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SMARTNESS AS INSTRUMENT

by Orit Halpern

Decision making and the legacy of the nervous net.

Published May 3, 2016

In November 2008, shortly in the aftermath of what has largely been labelled the "economic crisis" resulting from the sub-prime mortgage market's collapse, the then chairman of IBM, Sam Palmisano, delivered a speech at the Council on Foreign Relations in New York City. "The Council, which is one of the foremost think tanks in the United States, is comprised of senior figures in government, the intelligence community, including the CIA, business leaders, financiers, lawyers and senior media figures. However, Palmisano was not there to discuss the fate of the economy. He was there to introduce his corporation's vision of the future of cities. This vision, entitled "Smarter Cities," argued that "new, high bandwidth infrastructure, seamless supply chain and logistical capacity, clean environments and eternal economic growth through a new discourse of "smartness." IBM, he argued, would lead the world to the next frontier, a network beyond social networks and mere twitter chatz; a future in which humans and machines are integrated into a seamless "Internet of Things" capable of generating data to make decisions, organize production and labor and enhance marketing. An "Internet of Things" with the ability to precipitate more democracy and prosperity, and perhaps most importantly, guarantee the very existence and survival of the human species' bandwidth would come to mean, quite literally, survival.

What is most remarkable about this emerging discourse is the argument that corporations like IBM should be the primary actors in governance and urban planning. Why should we listen to IBM's decision making?[1] One must immediately ask what forms of instrumentation will produce this "decision making?" What methods, techniques and processes are being suggested by these global corporate entities? The so-called "smart mandate" has become perhaps one of the governing notions of global polity—creating novel infrastructures, methods and instruments, which now underpin design and practice across many fields and have come to organize environment, economy, energy, supply chains, food and medicine distribution, and of course, security.

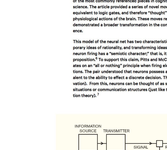
So how has "smartness" become a technology? In order to contemplate this question and contemporary concerns over "smartness," as well as rethink the very nature of "instrument," one must examine how reason was reformulated into logical networks at the middle of the twentieth century.

THE LOGICAL CALCULUS OF THE NERVOUS NET

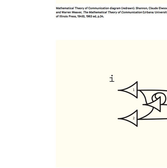
One place to start is with the reconceptualization of memory and intelligence introduced by the sciences of communication and control that emerged from World War II. Within these sciences is a genealogy of methods, tools and practices that have also been said to underpin the "smart" world. Cybernetics is one common way to rethink the instrumentalities of reason. Cybernetics, a transdisciplinary science of "control" and "communication" emerged at the Massachusetts Institute of Technology (MIT) from work at the Radiation Lab on anti-aircraft defence and servo-mechanisms during the Second World War. The MIT mathematician Norbert Wiener, working with MIT trained electrical engineer Julian Bigelow, and physiologist Arturo Rosenblueth, reformulated the problem of shooting down planes in terms of communication between an airplane pilot and the anti-aircraft gun. Rather than attempting to model simply the future location of the plane, they assumed that the pilot was acting in a purposive manner. Thus, the pilot's actions, as well as the airplane pilots would act repetitively and therefore display algorithmic behaviors both analogous to servo-mechanisms and amenable to mathematical modeling and analysis. This understanding meant that all entities be "black boxed" so as to be studied behaviorally and statistically.[2] Cybernetics has no language for representation or presence. Entities are not described ontologically, but rather pragmatically. Cybernetics is a discourse for anticipating future behaviors from past data.

Inspired by the idea that machines and minds could be understood together through the language of logic and mathematics, psychiatrist Warren McCulloch and logician Walter Pitts attempted to demonstrate the possibility of a logic emerging from neurons at the University of Illinois at Urbana-Champaign in 1943. The pair would later move to MIT at the Research Laboratory of Electronics. Their 1943 paper, "A Logical Calculus of Ideas Immanent in Nervous Activity," which appeared in the *Bulletin of Mathematical Biophysics*, is now one of the most commonly referenced pieces in cognitive science, philosophy and computer science. The article provided a series of novel moves by which neurons could be made equivalent to logic gates, and therefore "thought" made materially realizable from the physiological actions of the brain. These moves reformulated psychology, but they also demonstrated a broader transformation in the constitution of evidence and truth in science.

