

Abnormal Encephalization in the Age of Machine Learning

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To make machines look intelligent it was necessary that the sources of their power, the labour force which surrounded and ran them, be rendered invisible. — Simon Schaffer.

If a machine is expected to be infallible, it cannot also be intelligent. — Alan Turing.

Metacognition in the Californian Adult of the 21st century

The idea that 'machines think' displays an unintended solidarity with the animism of less industrialized cultures, which have long recognized autonomous minds in non-human entities. Artificial intelligence is animism for the rich, we might say, or that animism is a sort of artificial intelligence made in the absence of electricity.¹ The recent narrative which proclaims the imminent arrival of a Technological Singularity (according to which computing machines would become self-conscious) seems typical of the human tendency to anthropomorphize the unknown. What was once attributed to the obscure and infinite night is now projected onto the abstract abyss of computation, datacentres and machine learning. Rendering the uncanny (*Unheimlich*) familiar (*heimlich*) by way of mythology is an established survival method for the human animal in the act of mapping its territory. In a hostile environment, the utility of suspicion towards any alien object is obvious: even if it doesn't appear to move, it may be alive and dangerous. The same seems to be true even for the most advanced technological milieu. In psychology, this ability to speculate that other beings might have a will, drives, or 'thoughts' less friendly than what they articulate is called metacognition or Theory of Mind (ToM).

The Theory of Mind is a key issue in child psychology. As infants we do not know what our mother thinks: the first relation with her is a blind metabolic one: a need for milk, warmth and care. Only gradually do we develop the understanding that our mother does not always fulfil our desires, that she may have different intentions and thoughts than ours. That is the traumatic moment in which we project the theatre of the mind, i.e. we “theorize” the mind into another body. However Soviet psychologist Lev Vygotsky stressed that we form the image of our mind only after picturing the mind of adults around us. Growing older, we develop an even more sophisticated mind reading: in playing poker or listening to a politician speaking, we always engage in simulating the backstage, imagining the other’s mind tricks behind and beyond their appearance. This process may unfold into pathological excess, like in the case of paranoia and conspiracy theories, when an unreachable evil mind is evoked to explain catastrophes too big to be elaborated. Yet we may prefer to project a Mind onto the furnace below the window or develop a vast objectophilia like Eija-Riitta Eklöf, who married the Berlin Wall.

As art critic Anselm Franke suggests, animism is a good epistemic prism to capture the many refractions and responses to industrialized modernity. Artificial intelligence inevitably belongs to this history: “Animism had endowed things with souls; industrialism makes souls into things”.² British computer scientist Stephen Wolfram has argued that the universe is fundamentally digital in nature, and that natural laws are better approached as computational programs rather than as instances of traditional mathematics. Wolfram argues that animism somehow is an acknowledgement of nature’s computational power: a doctrine that can be called *computational animism*. This latest animism turns *panpsychism*, the idea that everything thinks, into *pancomputationalism*, the idea that everything computes (especially for business purposes).³

An abnormal Theory of Mind is common to all ages and classes, usually as a substitute for confronting more fundamental political issues. It is not surprising that the ruling-class engineers of California have started to anthropomorphize supercomputers and fear their awakening as sentient and autonomous beings, while Silicon Valley entrepreneur Elon Musk has warned against the risk posed by future machine intelligence.⁴ In a clinical sense, the narrative of Singularity is a good example of the faculty of metacognition in the 21st century Californian adult as surely as the Theory of Mind explains many popular publications on so-called Artificial Superintelligence. Time to ask Western anthropologists to visit the valleys of Northern California.

