Architectonic Explorations of Radio

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Introduction

The book *Radio Explorations* engages with digital data on radio signals to trace the entanglements of nature and culture in this electromagnetic medium. The wider scope of this effort is to challenge the foundational essentialization of opposites in modern conceptions of the world – body-mind, nature–culture, matter-information, one and the other – and to do that by exposing the necessity of an intersectional perspective on technology. Radio signals do not easily fit the categories: they can be 'natural' (i.e., solar storms) and 'cultural' (i.e., telecommunications); they are 'immaterial' and yet able to transport information across space.

This book is the result of a practice-based exploration of digital and computational processes, materiality of radio signals and the promise of data self-organization. Rooted partly in practice of experimental design, and partly in feminist new materialism and intersectionality, this research reimagines what it means to know radio signals, that is, to articulate an architectonic position engaging with their material, informational, mediating, political and social aspects. While this research can claim none of the academic fields it visits as its own, it seeks to frame the problem of the conceptualization of radio signals as an interdisciplinary problem that relates and connects different disciplines, without reducing them to one dominant view. The diversity of contributions in the present volume demonstrates the importance of intersectional perspectives on radio signals, digital archives, and technical artefacts more generally. Radio cannot be known through engineering knowledge alone,

nor can it be reduced to a singular disciplinary perspective. In *Data Feminism*, Catherine D'Ignazio and Lauren F. Klein[1] engage with intersectional analysis of the ways in which systems for data collection and classification perpetuate oppression. They recognize an initial impasse: to be put to use, data must be classified in some way, as Geoffrey Bowker and Susan Leigh Star pointed out[2]. Once the system works, it becomes 'naturalized'. To question classification is a feminist concern: how are people divided in categories by age, gender, race, place of birth or postal code?

The collection of texts presented here documents the encounter of invited artists, architects and scholars at two research meetings held as part of the research project *Negentropic Explorations of Radio*[3] (2020–21). This collection is complemented by two interviews which extend the perspective on radio between technical expertise of telecommunication and artistic concerns for the materiality of energy. The starting point for the discussions and reflections in this volume is the experimental design engagement with digital information, which itself starts from a digital archive, the Signal Identification Guide (SIGID).[4] The SIGID wiki documents listening practices of a community of radio amateurs and enthusiasts. Recordings of radio signals 'in the wild' can capture the interest of a telecommunications engineer, a media archaeologist, a data scientist, an ecologist, a historian of science and technology. The outcome of the experimental work with the data are two 'data observatories' which pro-

1 Catherine D'Ignazio and Lauren F. Klein, *Data Feminism* (Cambridge, Massachusetts: MIT Press, 2020).

2 Geoffrey C. Bowker and Susan Leigh Star, *Sorting Things out: Classification and Its Consequences*, 1st paperback edition, Inside Technology (Cambridge, Massachusetts London, England: The MIT Press, 2000).

3 Documentation of the SNSF-funded project Negentropic Explorations of Radio (SNSF 190310) is available at: http://radioexplorations.ch (accessed 11.12.2021).

4 The SIGID guide wiki is a collection of digital recordings of radio signals captured 'in the wild' by the wiki contributors. Information on the signals is gathered mainly for the purpose of identifying signals by this community of radio amateurs. All recordings and descriptions are available here: https://www.sigidwiki.com/ (accessed 11.12.2021).

pose intuitive ways to orient oneself across different aspects of digital data: categories, features, similarity.

Encountering radio signals

In the summer of 2009, at a workshop on *Data Forensics and Urban EM interventions* at Haus der Kulturen der Welt (HKW) in Berlin, participants learned to use open-source Wi-Fi network analysis tools and build *cantennas* from scrap material. Artists Martin Howse and Julian Oliver who led the workshop, problematized the 'leaking' of private, secured networks into public space, and access to networks more generally. Howse and Oliver were active within an artistic scene that explored networked media and communication through hacking, visualization and playful interference. As one of the participants at the HKW workshop, I became interested in materiality of wireless networks and other radio signals, which gradually developed into the research that addresses materiality of signals as data and energies, discussed in this book.

