

Shintaro Miyazaki

Unrecognized Links between Algorithmic and Audio Filtering Fragments of a Critical (Media-)Theory of Filters and Extraction

2024

<https://doi.org/10.25969/mediarep/22943>

Veröffentlichungsversion / published version

Sammelbandbeitrag / collection article

Empfohlene Zitierung / Suggested Citation:

Miyazaki, Shintaro: Unrecognized Links between Algorithmic and Audio Filtering Fragments of a Critical (Media-)Theory of Filters and Extraction. In: Ralf Adelman, Tobias Matzner (Hg.): *Filter*. Paderborn: Universität Paderborn 2024 (Medienwissenschaftliches Symposium der DFG 4), S. 1–6. DOI: <https://doi.org/10.25969/mediarep/22943>.

Nutzungsbedingungen:

Dieser Text wird unter einer Creative Commons - Namensnennung 4.0/deed.de Lizenz zur Verfügung gestellt. Nähere Auskünfte zu dieser Lizenz finden Sie hier: <https://creativecommons.org/licenses/by/4.0/deed.de>

Terms of use:

This document is made available under a creative commons - Attribution 4.0/deed.de License. For more information see: <https://creativecommons.org/licenses/by/4.0/deed.de>

Shintaro Miyazaki

Unrecognized Links between Algorithmic and Audio Filtering Fragments of a Critical (Media-)Theory of Filters and Extraction

The idea I want to present here is as follows: If information filtering is to be studied in the age of digital capitalism, or as McKenzie Wark argues, in the age of something much worse,¹ then it might be helpful for debates and critical analyses to reconsider our² conventional understanding of the object called filtering. Filtering is predominantly conceived in the sense of a mechanical filter,³ as in the case of the coffee filter, that is, as a module, intermediate part, indeed a medium, through which information, data, and meanings flow. Portions of which are then left behind, as in the case of a sieve; the residues, if you will, can have positive as well as negative or even neutral connotations. Another field of meanings is provided by the optical filter effect we know from sunglasses. Both approaches understand filtering as a procedure to control the flow of information and they both already offer to media studies scholars useful concepts for process-oriented analysis and critique. My thesis here, however, is that since the advent of first analog-electronic (1910–), then digital-electronic media (1940–), a somewhat different understanding of the filter would be more appropriate, especially when it comes to aspects of current data extractivism in digital capitalism. In contrast to the coffee filter and sunglasses, the electrical filter, also called the wave filter, as a communications engineering component first used in telephony as a sound filter and modeled⁴ as a combination of electrical resistance and capacitor, provides a direct link to techno-mathematics, which could provide the basis for an analysis of the current exploitative and discriminatory methods of information filtering and extraction, such as those in use on social networks or gig economy platforms (MTurk, Uber, Deliveroo) for the purpose of immeasurable profit generation. The wave filter refers to developments that already became virulent with the advent of telegraphy and the laying of the transatlantic submarine cable in the late 19th century. Before the filter comes into play, the cable as a material object had to be made calculable, i.e. techno-mathematically calculable and operable.⁵ Here in this contribution, I am by no means concerned with a technical quibble, but rather with an attempt to take the position between a purely mathematical explanation of filtering, such as is often provided by the engineering sciences nowadays, and the simple image of filtering as we can experience it when making filtered coffee or putting on sunglasses. This intermediate position allows to emphasize the materiality of filtering, its materialization in reality, which, as mentioned, also produces sociopolitical and technopolitical effects, while at the same time making excursions into the mathematics of the vector. The materiality of the filter has a particularly memorable effect in the realm of the audible, so that through my theory of the algorithmic,⁶ it also

1 See McKenzie Wark: *Capital Is Dead: Is This Something Worse?*, London, New York 2019.

2 I use the pronouns 'we' and 'us' inclusively. Nevertheless, I do of course respect differential opinions within our thinking community.

3 Etymologically related to the word 'felt'.

4 I define model as a construct that has both real and symbolic parts and has been instrumentalized to simplify facts, processes, relations, situations and to make them calculable.