Two Lineages of Machine Intelligence

The history of machine intelligence can be roughly divided into two lineages: the analytical one, based on the idea of the *representative brain*, and the holistic one, based on the idea of the *adaptive brain*.⁵ Where the analytics emphasizes logic, the holistics emphasize abstraction, considering the human brain as an organism that strives to adapt to the surrounding world and which conceives and projects new ideas (*Gestalten*) in the course of this process. In the holistic, adaptive tradition intelligence is understood as an antagonistic and embodied relation with the environment. In fact, the idea of the cybernetic feedback loop was inspired by this model of biological adaptation.⁶ This is the lineage of Norbert Wiener, William Ross Ashby and the Anglo-American cybernetics influenced by German *Naturphilosophie*. Epistemologist David Bates has noticed that early cybernetics, being particularly influenced by neurology and cognitive sciences, was not just obsessed with the mechanization of reason but interested also in the abnormal states of machines, in those pathological breakdowns that could push machine structure to form new equilibria and new compositions.⁷

The epistemic distinction between the two lineages is the distinction between analytic logic and perceptual *Gestalt* as universal diagrams of human thought. They are not a perfect contrast: perceptual *Gestalten*, for example, would be encoded into information by Wiener while digital logic would become purely statistical and 'gestaltic' in the process of encoding chaotic phenomena. In his founding text *Cybernetics* (1948), Wiener wrote that cybernetics would more closely resemble a predictive and statistical discipline such as meteorology than it would the exact laws of physics. And one could do worse for a description of the study of the human brain than a 'meteorology of intelligence'.⁸

The analytical lineage, as mentioned, sees the human brain as a machine that *represents* the world through language. Specifically, it states that human thought can be translated by Boolean logic into logic gates, the elementary building blocks which construct digital circuits, transistors and microchips out of three fundamental functions: AND, OR, and NOT. The mind can be mechanized thanks to this equivalence between human logic, Boolean logic and logic gates. This is the legacy of Gottfried Leibniz, Charles Babbage and Alan Turing. Turing is famous for introducing the Universal Turing Machine, the abstract algorithm that separated for the first time software and hardware in computation, but he also signed the history of philosophy with a controversial intervention into the Theory of Mind: the Turing Test.

Turing's Foray into the Theory of Mind

In his 1950 paper "Computing Machinery and Intelligence" Turing proposed to resolve the question "can machines think?" via a negative thought experiment, the Turing Test, also known as the Imitation Game. Rather than asking what the positive content of intelligent behaviour must be, Turing reasoned that if we humans cannot tell the difference between the answers given by a machine and a human—when these are disguised by a textual interface—then we cannot say that machines do not think. With its absolute emphasis on the social convention of human language, the Turing Test is the ultimate *Gedankenexperiment* of Analytical Philosophy and a metaphysical reiteration of the Theory of Mind. The test reinforces, rather than questions, the metacognitive assumptions behind artificial intelligence, precisely by advancing computation as empirical proof of thought in nonhuman entities. The Turing Test does not prove machine intelligence *per se* but it postulates that an anthropomorphic Theory of Mind can be logically imbricated in computation. Moreover, it does not just imply that artificial intelligence has to pedantically resemble the human, a crystalline example of the anthropomorphic fallacy, but it renders artificial intelligence as *brute force imitation* of human habits and conventions, a grand machine for the recognition of the Same.

By employing a schema of mind that prioritizes good manners and familiarity with social conventions, The Turing Test remains an example of austere social normativity: the same one, it has been suggested, that Turing himself was subjected to as a closeted gay man. Turing addresses briefly the issue of metacognition in the answers to the "Arguments from Various Disabilities", where he mentions the fact that a machine could "be the subject of its own thought" by running a program to check its own structure, again rendering the Theory of Mind in terms of computation.

In the history of the systemic and holistic thought a famous counter-part of the Turing Test is Hegel's master-slave dialectic which also attempts to explain self-consciousness via the recognition of consciousness in the Other. It would suffice to replace Turing's intelligence with Hegel's self-consciousness to reveal the similarity between these two approaches to the Theory of the Mind. In Hegel's account, however, the framing power structures remain obvious, manifest and unavoidable (an aspect that pleased Marx), while in the Turing test politics evacuates the field (an aspect that pleases the Artificial Intelligence community today).