A couple of years after the HKW encounter, an important discovery hit network-aficionado communities. Engineers gathered around the open-source mobile communications project (osmocom)[5] found a way to turn small USB dongles, made for digital television (DTV) reception, into computer-based radio scanners. The discovery of this affordable software-defined radio (SDR) opened the specialized domain of electromagnetic engineering and research to tech-savvy radio amateurs. The use of RTL-SDR proliferated and a community formed around it, curious to explore the radio space.

The struggle to access and understand the propagation of Wi-Fi networks lead Carl Colena, a computer engineer and a student at the City College of New York at that time, to purchase a small electronic device

5 The project documents the way DVB-T dongles based on the Realtek RTL2832U can be used as a cheap SDR, as described here: https://sdr.osmocom.org/trac/wiki/rtl-sdr.

made for digital television reception (DTV) to understand the Wi-Fi environment at the college campus and orient himself towards stronger signals.[6] Gradually, his interest in radio signals lead him to become one of the main contributors and eventually the administrator of the Signal Identification Guide (SIGID) wiki website, which documents radio signals recorded 'in the wild'. The SIGID wiki project dates back to 2014, when Carl Laufer, the owner of the RTL-SDR radio amateur blog, started a centralized database of radio signals that could be recorded using this accessible equipment. The SIGID wiki website is a collection of all the information about radio signals that is held among a community of amateurs and enthusiasts, in form of a digital archive. It includes digital recordings of signals, as well as textual descriptions and meta-data in an online database. This digital archive is the starting point and the source of data for radio explorations discussed in this book.

Encountering data: the architectonic disposition of a dataset

Different domains of theory and practice related to radio and telecommunications would approach the systematization of radio signals knowledge each with their own specific set of questions. An information studies scholar might focus on protocols and modulations, ways to keep track of different properties of signals and organize this knowledge in the archive. A data feminist might problematize these archival practices, looking into the way differences among signals have been naturalized (or not), as well as the presence of certain types of transmissions and certain archivists in the archive. A data visualization scholar could bring forward the importance of paying attention to methods that transform unobservable phenomena, such as radio, into visual systems that give us access to relationships between data on signals. What can recordings of radio signals tell us that we do not already know in theory? And how could we move across these different domains, without trading

6 See interview with Carl Colena in this volume.

the depth and span of expert knowledge for general understanding of communication technologies?

Large datasets form the basis of patterns and predictions identified in algorithmic operations of contemporary computational practices. In an article about historical technologies of information management, Shannon Mattern questioned if patterned data can ever be considered meaningful information. She noted that data, "in both its digital and analogue forms, has long been transformed into spectacle and packaged as a critical tool for cultural transformation."[7] What else, besides patterns or spectacle, might we see in data on radio signals?

Machine learning algorithms and artificial intelligence are often discussed in term of *black boxes* in engineering circles today. The *black box* articulation currently in circulation is rooted in post-World War II cybernetics and psychology research, where it was used to generalize a notion of systems so that the effects could be observed independently from their operation on an established consistency of inputs and outputs. Science and technology studies cultivated an interest in the black box of scientific facts, notably in the writings of Bruno Latour such as his collection of essays entitled *Pandora's Hope*.[8] With the box opened and absolute truth out of sight, Latour suggested, the only thing to do is to go deeper to reach the hope at the bottom. Importantly, Latour did not propose to simply smash black boxes open with hammers. Felix Stalder poignantly reminds us: "Treating complex systems as black boxes is a way of reducing complexity and this is often a very sensible thing to do."[9] Still, he continued, we can distinguish between an old and a new kind of black: between systems whose logic is accessible to specialized knowledge and systems whose elements are non-transparent even to the people who built them.

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7 Shannon Mattern, "The Spectacle of Data: A Century of Fairs, *Fiches*, and Fantasies," *Theory, Culture & Society* 37, no. 7–8 (December 2020): p 136, https://doi.org/10.1177/0263276420958052.

