THE INTERNET OF ONTOLOGICAL THINGS: ON SYMMETRIES BETWEEN UBIQUITOUS PROBLEMS AND THEIR COMPUTATIONAL SOLUTIONS IN THE AGE OF SMART OBJECTS

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DISSEPTION

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ABSTRACT

This dissertation is about an abstract form of computer network that has recently earned a new physical incarnation called “the Internet of Things.” It surveys the ontological transformations that have occurred over recent decades to the computational components of this network, objects—initially designed as abstract algorithmic agents in a source code of computer programming but now transplanted into real-world objects. Embodying the ideal of modularity, objects have provided computer programmers with more intuitive means to construct a software application with lots of simple and reusable functional building blocks. Their capability of being reassembled into many different networks for a variety of applications has also embodied another ideal of computing machines, namely general-purposiveness. In the algorithmic cultures of the past century, these objects existed as mere abstractions to help humans to understand electromagnetic signals that had infiltrated every corner of automatized spaces from private to public. As an instrumental means to domesticate these elusive signals into programmable architectures according to the goals imposed by professional programmers and amateur end-users, objects promised a universal language for any computable human activities. This utopian vision for the object-oriented domestication of the digital has had enough traction for the growth of the software industry as it has provided an alibi to hide another process of colonization occurring on the flipside of their interfacing between humans and machines: making programmable the highest number of online and offline human activities possible. A more recent media age, which this dissertation calls the age of the Internet of Things, refers to the second phase of this colonization of human cultures by the algorithmic objects, no longer trapped in the hard-wired circuit boards of personal computer, but now residing in real-life objects with new
wireless communicability. Chapters of this dissertation examine each different computer application—a navigation system in a smart car, smart home, open-world videogames, and neuro-prosthetics—as each particular case of this object-oriented redefinition of human cultures.
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This dissertation is dedicated to my parents
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INTRODUCTION

This study is about an abstract form of computer network that has recently earned a new physical incarnation called “the Internet of Things.” It surveys the ontological transformations that have occurred over recent decades to the computational components of this network, objects—initially designed as abstract algorithmic agents in a source code of computer programing but now transplanted into real-world objects. Embodying the ideal of modularity, objects have provided computer programmers with more intuitive means to construct a software application with lots of simple and reusable functional building blocks. Their capability of being reassembled into many different networks for a variety of applications has also embodied another ideal of computing machines, general-purposiveness. In the algorithmic cultures of the past century, these objects mostly existed as mere abstractions to help humans understand electromagnetic signals, which had infiltrated every corner of automatized spaces from private to public. As an instrumental means to domesticate these elusive signals into programmable architectures designed by professional programmers and amateur end-users, objects promised a universal language for any computable human activities. This utopian vision for the object-oriented domestication of the digital had enough traction for the growth of the software industry as it provided an alibi to hide another process of colonization occurring on the flipside of their interfacing between humans and machines. Computer algorithms have, as Ed Finn says in What Algorithms Want, expanded their fields of application to generalize their “desire for effective computability” further to any sorts of “working systems of actual computers, humans, and social structures” (2017, p.47), and have made programmable the highest number of online and offline human activities possible—the desire that Jonathan Beller terms “the full colonization of the life-
world by computational capital” (2018, p.72). A more recent media age, which this dissertation calls the age of the Internet of Things, refers to the second phase of this colonization of human cultures by algorithmic objects, no longer trapped in the hard-wired circuit boards of personal computers, but residing in real-life objects with new wireless communicability.