The Imitation Game was sketched for the first time by Turing in his 1948 paper “Intelligent Machinery”, wherein, more compellingly, he proposed the idea of an *unorganized machine* that would be able to learn by continuous interferences in its open structure.⁹ Turing made a direct parallel between the learning machine and the cortex of an infant, in which he cheerfully sided with the fallibility of machines: “It would be quite unfair to expect a machine straight from the factory to compete on equal terms with a university graduate”.¹⁰ In a 1947 lecture he went so far as to equate intelligence with fallibility: “If a machine is expected to be infallible, it cannot also be intelligent”. Turing’s hypothesis, which puzzled many mathematicians, was that a machine could be programmed to make mistakes like humans do: a statement that would reduce Gödel’s incompleteness theorem to irrelevance.¹¹ Turing had different conceptions of machine intelligence during his life, but it is the Turing Test that has monopolized the attention of the philosophers of mind and galvanized the neovitalism of Artificial Intelligence.

Once Turing made the hypothesis that a machine could imitate human mistakes, his argument risked deteriorating in a toxic loop, since it envisions machine intelligence as cosmic plagiarism mirroring the routines of an already bored-to-death humanity. In this respect, the Turing Test is the premonition of universal industrial imitation, a Universal Machine, which would replace not only the previous division of manual and mental labour but would be able to replicate all imaginable divisions of labour. The Turing Machine would be better defined itself as Social Imitation Machine, as its power is revealed in the power to imitate, amplify and accumulate social relations. In the belly of datacentres, machine intelligence is already emerging as a novel perspective on supra-human and invisible clusters of social data, not as the quality of imitating human features and feelings. Machine intelligence is not anthropomorphic, but *sociomorphic*: it imitates and feeds on the *condividual* structures of society rather than the individual ones.

The Metastable Mind and Its Technological Individuation

After WWII the French philosopher Gilbert Simondon attempted to develop a philosophy of the mind that would depart both from the organism-form inherited from German vitalism (still influential at the time) and the information-form that had just been introduced by North-American cybernetics.¹² These two polarities had long been operative in French philosophy, at least since Descartes and the dispute over the mechanistic body. Against the primacy of the new technical form and the old *Lebensform*, Simondon envisioned a *metastable mind* that is constructed in a triangular space between

the biological, the technological and social, giving the latter a leading, even constituent, role. Simondon was not concerned with individualized structures (brain, organism, technology, society), so much as with the collective process of individuation (the old *principium individuationis*) that made these hegemonic structures possible. What makes a mind? Simondon considered both mechanicism (later: informationalism) and holism (later: organicism and *Gestalttheorie*) as enclosures of a process that must be kept conceptually open. In Simondon the actual mind emerges to “solve the problems posed to the living being”¹³ by the surrounding world and it always reinvent itself in a process opened towards the social.

In Simondon the construction of the mind (or psychic individuation) is not originary but a process of collective individuation: the mind is constructed with signs, object and artefacts of the external and social world. In this sense, we all have developed a ‘technical mentality’ (yet developing a technical mentality, *nota bene*, does not mean to employ technology as a model of the mind). The Marxist philosopher Paolo Virno has underlined the similarity between Simondon’s notion of individuation and Soviet psychologist Lev Vygotsky’s work on the development of language skills and thought in the child.¹⁴ For Vygotsky the faculty of inner speech in the child (and so the Theory of Mind, we may add) is produced by the power of individuation of social language and this process continues in the adult life.¹⁵ For Simondon, similarly, individuals are never completely individuated but maintain an excess of *transindividuality* that distinguishes them from technological artefacts as much as from animals.

In terms of logic forms, Simondon struggled to find a concept that could synthesize and overcome the notions of both organic *Gestalt* (inherited via German *Naturphilosophie*) and technological information (received from cybernetics). Simondon called *transduction* this concept that could cross the *transindividual* psyche without enclosing it either an organic or a technological form, leaving its excessive potentiality open. Transduction is not the idea of a multiple realize-ability of the One Mind but the idea of multiple genealogies of mentalization that keep on innervating the fabric of the world, along the lines of that *parallel ontology* that Deleuze would term *transcendental empiricism*. One model of the mind can be transducted into another but the process is not frictionless and free of conflict like in the idea of a Turing-complete universe. The historical translation of a model of the mind into another is not only a technological problem but still a political one.