This model of the neural net has two characteristics that are critical in producing contemporary ideas of rationality, and transforming ideas of technology.[3] The first is that every neuron firing has a "semiotic character," that is, it may be rendered mathematically as a proposition.[4] To support this claim, Pitts and McCulloch imagined that each neuron operates on an "all or nothing" principle when firing: electrical impulses over synaptic separations. The "all or nothing" principle means that neurons are either activated or not activated (or able to the ability to affect a decision. The effect affirms or denies but it is not an action. From this, neurons can be thought of as signs (true/false), and nets as semiotic situations or communication structures (just like the structural overview of communication theory).[5]



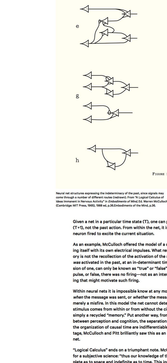
Mathematical Theory of Communication diagram (redrawn). Shannon, Claude Elwood, and Warren Weaver. The Mathematical Theory of Communication (Urbana: University of Illinois Press, 1949), 1997 ed., p.34.



Mimesis neuron (redrawn) from "A Logical Calculus of Ideas Immanent in Nervous Activity" in *Embodiments of Mind*, 22. Warren McCulloch (Cambridge: MIT Press, 1965), 1988 ed.,p.29.

This discrete decision (true or false, activate or not) also made neurons equivalent to logical propositions and Turing machines.

The second element of the model that is important here is the adoption of a strictly probabilistic and predictive temporality. Neurons' nets are determinate in terms of the future (they are predictive), but indeterminate in terms of the past.



Neural net structures expressing the indeterminacy of the past, since signals may come through a number of different route (redrawn) From "A Logical Calculus of Ideas Immanent in Nervous Activity" in *Embodiments of Mind*, 22. Warren McCulloch (Cambridge: MIT Press, 1965), 1988 ed.,p.32.Embodiments of the Mind, p.36.

Figure 1

Given a net in a particular time state (*T*), one can predict only the future action of the net (*T*+1), not the past action. From within the net, it is also impossible to determine which neuron fired to excite the current situation.

As an example, McCulloch offered the model of a circular memory neuron (Fig.2) activating itself with its own electrical impulses. What results as a conscious experience of memory is not the reactivation of the activation of the neuron, but merely the awareness that it was activated in the past, at an in-determinant time. The firing of a signal, or the suppression of one, can only be known as "true" or "false" declarations—true, there was an impulse, or false, there was no firing—not as an interpretative statement of context or meaning that might motivate such firing.

Within neural nets it is impossible know at any moment which neuron sent the message, when the message was sent, or whether the message is the result of a new stimulus or merely a misfire. In this model the net cannot determine with any certitude whether a stimulus comes from within or from without the circuit, or whether it is a fresh input or simply a recycled "memory." Put another way, from within a net (or network) the boundary between perception and cognition, the separation between interiority and exteriority and the ability to differentiate between "signal" and "noise" are impossible. Information, messages, McCulloch and Pitts brilliantly saw this as an advantage for the capacity of a neural net.

"A logical Calculus of mind is a triumphant map of which actual mind announce an aspiration to be the territory," Gilles Deleuze and Félix Guattari write.[6] Logic is a map that anticipates as to space and indefinite as to time. This ignorance, implicit in all our brains, is the counterpart of the abstraction which renders our knowledge useful."[7] If subjectivity had long been the site of inquiry for the human sciences, now perhaps, in the era of sensory lack of transparency to itself or its incompleteness—become an explicit technology. A technology to be programmed as machine learning; eventually, built into our social networks and financial systems.