8 Bruno Latour, *Pandora's Hope: Essays on the Reality of Science Studies* (Cambridge, Massachusetts: Harvard University Press, 1999).

9 Felix Stalder, "The Deepest of Black. AI as Social Power," *Entangled Realities – Living with Artificial Intelligence Exhibition Catalogue*, May 9, 2019, http://felix.openflows.com/node/539

The view of the process gets lost among layers of computational routines initiated with a couple of parameters and goals towards which to optimize the 'learning' or 'training' process. The question is, what should we do with these systems, given that they cannot be simply opened, while slowly creeping into every aspect of anticipation, without much accountability.

The method of working with digital data discussed in this book is inspired by the notion of *architectonic disposition*, articulated by Vera Bühlmann in *Posthuman Glossary*.[10] This method implies a volumetric thinking model that puts nature (the given or potential), the observable (a layout, a ground) and the viewing operation (perspective) into a volumetric relationship of proportionality. This method is inspired by a historical experimental approach of the ancient Greek mathematician Thales of Miletus to geometric measurement. Michel Serres described in the *Origin of Geometry*[11] how Thales measured the height of the Great Pyramid of Cheops. He established a proportionality between the height of a wooden stake and the height of the pyramid through the lengths of their shadows cast in the sand, establishing a space of similarity. The pyramid could not be measured directly, not only due to physical difficulty, but also because it would be considered a gesture of sacrilege to the pharaoh. Having no access to the pyramid itself, Thales turned to the sun to speak about it: "he asks the object in motion to provide a constant flow of information about the object at rest."[12]

Consider again the black box. As Latour pointed out, we might open it but find almost nothing there.[13] Serres' figure of the Harlequin, the Emperor of the Moon, is even more explicit: Harlequin's composite body dressed in a thick layer of coats, each made of thousand pieces and

10 Vera Bühlmann, "Architectonic Disposition: Ichnography, Scaenography, Orthography," in *Posthuman Glossary*, ed. Rossi Braidotti and Maria Hlavajova (London: Bloomsbury, 2018).

11 Michel Serres, *Hermes. Literature, Science, Philosophy*, ed. Josué V. Harari and David F. Bell (Baltimore: Johns Hopkins University Press, 1982) see Part II, chapter 10. The Origin of Geometry, pp 125–133.

12 Serres, p 87.

13 Latour, *Pandora's Hope*.

colours of clothes stitched together, withstands any methodical analysis: no amount of undressing will reveal its true nature.[14]

Radio explorations and materiality of information

The book and the project *Architectonic Explorations of Radio* demonstrate ways to work with abstract datasets, computational training processes, and to understand situated yet invisible radio transmissions. The transmissions are situated by virtue of being recorded by specific people, on specific locations on Earth, and included in the database on radio signals, SIGID wiki. A wiki user can compare a signal they recorded in the wild to signals organized in the database, using some form of classification – according to the frequency band, or broadcast category – looking for a match. This identification process relies on profound and often implicit knowledge of signal engineering and experience of having 'heard' or 'seen' a signal before.

One of the premises of this book is to question the way we order things. This builds on the well-known work by Susan Leigh Star and Geoffrey Bowker[15] who saw classification as essential to any working infrastructure. With an interest in difference, or similarity, between the way people and machines perform intuitive pattern recognition, they propose a method for re-ordering digital information. This method is based on the development and use of *data observatorie*s to organize and explore concrete manifestations of radio signals, using the self-organizing map (SOM) – an unsupervised machine learning algorithm. The *digital observatories* enable the complex, mediated observation of radio sig-

14 Michel Serres, *The Troubadour of Knowledge*, Studies in Literature and Science (Ann Arbor: University of Michigan Press, 1997).