Simondon's work has inspired discussions also in the Artificial (General) Intelligence community. The problem of psychic individuation in the debate on machine intelligence and the Turing Test can be translated as the problem of mentalization or *encephalization*, to borrow a term from evolutionary biology. How do you recognize a mind? Some answer by saying that you recognize a mind, if you know how to construct it. Instead of starting with the question "what does it mean to be intelligent?" David Weinbaum and Viktoras Veitas from The Global Brain Institute in Brussels ask "what does it mean to become intelligent?". Drawing from Simondon's idea of individuation, they come up with the paradigm of Open-Ended Intelligence, that however reiterates the old idea of intelligence as emergent property of natural systems.

Open-ended Intelligence is a process where a distributed population of interacting heterogeneous agents achieves progressively higher levels of coordination. In coordination here we mean the local resolution of disparities by means of reciprocal determination that brings forth new individuals in the form of integrated groups of agents (assemblages) that exchange meaningful information and spontaneously differentiate (dynamically and structurally) from their surrounding milieu. This kind of intelligence is truly general in the sense that it is not directed or limited by an a priori given goal or challenge. Moreover, it is intrinsically and indefinitely scalable, at least from a theoretical point of view. We see open-ended intelligence manifesting all around us and at many scales; primarily in the evolution of life, in the phylogenetic and ontogenetic organization of brains, in life-long cognitive development and sense-making and in the self-organization of complex systems from slime molds, fungi, and bee hives to human sociotechnological entities.¹⁶

This description of Open-End Intelligence appears to conflate the two forms that Simondon actually attempted to overcome: the biological and the technological. In other words, it is a naturalisation of machine intelligence and its equation to the living. In explaining the biomorphic fallacy, it is helpful to remember that we did not design the airplane to fly as birds do, and so machine intelligence may not follow the path of some biological ancestor. Even so Weinbaum and Veitas stress that "many believe that one day in the foreseeable future the internet, will awaken and become a conscious aware super-intelligent entity. Some even claim that this is already happening".¹⁷ Such professions of computational animism seem like an a priori condition for being accepted in these tech communities. Animism keeps on haunting Artificial Intelligence: non-biomorphic notions of machine intelligence are urgently needed.

More importantly, the idea of *pancomputationalism* in nature mystifies a basic reality: computation is actually an economic process, one that aims at extracting valuable information and discarding useless one. In this sense computation is also a process of capitalization. And so to assert, as Stephen Wolfram and Ray Kurzweil do, among others, that all atoms encode and compute, is to equate capital and nature.¹⁸ Atoms do not get rid of useless information in order to escalate to a higher degree of complexity. Apologies to Kurzweil's vision of a computational sublime in front of a stormy ocean, as reported in the documentary *Transcendent Man* (2009), but the molecules of water in the ocean do not compute.¹⁹ That's just us.

The Artificious Intelligence of the Market

Markets have been a place of vernacular artificial intelligence for a long time. The Austrian economist Friedrich Hayek believed that the market is the ground of a preconscious and transindividual knowledge that needs neither state centralisation (like in socialist planning) nor formulation in objective economic laws (Hayek is the godfather of the notorious Chicago School but he maintained, interestingly, a great interest for psychology and neuroscience during all his life). The *infrarationality* of the market is for Hayek far beyond the comprehension of the individual as much as the state: "The economic problem is... a problem of the utilization of knowledge not given to anyone in its totality", he wrote in his 1945 seminal text "The Use of Knowledge in Society".²⁰ Hayek castigated the ambitions of statistics and, in this way, implicitly, also the ones of computation: "[The] sort of knowledge with which I have been concerned is knowledge of the kind which by its nature cannot enter into statistics and therefore cannot be conveyed to any central authority in statistical form".²¹ Hayek believed that prices are the best signals to condense and transmit all the necessary economic information: they work in fact like a collective computer ("system of telecommunications" in the wording of 1945).