The adjective “smart” has become applicable to any social spaces in different scales through the recent achievement in miniaturizing sensor, processor, actuator technologies to the size tiny enough to be embedded in any object. This has also redefined the meaning of smartness in the current age. Our smart life now stems from the awareness of our very standing at the interlocked edges of these spaces, re-divided into each hardware infrastructure in the low and software application in the high. Think of one’s physiological body, domestic space, and urban neighborhood tracked by different sets of sensors embedded in the lower layers of a smart cloth, smart home, and smart city, under the governances of software applications in the high. Augmented by the wireless communicability of these computational agents, the natural and technological objects otherwise isolated in different contexts are communicable through their algorithmic doubles in the digital networks. From the periodic movements of human organs under wearable sensors to the seemingly unpredictable patterns in people’s collective behaviors under citywide environmental sensors, the ontological boundaries of subject/object are no longer determinant for their legitimate place of existence because these boundaries are resolved into the intensive object-to-object communications resumed in the networks. Any dynamics in culture, from habitual patterns of our everyday practices in smart home/office/city to the irregular patterns of insurgents under the surveillance of military drone swarms, are now potentially translated into the digital signals exchanged by their digital avatars. In these networks, the problems once believed to be isolable in each particular context would appear not to belong to
that single domain but straddle several or, potentially, all domains digitally simulated and put together in the network. For instance, your heartbeat under the 24/7 monitoring of your smart watch is also an efficiency problem in the task to find the most optimal behaviors in your house/office/city as much as detecting terrorists becomes a problem to find irregular shopping behaviors online.

Referred to by different names, such as Ubiquitous Computing (Wieser & Brown, 1997), Pervasive Computing (Satyanarayanan, 2001), Amorphous Computing (Abelson et al., 2009), the Internet of Things (Ashton, 2009, June), and consisting of various technological and theoretical incarnations of “smart objects” (Kortuem et al., 2010), “computational particles” (Abelson et al., 2009), “smart dust” (Kahn et al., 1999), and so forth, these networks redefine their operational environment as a topological continuum which can be folded and filtered in many different ways through the sensors and actuators embedded. One working metaphor to describe these algorithmic objects is to think of their wireless networks as flexible and temporary reflex arcs for an artificial nervous system (Hayles, 2016; Hill, 2008). As the quasi neurological units embedded in a space, they function to foreground the manifold sensor-actuator responses hidden in the space; such as drivers’ collective and otherwise unrecognizable responses to the traffic congestion in an intersection that a network of smart traffic lights foregrounds (Xie et al., 2012; Xie and Wang, 2018), or your pace of running as a habitual and nonconscious response to your heartbeat that your smart watch visualizes. This Big Data-driven control of social and biological spaces is often based on the speculation about a space’s hidden orders or its implicate orders,¹ whose presences are hardly felt by humans until translated into certain sensor-actuator

¹ David Bohm (1980) calls this excess of orders enfolded in the wholeness of a space the “implicate order,” which can be unfolded into “explicate order” through proper topological transformations of the space.
relations between smart objects. A space remapped by these objects is thus constantly folded into the multiple algorithmic arcs, drawn by their intensive sensor-actuator interoperations to detect hidden parameters of the space. These parameters, currently unspecifiable but ready to be discovered by the networks of smart objects, are the hidden resources in which the recent media industry speculatively invests its venture capital for its utopian future of the ever-repeatable commodification. The Internet of Things (IoT), which this dissertation defines as the internet’s new phase of physical infiltration, should in this respect be understood as more than a simple change in technical means to extract data, which Kevin Ashton originally intended this term to mean. For him (2009, June), the IoT was most of all the change in the data entry method for the internet’s information economy, from the entry performed entirely by human labors such as “typing, pressing a record button, taking a digital picture or scanning a bar code” to the environmental sensing of autonomous smart objects. On the other hand, the Internet of Things in this dissertation rather signals an ontological shift in our understanding of everything—from our body, home, office, vehicle, to our city, potentially folded into the networks of these miniaturized algorithmic agents. It also signifies our consequent rediscovery of everything as problematic topological objects with lots of hidden parameters inaccessible by our too-human approaches to the problems.

The “things” in the IoT encompass not only smart sensors and actuators (which Chapter 1 and 2 of this dissertation discuss as functional elements in a smart car and home), but algorithmic and graphical objects in virtual reality (such as videogame objects in Chapter 3), and those of organic matters digitally augmented (such as primate and human neurons in Chapter 4). This list is expandable even to any unknown beings insofar as our speculations about their secret networks are justifiable. The condition in which these speculations would be more than just
paranoid can be fulfilled as we deepen our speculation further to the consequences that our ignorance of them would possibly bring to our lives. As much as our groundless speculations about unknown terrorist activities or pathogenic networks are somewhat justifiable given the possible consequences of their actual existence by any chance, to build invisible networks of things that counter these invisible dangers would also be justifiable. In my definition, the lowercase “o” in the IoT stands for many small ontologies about these unknown consequences, which the objects communicate not so much to help us incorporate them into our big Ontology as to persuade us that our too-human world view is not enough to manage these problematic tiny ontologies within our lives.