5 In the media history of telegraphy, it was noticed early on that the channel delays the signal (later one would say filter). The wave filter was not created until around 1920. First the channel had to be made calculable and manageable by modeling. See generally Kilian Hirt, Axel Volmar: *Kanalarbeit. Das Übertragungsproblem in der Geschichte der Kommunikationstechnik und die Entstehung der Signalverarbeitung*, in: Axel Volmar (ed.), *Zeitkritische Medien*, Berlin 2009, p. 213–238.

6 See Shintaro Miyazaki: *Algorithemics: A Diffractive Approach for Understanding Computation*, in: Jentery Sayers (ed.), *The Routledge Companion to Media Studies and Digital Humanities*, London 2018, p. 243–49.

allows for an aesthetico-ethical perspective on the signals and rhythms produced by information filtering and extraction.

Processes of information filtering in and through everyday media and the many systems they form occur at a wide variety of levels, places, and times. The perspective adopted here for the time being is the micro-perspective. In the following, contrary to the convention to historicize in a chronological order, the first step is to try to theorize so-called artificial neural networks as an update of the electrical filter, from the perspective of the last decade, and thus to illuminate them epistemically and at the same time to simplify them. Artificial neural networks build the basis of all the hypes around Deep Learning, artificial intelligence and ChatGPT. After that, the temporal frame jumps back a whole century to the decades around 1900. Then, the gaps in between are tentatively filled with contexts of a media history and media archaeology of filtering.

2020

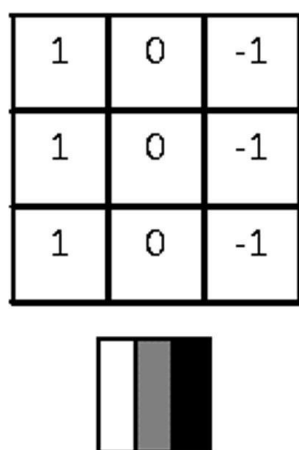


Fig. 2: Convolution Matrix

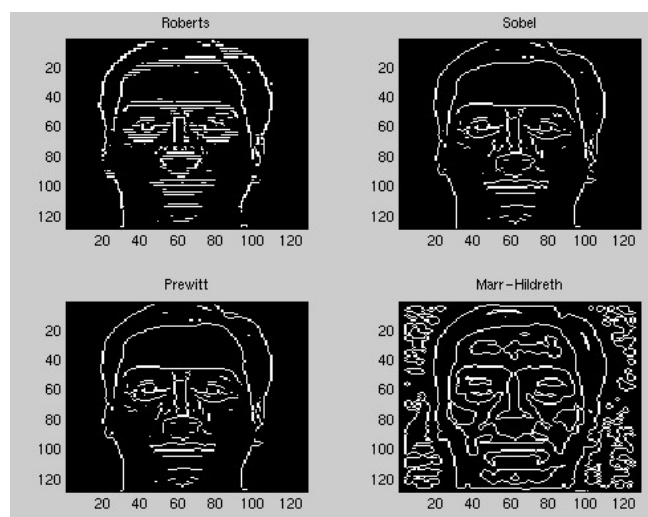


Fig. 1: Image Filter

The recognition and analysis of both the identity of the source and the content of voices, faces, motion and person profiles have been done for several years with artificial neural networks, which are known to be fed with vast amounts of data and conditioned so that they can discriminate⁷ the desired content. In this context, the recognition of a trained content in image recognition is mostly done by so-called *Convolutional Neural Networks (CNN)*. A CNN consists of several layers of two- or three-dimensional matrices, which are tables of numbers consisting, for example, of the brightness values of an image. As in all artificial neural networks, a single element of a matrix, also called an artificial neuron, receives input from a neuron in the previous layer and forwards this input to a neuron in the next layer. In convolutional networks, a so-called convolution occurs during forwarding. A smaller matrix, also called convolution matrix⁸ or filter mask (see Fig. 1), consisting of, for example, 3x3 fields, scans the current layer.

See also Shintaro Miyazaki: *Algorithmiert. Eine Medienarchäologie digitaler Signale und (un)erhörter Zeiteffekte*, Berlin 2013.

⁷ Relevant to the topic of data and discrimination, see generally Wendy Hui Kyong Chun, *Discriminating Data: Correlation, Neighborhoods, and the New Politics of Recognition*, Cambridge (MA) 2021.