It is more than a metaphor to describe the price system as a kind of machinery for registering change, or a system of telecommunications which enables individual producers to watch merely the movement of a few pointers, as an engineer might watch the hands of a few dials, in order to adjust their activities to changes of which they may never know more than is reflected in the price movement.²²

Hayek might have been the first to introduce a modern (i.e. functional) notion of information: it must be remembered that Claude Shannon defined the mathematical measure of information only in 1948, the same year in which Norbert Wiener publishes his book *Cybernetics*.²³ Nevertheless Hayek described the market as a *cognitive apparatus* in a strong similarity with early cybernetics and long before the theories of knowledge society and cognitive capitalism. Since Adam Smith, the topos of the 'invisible hand' has been repeated to describe the virtues of free market, but the expression 'invisible mind' would be more accurate to frame such a distributed and spontaneous coordination of prices. In Hayek's vision the market seems to be run by an invisible *general intellect* that cannot be objectified in any machinery, but only in commodity prices. Yet such idealism has been contradicted, most recently, by what has been called algorithmic capitalism. Today, companies like Uber and Airbnb are able to centralise price calculation through their global databases in real time. In this respect algorithmic capitalism is the rise of a third paradigm: the worst nightmares of both centralised planning and free-market deregulation which come true under the rule of one master algorithm designed by the mathematicians and engineers of machine learning.²⁴

Capital as Encephalization

Even if there comes no Artificial Intelligence that one day will awake as a sentient being, nevertheless there are already millions of Machine Learning algorithms that day-to-day scavenge gigantic datacentres of social data to detect correlations, extract patterns, distil norms, predict tendencies and make metadata mug shots of the population as a whole. Machine intelligence is not *biomorphic*, it will never be autonomous from humankind and, for sure, difficultly from capital, since it is a functional component of industrial planning, marketing strategies, securitarian apparatuses and finance.

Machine intelligence is *sociomorphic*, but not in a good way. Machine intelligence mirrors social intelligence in order to control the latter. The Turing universe is one of those magnifying mirrors, which makes the collective body look grotesque, disproportioned, *abnormalized* by the glitches of computational power. We feed algorithms our racist, sexist and classist bias. As Karl Marx knew, absent political action, machines do not just replace but *amplify* previous divisions of labour and social relations. Turing machines are no exception: datasets of populations educated to fundamentalism project an even more fundamentalist machine intelligence pattern. Machine intelligence

is then *anamorphic*: in the 2016 conference “Tyranny of the Algorithms?” even the New York Police Department acknowledged the class and racial bias produced by its crime predictive algorithms.²⁵ The Microsoft Twitter bot that turned its posts into fascist rants is another example of how machine intelligence can be easily misdesigned, especially if this happens at companies with dubious standards.

Machine intelligence should become sociomorphic in a good way. Machine learning and data analytics do manage to unveil a superior social dimension that is intrinsic in any piece of digital information and that has been intangible and inaccessible until now. The techniques of data visualization and navigation finally give an empirical form to the collective mind and to modern concepts of collective agency, such as Marx’s general intellect, Foucault’s episteme, and Simondon’s transindividual, which have been so far pretty abstract and invisible to the eye of the individual mind. Alternative and progressive uses of machine intelligence are always easy to imagine but difficult to realize. Alternative techniques of data mining are being explored today by an emerging field known as *data activism* that fights for social justice, human rights, and equal access to education and welfare. In this respect, the Artificial (General) Intelligence community (AGI) astonishingly lacks a basic ABC of politics that is found in other tech communities (see the history of the Free Software Foundation and Electronic Frontier Foundation). A short manifesto of transcendental empiricism for the AGI community: not trying to realize the One Mind, like who like to replace Chairman Mao with the role played by Artificial Intelligence, but trying to construct a metastable collective intelligence that would be politically more ‘intelligent’ than the ideal of the One Mind.