PERICHOTIC RATIONALITY

McCulloch went even further to propose that logic was not reasonable, but actually psychotic. He proudly announced that the nature of computing is analogous to a psychotic mind: "what we thought we were doing (and I think we succeeded fairly well) was treating the brain as a Turing machine that is, as a device which could perform the kind of functions which a brain must perform if it is only to go wrong and have a psychosis."[8]

Speaking at a conference on circuits and brains in Pasadena California, to a room full of the most prominent mathematicians, psychologists and physiologists of the day, McCulloch sought to provide his respectable audience by clarifying there a seemingly counter-productive analogy. Finite state automata—the models of calculative and computational behavior that templates for programming, the very nature of reason, reliability, mathematical, logical and anticipative behavior—might be just as "psychotic" as brains can sometimes be.

These statements should not be thought of in terms of human subjectivity or psychology. McCulloch and Pitts were explicit that their work was a Gedankenexperiment in thought experiment that produces a way of doing things, a methodological machine. They discussed this logical reasoning as an experiment, a machine like the one described by Deleuze and Guattari in *Thousand Plateaus*—a machine that does not describe a reality, but "makes up reality, or makes it unrecognizable, or makes possible what is not."[9] as well as challenge pre-existing knowledge of mental processes. Cheerily, McCulloch admitted that this was an enormous "reduction" of the actual operations of the neurons: "but one point must be made clear: neither of us conceives the formal equivalence to be a factual explanation. *Per contra*" At no point should we assume that neural nets are an exact description of a "real" brain.[10] Nets are not representations, they are methodological models and processes.[11]

Reductive or not, the pair had established that the capacity for logic and sophisticated problem solving could emerge from small physiological units such as neurons linked up in circuits. In doing so, and by exploiting the amnesia of these circuits, McCulloch and Pitts were able to not only make neural nets analogous to communication channels, but also to Turing machines. Thus, they could begin to imagine how to mathematize memory, automatization, cognition and capacities. Their conception of how the neural net informs a change in the attitude towards psychological processes that makes visible an epistemological transformation in what constituted truth, reason and evidence in science.

This new epistemology rests on three seemingly unimportant points that when looked at together join the history of logic, engineering practices and mathematics into a new assemblage. In the first is a shift in the fragmentary, partial and unknown, and agents can be an or non-ontologically defined or "black boxed." Second, cybernetic attitudes rely on the repression of all concerns over documentation, indexicality, archive, learning and historical temporality. And third, the temporality of the net is pre-emptive. It always operates in the future perfect tense, without necessarily defined endpoints or contexts.[12] Nets are about T+1. The past is indeterminate. McCulloch regularly dismissed the actual context or specific stimulus that incited trauma in patients or systems.[13] Together, these points redefined rationality, and with it, the practices of reason. Reason was no longer the slow production of certitudes, but rather the account of chance and indeterminacy. For neural net researchers, the determining question was not how similar or different minds and machines are, but rather, as anthropologist Joseph Dumit has said, "what difference does it make to be in one circuit or another?"[14] According to Dumit, cybernetics does not ask what a mind or machine is, but instead asks what minds can do with a mind or a machine?

Significantly, for us, McCulloch and Pitts inverted the question posed by the original negative proof of the entscheidungsproblem, or "decision problem," and answered by the Turing machine. Throughout the nineteenth and twentieth centuries, an army of mathematicians and philosophers struggled to infinitely extend the limits of logical representation. Kurt Gödel, David Hilbert, Bertrand Russell, Alfred North Whitehead and Alan Turing—McCulloch and Pitts asked a different question. What if mental function could be understood as computation? What if the brain could be thought of as a logic? What if instead of what could be proven, McCulloch and Pitts asked, what could be built? Similarly, rather than seeking the limits of calculation, the problem became about examining the possibilities for logical nets. What had been an absolute limit to mathematical logic became an extendable threshold for engineering. McCulloch implied that humans should accept our partial and incomplete perspectives, our inability to know ourselves, and consider this "paucityness" an "experimental epistemology."[15]