⁸ Wikipedia, Kernel (image processing), [https://www.en.wikipedia.org/wiki/Kernel_\(image_processing\)](https://www.en.wikipedia.org/wiki/Kernel_(image_processing)) (4.4.2023).

In each case the scalar product of the 3x3 field of the layer with that of the smaller matrix is calculated. This calculation creates a new filtered layer. A matrix like the one shown in Fig. 1 operates as a vertical edge filter. The composition of many such filters over several matrix layers in the entirety then forms a specific CNN, which can, for example, filter the front view of a dog and thus ‘recognize’ it in the figurative sense. We may be familiar with image filters (see Fig. 2) from image processing with *Adobe Photoshop*, with which we can emphasize, blur or make certain image elements disappear. Conceptually, they are to be understood as a mask, the word filter mask has already been used above, that is, as a template. So now we have, in addition to the coffee filter and the sunglasses, the metaphor of the template to understand filtering. The visualization of the operativity of individual layers, their masks and templates is colloquially called “feature visualization”.⁹ In addition, “feature sonification”¹⁰ exists in the field of music recognition. It seems to be handy when it comes to understanding CNNs superficially. However, the electrical filter, i.e. the filter that we might know from the various sound settings of the audio system in the car or the wireless speakers – I mean here sound settings like *Bass Boost*, which emphasize the basses or similar – offers, as I argue here, additional, useful perspectives.

1900->1920

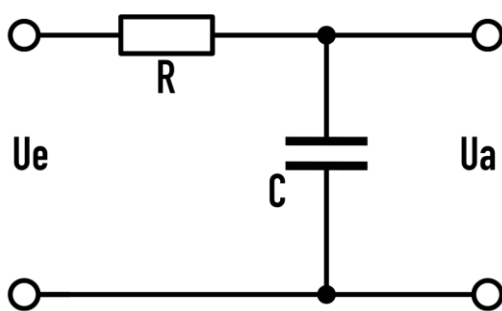


Fig. 3: Electrical filter

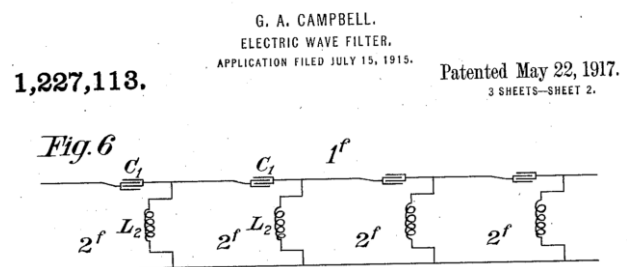


Fig. 4: Campbell's patent

The electrical filter, or wave filter as it was also called, was developed in the field of telephony, in a first iteration around 1917 by George A. Campbell of AT&T.¹¹ One of the simplest variations of an electrical filter consists of connecting a resistor to a capacitor (see Fig. 3).

A resistor reduces the voltage and a capacitor stores voltage (volts). This combination is called an RC element. Because Campbell was familiar with the telegraphic practice of modeling long cable lines with *artificial electric lines*, he knew that the transmission characteristics of a cable could be influenced by means of capacitors, coils and resistors. These models no longer consisted of architectural elements or mechanical parts, but of electrical resistors or coils and capacitors. By changing the electrical properties of the model parts, different lengths and metal combinations could be modeled. While *artificial electric lines* were used to simulate electric lines, Campbell simply reversed the principle of modeling, even before 1900 proposed to directly distribute coils in the telegraph line in order to achieve the desired transmission properties. In doing so, Campbell noted that they were significantly affected by varying the spacing between the coils. The greater the distances between the inductors, that is the

9 See Zhuwei Qin et. al., How convolutional neural network see the world – A survey of convolutional neural network visualization methods, in: *Mathematical Foundations of Computing 1*, No. 2, 2018, 149–80.

10 See Keunwoo Choi, György Fazekas, Mark Sandler, Explaining Deep Convolutional Neural Networks on Music Classification, in: *arXiv*, 2016, <https://doi.org/10.48550/arXiv.1607.02444> (04.04.2023).