Within the regime of cognitive capitalism, computation comes to occupy a rising hegemonic role: specifically, machine intelligence replaces a complex division of mental and manual labour and encephalizes collective intelligence and social behaviours into datacentres. The reductionist philosophy of mind promoted by the artificial intelligence community is organic, therefore, to the issue of capital qua computation and cognition. Historically the rising hegemony of the paradigm of machine learning marks the final transition from cognitive capitalism to computational capitalism that is towards centralised forms of machine intelligence. As much as the British industrial class worshipped the steam engine as the idol of a new society and concretion of power, likewise the new vectorialist class of artificial intelligence is starting to animate supercomputation.²⁶ In this respect, the movie *Esiod 2015* by German artist Clemens von Wedemeyer is right in imaging that if the Singularity ever happens, it will be a financial one: it will be the most likely your family bank to become an autonomous sentient

entity.²⁷ To still believe in the myth of the autonomy of artificial intelligence is to support the autonomy of capital against the autonomy of society.

Capitalism is a process of *encephalization*, that is an accumulation process of human intelligence that started already in the industrial factory, when Charles Babbage designed the Analytical Engine with the idea to absorb and automate the division of mental labour. Simondon was the first to recognize, by the way, that the industrial machine was already an *infomechanical* relay separating the source of energy from information, that is the intelligence of the worker. As British historian of science Simon Schaffer recounts:

The word [intelligence] refers both to signals received from without and to the capacity to register and interpret these signals. In early nineteenth-century Britain the word intelligence simultaneously embodied the growing system of social surveillance and the emerging mechanisation of natural philosophies of mind. [...] To make machines look intelligent it was necessary that the sources of their power, the labour force which surrounded and ran them, be rendered invisible. [...] The replacement of individual human intelligence by machine intelligence was as apparent in the workshop as in the engines. This task was both politically and economically necessary.²⁸

Computation could have a different destiny but quickly slipped under the dominion of capital, reinforcing a new stage of power. Computation secularized the human mind only to industrialize and venerate, immediately afterward, the automation of mental labour as Artificial Intelligence (according to the classic oscillation of desubjectification and resubjectification). Supercomputation displaced the subject of Western humanism even further from the centre of thought but so that capital might think in its place. As also the root of the word suggests (*caput* in Latin means head), capital is a vast process of encephalization: it continuously returns to destroy and reconstruct again its own head.

¹ In this text the term Artificial Intelligence refers to anthropomorphic and biomorphic models of intelligence, whereas the term Machine Intelligence to a form of intelligence that does not resemble features of the living (including human feelings and 'consciousness'). A more secular definition of machine intelligence will help, hopefully, to disclose posthuman and antinormative correlations in social data rather than to reinforce the individual and social norms of class, gender and race.

² Theodor Adorno and Max Horkheimer, *Dialectic of Enlightenment* (Stanford: Stanford University Press, 2002), p. 21. Quoted in: Anselm Franke, *Animism* (Berlin: Sternberg Press, 2010).

³ Stephen Wolfram, *A New Kind of Science* (Champaign: Wolfram media, 2002), p. 845.

⁴ Musk's concerns about AI would be originated, by the way, in the unfair practices of Google, his largest corporate competitor. See: Rich McCormick, "Elon Musk: There's only one AI company that worries me", *The Verge*, 2 June 2016.

www.theverge.com/2016/6/2/11837566/elon-musk-one-ai-company-that-worries-me

⁵ See: Andrew Pickering, *The Cybernetic Brain: Sketches of Another Future* (Chicago: University of Chicago Press, 2010), chapter 1.

⁶ The German biologist Jacob von Uexküll described the relation between the animal's nervous system (*Innenwelt*) and the outside world (*Außenwelt*) as a "functional circle" (*Funktionskreis*). Similar to the *Funktionskreis*, the feedback loop of cybernetic systems was conceived as a circulation of information and response to an external stimulus.

⁷ David Bates, "Unity, Plasticity, Catastrophe: Order and Pathology in the Cybernetic Era". In: Andreas Killen and Nitzan Lebovic (eds) *Catastrophe: History and Theory of an Operative Concept*, De Gruyter, 2014.

⁸ Norbert Wiener. *Cybernetics: or Control and Communication in the Animal and the Machine* (Cambridge: MIT Press, 1948), p. 30

⁹ The model was inspired by McCulloch and Pitt's model of neural networks: their work was not referred to, but Turing's paper was not published either. See: Warren McCulloch and Walter Pitts, "A logical calculus of the ideas immanent in nervous activity". *The Bulletin of Mathematical Biophysics* 5(4), 1943.