EXPERIMENTAL EPISTEMOLOGY

These experiments were central in reformulating older ideas of agency and consciousness into agents. As numerous science historians have demonstrated, cybernetic and communicative concepts of mind were part of a broader reconceptualization of reason, psychology and the human sciences.[16] Cybernetic epistemologies, from theories of learning machines, to the environmental psychology and urban planning programs headed by Individuals like Kevin Lynch and Nicholas Negroponte (Media Lab), as well as MIT's Architecture Machine Group, to the political science models of Karl Deutsch at Harvard and Herbert Simon's "bounded rationality," widely considered the foundation of contemporary finance. The post-war social sciences were reconstituted by techniques that transformed the question of political economy, value production and the organization of human desire and social relations into problems of circulation and communication by way of a new approach to modeling intelligence and agency.[17]

If this is true, then our financial instruments, markets, governments, organizations and machines are rational, affective, sensible and preemptive—not reasonable. To recognize the significance of this thinking in the present, it might help to contemplate Brian Massumi's definition of "preemption." Preemption, he argues, is not prevention; it is a different "causality of threat." Preemption "does not work on the cause-effect line. It works directly empirically and identify their causes." Preemption on the other hand is affective. It lacks representation. It is consistent nervous anticipation at a neural if not molecular level, for a never fully articulated threat or future.[18]

Within ten years from the war, cybernetricians moved from working on anti-aircraft prediction to building systems without clear end points or goals—embracing an epistemology without final objectives or objectivity (though many practitioners have denied this). Even if a neuron can act definitively, nets, taken as systems, are probabilistic scenarios with multiple states and indefinite run times. In cognitive and early neuro-science, the forms of knowledge being espoused were framed in terms of experiment, never definitive conclusions. "Experimental epistemologies," as McCulloch put it, came to mean ongoing experiments unconcerned with final facts.

These human and social scientists made operative the unknowable space between legibility and emergence, and turned it into a technological impulse to proliferate new tools of measurement, diagrams and interfaces. At the limits of this analysis is the possibility that emergence itself has been automated. The problem of how to sort under conditions of uncertainty, or how to define a man or a machine, became instead a pragmatic mandate and a way of life. Indeed, as Dumit has argued, "we have all become test subjects in the experiments and cybernetics began asking, what do circuits do? What do agents act?"[19] They entangled calculation and life at the level of nervous networks, correlating the nervous system with the financial and political system.

Today, we continue to live in the legacy of this experimental epistemology. Performativity, affect and nervousness network are still the very instruments we use to architect our machines, environments and perhaps even ourselves.

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1. From "A Smarter Planet," speech by Sam Palmisano at the Council on Foreign Relations in New York City on November 6, 2008, accessed April 21, 2016, http://www.ibm.com/ibm/files/N731903W58418M91.pdf

2. Peter Galison, "The Ontology of the Enemy: Norbert Wiener and the Cybernetic Vision," *Critical Inquiry* 21 (1994): 228-66; Katherine Hayles, *How We Became Post-Human* (Chicago University of Chicago Press, 1999). See also Arturo Rosenblueth, Norbert Wiener, Julian Bigelow, "Behavior, Purpose and Teleology," *Philosophy of Science* 10 (1943): 18-24.

3. Cf.E. Ray, "From Logical Neurons to Poetic Embodiments of Mind: Warren McculloCh's Project in Neuropoetics," *Science in Context* 5, no. 1 (2013): 67-4.

4. This method has been reviewed elsewhere, here I am briefly outlining the work with focus on epistemology. Cf. S. Abe, "From Logical Neurons to Poetic Embodiments of Mind: Warren McculloCh's Project in Neuroscience by J. Abraham Arbib," *Science in Context* 5, no. 1 (1992): 226-28; The Intellectual Origins of the Wiener/Rosenblueth Theory of Teleology," *International Journal of Philosophy of Science* 10, no. 1 (1996): 79-92; Peter Galison, "The Ontology of the Enemy: Norbert Wiener and the Cybernetic Vision," *Critical Inquiry* 21 (1994): 228-66; Katherine Hayles, *How We Became Post-Human* (Chicago University of Chicago Press, 1999). See also Arturo Rosenblueth, Norbert Wiener, Julian Bigelow, "Behavior, Purpose and Teleology," *Philosophy of Science* 10 (1943): 18-24.