11 George A. Campbell, 1917, Electric Wave filter, US Patent 1,227,113A, filed July 15 1915, and issued May 22 1917.

coils, along the conductor, the less the high frequencies succeeded in exciting the electric field to resonate, so that their transmission dried up.¹² While the advent of the electron tube and thus audio amplification made this method of optimizing transmission characteristics obsolete, the side effect of attenuating high frequencies found its way into the development of the wave filter (see Fig. 4 for an image of Campbell's patent).

A media archaeology of artificial neurons as filters

The practice of modeling technical processes of signal transmission by electrical circuits of resistors, coils and capacitors also found application in physiology. Here, organic living parts were modeled by electrical circuits. In 1952, Alan L. Hodgkin (1914–1998) and Andrew F. Huxley (1917–2012) published a description of their model – an equivalent circuit¹³ with a capacitor¹⁴ – for the detailed formalization of the bio-electrical processes involved in the generation of a pulse-like voltage change at the membrane surface of the nerve fibers of an octopus – the action potential. In 1963, they were awarded the Nobel Prize in Physiology or Medicine for their work. Essentially, the Hodgkin-Huxley model is a simple electrical network consisting of three resistors and a capacitor, all connected in parallel in series (Fig. 5, A). It is thus comparable to an electrical filter.

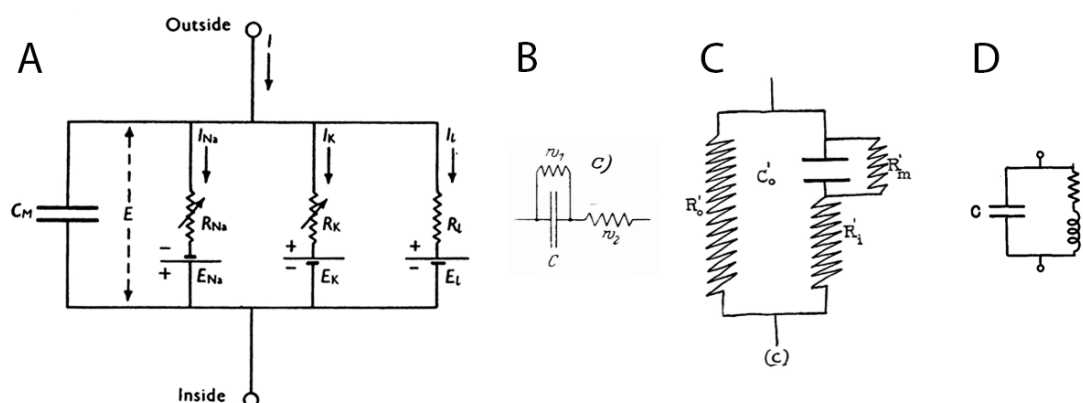


Fig. 5: The Hodgkin-Huxley model

By 1950, techno-mathematical crystallizations into equivalent circuits were not uncommon but had long been part of the medial practice of electrophysiology. When electrical engineers such as William Henry Eccles (1875–1966), Heinrich Barkhausen (1881–1956), Hans Ferdinand Mayer (1895–1980), and Edward Lawry Norton (1898–1983) developed the idea of the equivalent circuit in the 1920s, in some cases independently of each other, it had long since become established in physiology as well. Kirchhoff's rules, which provided the basis for all equivalent circuits, were already used by Helmholtz in 1850. However, he did not draw circuit diagrams, but only equations. As already explained, it was

12 See generally on the work of Campbell: Kilian Hirt, Axel Volmar: Kanalarbeit. Das Übertragungsproblem in der Geschichte der Kommunikationstechnik und die Entstehung der Signalverarbeitung, in: Axel Volmar (ed.): *Zeitkritische Medien*, Berlin 2009, 229f.

13 See D. H. Johnson: Origins of the equivalent circuit concept: the voltage-source equivalent, in: *Proceedings of the IEEE* 91, No. 4, April 2003, 636–40. See also Roland Wittje: The Electrical Imagination: Sound Analogies, Equivalent Circuits, and the Rise of Electroacoustics, 1863–1939, in: *Osiris*, Vol. 28, No. 1, 1.1.2013, 40–63.