¹⁰ Alan Turing, "Intelligent Machinery" (1948). In: Jack Copeland (ed.) *The Essential Turing* (Oxford: Oxford University Press, 2004), p. 421.

¹¹ Alan Turing, "Lecture on the Automatic Computing Engine" (1947). In: Jack Copeland (ed.) *The Essential Turing* (Oxford: Oxford University Press, 2004), p. 394. See: Andrew Hodges, "Alan Turing". In: Edward Zalta (ed.) *The Stanford Encyclopedia of Philosophy* (Winter 2013 Edition): "Once the possibility of mistakes is admitted, Gödel's theorem become irrelevant. Mathematicians and computers alike apply computable processes to the problem of judging the correctness of assertions; both will therefore sometimes err, since seeing the truth is known not to be a computable operation, but there is no reason why the computer need do worse than the mathematician".

¹² Simondon had a profound influence on Gilles Deleuze, who dedicated to him one of his rare book reviews. See: Gilles Deleuze, "Gilbert Simondon: L'Individu et sa genèse physico-biologique", *Revue philosophique de la France et de l'étranger*, CLVI:1-3, 1966.

¹³ Gilbert Simondon, "Individuation in the Light of the Notions of Form and Information", p. 166. Quoted in: Andrea Bardin, *Epistemology and Political Philosophy in Gilbert Simondon* (Dordrecht: Springer, 2015), p. 70.

¹⁴ Paolo Virno, *When the Word Becomes Flesh: Language and Human Pature* (Los Angeles: Semiotexte, 2015). See also: Charles Wolfe, "De-ontologizing the Brain: from the fictional self to the social brain". *CTheory* (2007). www.ctheory.net/articles.aspx?id=572

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- ¹⁵ Lev Vygotsky, *Thought and language* (Cambridge, MA: MIT Press, 1986 [1934]).
- ¹⁶ Weinbaum, David, and Viktoras Veitas. "Open ended intelligence: the individuation of intelligent agents." *Journal of Experimental & Theoretical Artificial Intelligence* (2016): 1-26.
- ¹⁷ *Ibid.*
- ¹⁸ Pancomputationalism is addressed also by French philosopher Michel Serres. See: Matteo Pasquinelli, "On Solar Databases and the Exogenesis of Light", *e-flux*, n. 65 (Politics of Shine / Supercommunity 56th Venice Biennale), 4 June 2015.
- ¹⁹ Thanks to Lorenzo Sandoval for pointing to this passage of the documentary.
- ²⁰ Friedrich Hayek. "The Use of Knowledge in Society". *The American Economic Review*, 1945, p. 520.
- ²¹ *Ibid.*, p. 524.
- ²² *Ibid.*, p. 527.
- ²³ Claude Shannon. "A Mathematical Theory of Communication". *Bell System Technical Journal* 27 (3), 1948. And: Norbert Wiener. *Cybernetics: or Control and Communication in the Animal and the Machine* (Cambridge, MA: MIT Press, 1948).
- ²⁴ Master algorithm is an expression used in machine learning. See: Pedro Domingos. *The Master Algorithm* (New York: Basic Books, 2015).
- ²⁵ Even the New York Police Department acknowledged the class bias produced by its predictive policies algorithm: see the "Tyranny of the Algorithm? Predictive Analytics and Human Rights", conference, New York University, 21-22 March 2016.
- ²⁶ For an account of the cult of the steam engine by the British industrialist class see: *Andreas Malm, Fossil Capital: The Rise of Steam Power and the Roots of Global Warming* (London: Verso Books, 2016).
- ²⁷ *Esiod 2015*. Director: Clemens von Wedemeyer. 39 min. Austria/Germany, 2016.
- ²⁸ Simon Schaffer, "Babbage's Intelligence: Calculating Engines and the Factory System". *Critical Inquiry* 21(1), 1994.