5. Warren S. McCulloch and Walter Pitts, "The Logical Calculus of Ideas Immanent in Nervous Activity," *Bulletin of Mathematical Biophysics* 5 (1943): 115-133, reprinted in *Embodiments of Mind* (Cambridge: MIT Press, 1965), 21-42.

6. Warren S. McCulloch and Pitts, "A Logical Calculus of Ideas Immanent in Nervous Activity," p.19.

7. John Von Neumann, "The General and Logical Theory of Automata," in *Papers of John Von Neumann on Computing and Computer Theory*, ed. William Aspray and Arthur Burks (Hoschette California: MIT Press and Tomash Publishers, 1948/1986), 422.One emphasized, the neuro-scientists there are also "black boxed" and their internal processes ignored. Cf. Gilles Deleuze and Félix Guattari, *A Thousand Plateaus* (Cambridge, Mass.: London: Athlone, 1987), 373.

8. Von Neumann, "The General and Logical Theory of Automata," 422.

9. The pair had stressed that assumptions about how neurons work or what by that rate, was the dominantly accepted neural doctrine in neuro-physiology at the time. Warren S. McCulloch and Pitts, "A Logical Calculus of Ideas Immanent in Nervous Activity," p.21. Pitts and McCulloch were also explicit that they were not simply mathematizing the brain: "we are not concerned with the real neuron, but rather with an idealized artificial one, as logically perfect, detached and free of all inessential material implied by the qualities of the actual neuron. Theorems concerning our fictitious neurons are to be found in the literature of applied mathematics, of which our present notions are only a small part." Warren S. McCulloch and Pitts, "A Logical Calculus of Ideas Immanent in Nervous Activity," p.21.

10. Warren S. McCulloch and Pitts, "A Logical Calculus of Ideas Immanent in Nervous Activity," p.21.

11. Warren S. McCulloch and Pitts, "A Logical Calculus of Ideas Immanent in Nervous Activity," p.21.

12. See, for example, interviews or treatment of addicts coming from World War II (John H. Knowles, "Psychosocial studies of addiction," *Psychosomatic Medicine*, and psychiatrist promoted drug treatment to rewire circuits in the brain; see British Broadcasting Corporation, "Physical Treatments of Mental Disorders," Broadcasting Corporation Broadcasters Central Programme (BBC, 1952)) and the papers of Warren McCulloch, Box 5 MIT Film Series 5, American Philosophical Society, Philadelphia, PA.

13. Joseph Dumit, "Is it Alive?," p.7.

14. Joseph Dumit, "Is it Alive?," p.7. In Computability Numbers, edit on Application to the Entscheidungsproblem," in *Proceedings of the London Mathematical Society* ser. 2, no. 1 (1936). Bertrand Russell, *The Principles of Mathematics* (London; New York: Routledge, 2009). From "Paucityness" in Warren McCulloch, "Appendix to Cybernetics," in *Cybernetics: Circular, Causal and Feedback Mechanisms in Biological and Social Systems. Transactions of the Seventh Conference, March 15-16, 1951, New York, N.Y.*, ed. Heinz von Foerster, Margaret Mead, and Hans Lukas Teuber (New York: Josiah Macy, Jr. Foundation, 1952), 207.

15. Warren S. McCulloch and Pitts, "A Logical Calculus of Ideas Immanent in Nervous Activity," p.21.

16. See, for example, interviews or treatment of addicts coming from World War II (John H. Knowles, "Psychosocial studies of addiction," *Psychosomatic Medicine*, and psychiatrist promoted drug treatment to rewire circuits in the brain; see British Broadcasting Corporation, "Physical Treatments of Mental Disorders," Broadcasting Corporation Broadcasters Central Programme (BBC, 1952)) and the papers of Warren McCulloch, Box 5 MIT Film Series 5, American Philosophical Society, Philadelphia, PA.

17. Joseph Dumit, "Is it Alive?," p.7.

18. Brian Massumi, "Potential Politics and the Primacy of Preemption," in *Theory & Event* 10, no. 2 (2007): n. 7.

19. Joseph Dumit, "Circuits in the Mind."

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