & Kitchin, 2017; Issar & Aneesh, 2022) have explored the mutual entanglement between algorithmic technologies and societies. Despite different theoretical backgrounds, STS and, more generally, social science scholars appear increasingly interested in showing how algorithmic technologies are programmed to reshape the daily lives of their users and, in turn, how users are involved in appropriation processes, transforming algorithms into terrains for participation, resistance and conflict.

Against this framework, this book aims to offer a fully fledged exploration of STS encounters with a less covered topic in the debate: the design and use of algorithmic technologies in healthcare. To take a non-normative and comprehensive perspective, for us, "healthcare is about keeping people healthy or fixing them up when they get sick".[2] From this standpoint, healthcare regards the prevention, treatment and management of an illness and the preservation of mental and physical well-being as involving professionals as well as patients and their caregivers. Why is there a need for an STS book focused on algorithms in healthcare?

Over the last decade, thanks to advancements in artificial intelligence (AI) techniques, complex algorithms have been developed and put to work in the healthcare sector, with the aim of assisting or replacing human actors. In parallel, policymakers have begun to imagine a world in which machines can analyse large and heterogeneous amounts of data, make accurate predictions and provide recommendations to support decision-making processes with a sort of techno-enthusiasm (Lupton, 2016). In contrast, scholars working in the interdisciplinary field of critical digital health studies have raised concerns about the ability of AI algorithms[3]

[2] See Emanuel, E. J. (2013, February 2). We can be healthy and rich. *The New York Times*. https://archive.nytimes.com/opinionator.blogs.nytimes.com/2013/02/02/we-can-be-healthy-and-rich/

[3] Here, we neither discuss nor review the literature concerning the multiple definitions of AI and the most recurrent criticisms of the massive use of this term. For the goals

to strengthen pre-existing social inequalities, enable new and pervasive surveillance processes and consolidate power asymmetries (Iliadis & Russo, 2016). These diverse polarised positions often share a deterministic perspective on algorithms, conceiving them as invisible and autonomous "entities" that can positively or negatively impact social life (Schwennesen, 2019).

A relevant prompt for this book is the deep dissatisfaction with these deterministic perspectives that are more interested in forecasting or assessing the broad effects of algorithmic technologies on society than in exploring the processes through which they are enacted and incorporated in ever-changing socio-material contexts. Technological determinism extended to the study of algorithmic technologies has contributed to keeping them opaque and—as evoked at the beginning of this introduction—mysterious for academic and non-academic audiences. As argued by Burrell (2016), the opacity of algorithms can take different forms. It can be intentionally pursued by institutions and corporations, linked to the inaccessibility of codes developed by highly specialised programmers (called "coding elites" by Burrell & Fourcade, 2021), or a consequence of the mismatch between mathematical procedures of machine learning algorithms and human styles of semantic interpretation. In the healthcare sector, keeping the ways through which algorithmic technologies are enacted opaque means remaining unaware of the imaginaries, interests, ideologies, legalities and repertories of knowledge that guide the design of technologies that can have impressive consequences on society (in terms of equal access to healthcare services, quality of care, relationships between patients and professionals and cultural representations of health and illness). Deterministic perspectives also overlook "how algorithms do work in the world" (Kitchin, 2019, pp. 25–26)—when they are put in everyday contexts, they are adopted, used, re-interpreted, tackled and domesticated by heterogeneous networks of individuals (e.g.

of this book, it is sufficient that this label is currently used for defining the algorithms that—at least for the purposes of designers—can evolve in response to learned inputs and data. The ability to learn from data and make decisions based on that knowledge is what distinguishes an AI algorithm from a traditional one, which is identified with a preset and rigid recipe that is executed when it encounters a trigger. For a deeper discussion about this difference see Tabsharani, F. (2023, May 5). *Types of AI algorithms and how they work*. TechTarget. https://www.techtarget.com/searchenterpriseai/tip/Types-of-AI-algorithms-and-how-they-work#:~:text=AI%20algorithms%20are%20a%20set,%2Dsolving%20and

patients, family caregivers and professionals), organisations (e.g. hospitals, community-based care services and working organisations involved in health promotion programmes), infrastructures and technological artefacts (e.g. electronic health records, digital images and data).

Thanks to the contributions collected in this edited book, we aimed to interpret algorithmic technologies as something intelligible and to shed light on the social processes through which they are enacted and incorporated into healthcare settings.