14 Timothy Lenoir: Models and Instruments in the Development of Electrophysiology, 1845–1912, in: *Historical Studies in the Physical and Biological Sciences*, No. 17 pt. 1, 1.1. 1986, 1–54, here 20.

probably engineers from the telegraphy environment such as Varley,¹⁵ who were the first to experiment with artificial substitute lines – *equivalence circuits* or *electrical analogues* – around 1860 for the purpose of modeling and predicting signal transmission.¹⁶

In 1919, Martin Gildemeister (1876–1943) used equivalent circuits to demonstrate the electrical properties of animal membranes (Fig. 5, B), but without electron tube technology. Hugo Fricke's (1892–1972) research, on the other hand, would never have happened without electron tubes and high-frequency technology (radio). He investigated the resistance and capacitance values of blood cell membranes (Fig. 5, C) around 1925 when measured at frequencies up to 4 MHz. Kenneth Stewart Cole (1900–1984), who later collaborated with Hodgkin, was Fricke's collaborator as a student in the 1920s. Cole, who was also aware of Gildemeister's research findings, was instrumental in cultivating equivalent circuits in the field of electrophysiology knowledge. His research in the late 1930s on the action potential of an octopus nerve fiber and the corresponding equivalent circuit (Fig. 5, D)¹⁷ were starting points for the Hodgkin-Huxley model. All these models can also be understood as derivatives of the electrical filter.

Coda

This article has simplified artificial neuronal networks in a fragmentary way as the most current forms of electrical filtering and has tried to justify this in terms of media archaeology, with three points coming into view: 1) The analog-comparative conceptualization of artificial neural networks as complicated filters based on differential equations and calculated by means of scalar products, and the electrophysiological prehistory of neurons as combinations of resistors, coils and capacitors points to a yet to be explored critical history of knowledge and media¹⁸ in which the organic-living is not only literally electrified, but also embodied, operationalized and replaced by a combination of electrical components called *equivalent circuit* and as transmitters, receivers and filters of electronic signals.¹⁹ 2) If Karl Marx probably thought of a worker's performance more in terms of biomechanics, and this was later complemented by a focus on cognitive labor by Maurizio Lazzarato, for example, the strange access I am trying to sketch here, with a focus on human electrophysiology, could open up an alternative view for an experimental critique of “what we are is at one and the same time the historical analysis of the

15 See Henry Holland: Cromwell F. Varley, On the Atlantic Telegraph (Friday, February 15, 1867), in: *Notices of the proceedings at the meetings of the members of the Royal Institution, with abstracts of the discourses* 5, London 1869, 45–59.

16 In 1871, Cromwell F. Varley (1828–1883) was one of the first to experimentally establish the relatively high electrical capacitance of some electrolytes – measured in Farads – and to compare his laboratory results with capacitance values of telegraph lines. It is no coincidence that the measurement and calculation of electrical capacitance phenomena was an important field of innovation at that time. The realization of the first transatlantic telegraph line was at stake. In 1867, Varley presented his artificial Atlantic cable in a lecture at the Royal Institution of Great Britain in London. It consisted of several capacitors connected in parallel and resistors connected in series. Electrical models of telegraph lines, also called artificial lines, were essential for optimizing signal transmission in longer, usually submarine cable lines. They replaced the inhumanly long cables of telegraphy with an array of simple components, thereby enabling their exploration and modeling under controlled conditions in the laboratory, rather than in the field or even underwater.

17 See Kenneth S. Cole: Rectification and Inductance in the Squid Giant Axon, in: *The Journal of General Physiology*, 25/1, 1941, 29–51.

18 See also the often forgotten media history of analog computers.

19 In German language, equivalent circuits are translated as replacement circuits. Therefore, the meaning of becoming replaced through circuits is clearer.

limits that are imposed on us and an experiment with the possibility of going beyond them.”²⁰ 3) Along with this, the thesis that we humans, but also animals, plants, even whole ecosystems are, from a normative, exploitative, and technological point of view, mere filters or part of a filtering process (extraction), could raise new questions about alternative circuits and about strange, analog computers and algorithms that do not filter, but hiss (are noisy), hallucinate, dream, dither, play, or confuse, etc.

²⁰ Michel Foucault, What Is Enlightenment?, in: Paul Rabinow (ed.), *The Foucault Reader*, New York 1984, 32–50, here 50.