15 Susan Leigh Star, "The Ethnography of Infrastructure," *American Behavioral Scientist* 43, no. 3 (November 1, 1999): 377–91, https://doi.org/10.1177/0002764991955326; Bowker and Star, *Sorting Things Out*.

nals through publicly available web-based interfaces.[16] We can approach a *data observatory* more like an instrument rather than a tool – an instrument to measure and perform multidimensional information. Architect and researcher Miro Roman, one of the contributors of this book, articulated such an instrument as a 'double articulation' of algorithm and data[17], loosely based on Deleuze's and Guattari's notion.[18] The instrument brings into relationship the person playing it, the radio signals in the environment, and the digital data from the SIGID database. It is a partial and engaged method that brings out different voices from the dataset.

This book does not seek to lay open the black box of machinic reason performed by the SOM algorithm. Rather, it inquires into the possibility of "digital literacy": a sensorial and cognitive coupling with digital information which enables one to play with it like an instrument. Digital literacy is about practicing intentionality: articulating ways to index data by a situationally meaningful criterion.

This book and research project aim to facilitate speculation on the connection between signal representation and technical communication protocols, by shifting criteria of similarity from taxonomical and instrumental (e.g. used in military) or physical (e.g. high or low frequency), to properties shared across all signals – such as the probability of silence or noise in the signal. If the challenge today is not to separate artificial from natural or information from noise in banal or fixed ways, it is in the interaction with this information that we should look for the ways to articulate productive differences.

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16 The two *data observatories* developed in this project are available online, as *Descriptions* https://radioexplorations.ch/descriptions/ and *Projections* https://radioexplorations.ch/projections/ (accessed 21.06.2022).

17 Miro Roman, *Play Among Books: A Symposium on Architecture and Information Spelled in Atom-Letters*, Applied Virtuality Book Series 17 (Basel: Birkhäuser, 2022).

18 Gilles Deleuze and Félix Guattari, *A Thousand Plateaus: Capitalism and Schizophrenia* (Minneapolis: University of Minnesota Press, 1987) see chapter 3. 10,000 B.C.: The Geology of Morals (Who Does the Earth Think It Is?) pp. 39–75.

Structure of the book

The special approach to radio signals, digital information and their materiality is introduced in a discussion with two interviewees: Douglas Kahn, the author of two books on the use of radio and energy more generally in the arts[19] and Carl Colena, the administrator of the SIGID wiki website. Douglas Kahn talked about the phenomenon of natural radio, its use in the arts as well as in climate science. Carl Colena introduced the background of the SIGID wiki project, related listening and knowledge practices and the community's archival strategies.

The second chapter presents essays that emanated from the research meeting on *Technicity of Listening* – knowledge, tools and approaches to digital data. Three invited guests, Carl Colena (SIGID wiki), Miro Roman (CAAD, ETHZ) and Simone Conforti (IRCAM) presented their current research into archives of radio signals, images, books and music, as well as strategies for articulating profiles and identities with data.

The third, intermezzo chapter documents the 'data observatories.' They were presented as a starting point for exchanges by the research team, Selena Savić and Yann Patricks Martins. The first *data observatory* called *Descriptions* was discussed at the first workshop meeting, while the prototype of the second data observatory, *Projections*, was discussed in terms of rewriting radio signals through different domains, such as music or sounds of nature.

The fourth chapter presents essays originating from the second research meeting, *Rewriting the Networks*. Together with three invited guests, Sarah Grant (Weise 7 and Kunsthochschule Kassel), Roberto Bottazzi (The Bartlett) and Miro Roman (CAAD, ETHZ), we explored the notion of *rewriting* in context of telecommunications and beyond: how to translate between domains, such as the natural environment and network infrastructures, digital and spatial, books and architecture.

19 Douglas Kahn, *Earth Sound Earth Signal: Energies and Earth Magnitude in the Arts* (Berkeley: University of California Press, 2013); Douglas Kahn, ed., *Energies in the Arts* (Cambridge, Massachusetts: MIT Press, 2019).

The final, post-scriptum chapter presents the findings and outlooks from the project, joined by an invited contribution by artist and researcher Lisa Müller-Trede. Her work is concerned with algorithmic order of difference within merged breath signals. Next to Müller-Trede's essay, this chapter presents the author's approach to understanding radio signal materialities and offers stories and resistance instead of hard discrete data, clusters and predictions.