More broadly, tackling algorithmic technologies in healthcare through different contributions of STS scholars allows us to address a fundamental issue that currently faces the social sciences: most existing social theories were not developed with the deep societal reach of algorithms in mind (Wagner et al., 2021). As mentioned earlier, the seductive myths circulating in the public sphere—developed in a context characterised by a shortage of economic resources and by a progressive affirmation of neoliberal assumptions in political agendas—emphasise the heroic role of algorithms in assuring excellent quality of care and, at the same time, containing expenditure in public health systems. In parallel, medical and computer scientists, supported by quantitative and standardised methods, are often engaged in studies and projects that support the economic and political decisions behind these myths and are irremediably bound to "the course of the progress" (Weber, 1958, p. 355). Accordingly, this book—in Weber's words—tries to reaffirm that the role of the intellectual sphere is to provide "a reasoned view of the world" (p. 355) that involves an inner devotion to the scientific tasks of theorising, understanding and unchaining academic work from political and economic domination (Ossewaarde, 2019). STS, born to explore the mutual entanglement between society and techno-science, are particularly suitable to take up this challenge because this field of studies:

> …instead of asking why things happen, . . . asks how they occur. How they arrange themselves. How the materials of the world . . . get themselves done in particular locations for a moment in all their heterogeneity. And how they go on shifting and relating themselves in the processes that enact realities, knowledges and all the rest. (Law, 2008, p. 632)

This approach to practising social critique moves away from the one that characterises the above-mentioned critical digital health studies that are mainly aimed at underlining how dominant ideologies and interests

play a crucial role in the creation and circulation of machines governed by algorithms. Rather than investigating why these technologies are increasingly spreading around the world and what the benefits or threats brought by them are, this book explores how "algorithms perform in context, in collaboration with data, technologies, people … producing localised and situated outcomes" (Kitchin, 2019, p. 25), taking for granted that the interests, imaginaries, ideologies, legalities and knowledge at stake are multiple and that the emerging arrangements are situated and temporary.

The work done for this book addresses this challenge because it considers issues relevant for all social scientists interested in an STS perspective on algorithms, whether or not they are involved in research about healthcare technologies. The dynamics through which imaginaries about a future with algorithmic technologies are negotiated and put into circulation, the inscription of professional knowledge in these machines, as well as the use of algorithms for distributing benefits among employers or the resistance practices enacted to avoid the control exercised by a population against algorithmic surveillance—to mention certain themes tackled by this book—are topics that can provide theoretical constructs that can meet also other scholars' interest even beyond the core of this book.

At this point, it is important to provide an overview of the role that algorithmic technologies can play in healthcare. Looking at the literature that has emerged around algorithms in healthcare, with reference to computer science and clinical studies, algorithmic technologies are currently spreading in three main areas of application (Ozcan, 2023; Yu et al., 2018):

- Diagnosis: Algorithmic technologies can be used to identify potential diagnoses based on a patient's symptoms and medical history. Algorithms are generally paired with databases composed of electronic patient records that show the medical histories of each citizen, images and numeric values generated during clinical examinations and real-time data gathered thanks to the adoption of sensor devices that detect and quantify patients' symptoms. Starting from the analysis of these data, algorithmic technologies can compare detected clinical parameters with those of a wider population (e.g. the same age group or people that have developed a certain disease over the years), identify patterns in the data that can be revealing of specific

medical conditions, indicate a diagnosis to healthcare providers and suggest recommendations for further testing or treatment.

- Treatment: Algorithmic technologies can support the formulation and execution of treatment plans for patients. In line with these general purposes and with the principles of so-called personalised medicine, algorithms embedded in algorithmic technologies can be programmed to provide treatment recommendations tailored to each patient's unique medical history, genetic makeup, disease progression and other factors. For example, algorithms can be developed to analyse a patient's genetic information and identify which medications are most likely to be effective for that individual or which diseases they may be more prone to. Algorithmic technologies are also designed to help patients and their caregivers comply with clinical prescriptions and/or efficiently self-manage therapies. This happens, for example, when mobile apps are designed to provide tailored suggestions for changing patients' habits and adopting healthy nutrition compatible with certain clinical conditions. Finally, algorithms can guide machines in delivering a certain therapy or intervention. This is the case, for example, in autonomous robotic systems that employ suturing algorithms and imaging systems to guide the movements of instruments in surgical interventions.
- Monitoring: Algorithmic technologies can be used to track a patient's progress over time and provide recommendations for adjustments to their treatment plans if necessary. For many years, remote monitoring systems have incorporated algorithms that analyse the values of patients with chronic conditions, applying a set of predefined rules to detect anomalous situations and alert clinicians and/or patients. This is the case in remote monitoring systems for people with diabetes that, using electronic logbooks filled in by patients, continuously monitor glucose levels in blood, sending alarms if values are out of the recommended range. In contrast, remote monitoring systems governed by AI are programmed for learning and redefining their recommendations, starting with the analysis of real-time data. This is the case in algorithmic technologies ideated for classifying patients by their response to chemotherapy, upgrading the prognosis of patients receiving thoracic organ transplantation and predicting the probability of a cardiac arrest in cardiopathic patients.