Speculative Economy of Media

The Internet of Things is not just an abstract form of technical network, but descriptive of a speculative economy of the current software industry, which capitalizes people’s speculations about hidden problems as the means to justify their speculative consumption of the IoT-driven smart solutions. Speculation—as a new form of cognitive labor through which we overvalue the significance of problems and eventually overpay for their IoT solutions—also redefines the meaning of alienated labor in the new digital economy: where the human speculators are the only smart beings excluded from the problems that their speculation creates, whereas other smart beings, such as smart objects and IoT service providers, could access these problems through their constant data mining and data analysis. If the attention economy, characterizing the internet of the previous era, has been constructed upon a specific form of cognitive labor called attention, the value-giving process of human brains modeled after manual labor in industrial capitalism (Beller, 2006, p.9), the speculative economy, which this dissertation
discusses as what characterizes the Internet of Things, is built upon the cognitive process that we often employ to make up our failure to pay proper attention to the hidden problems, namely speculation, and it overvalues the problems.

From this new economy of the internet, coincident with the mode of value production in the late capitalism, this study derives a new regime of surveillance in our smart everyday lives. For Foucault, the inaccessibility to the observing eyes in the central tower of Panopticon was the source for the hallucinatory omnipresence of the surveilling gaze, which the inmates gradually internalize as they respond to these hidden eyes by displaying normative behaviors the whole time (1995). The panoptics realized instead through actual physical sensors in various scales today are however not enough alone to justify their 24/7 surveillance as the necessary to prevent the problems from happening, because the problems are no longer measurable by the mere sum of sensors. The ideal of a panopticon as “an all-seeing vantage point” is not achievable simply by wiring multiple sensors insofar as their interconnections inevitably leave many gaps between sensors. Their network would, at best, just be an oligopticon as “partial vantage points with limited view sheds” unless proper software applications “integrate and bind data streams together, work to move the various oligopticon systems into a single, panoptic vantage point” (Kitchin, 2014, p.11). The urgency of problems is thus defined not so much as their degree of deviation from the normative responses to the hidden sensors any longer, but by their degree of deviation unable to redirect further to another measure in a continuous and seamless manner. For example, traffic congestions would be urgent problems not simply because they overrun the average but because they tend to be difficult to re-distribute through the nearby smart traffic lights. Your excessive heartbeat would likewise appear to be urgent when a smart watch detects it but cannot transmit to the health app, fitness app, sleep app, and so forth. Too widely distributed to be
perceived at any local posts, these anomalies necessitate more flexible surveillance networks, and for their partial detection by local devices to be analyzed further by other devices, these loosely interconnected smart devices should constantly re-make their network structures every moment.

The nature of these problems, constantly withdrawing from the mere sum of local observations, also provides the rationale for our voluntary subjection to the new surveillance networks. In the recent trend of panoptics which democratizes the “placeless and faceless” position of the observer in Foucault’s to whoever has access to the public or private webcams and other sensor devices (or what Mark Andrejevic calls “synopticism” characterized as “the many watching the few” (2004, p.13)), our willingness for the “deliberate exposal of the self” involves no longer our strategic response to the inaccessibility of the sensors (Koskela, 2006, pp.175-6). Rather, what we are blocked from accessing in smart environments is the control of ubiquitous actuators, such as the motors of security cameras whose secret motion tracking is black-boxed beneath the dark surfaces, the functions of smart objects to activate themselves or others, or their direct intervention in a space by transmitting imperceptible cues. These actuators become smart as their proactive distribution of machine-readable signals and human responding cues (or “nudges”) gradually foregrounds the hidden orders of a space, or hidden patterns of human behaviors in that space (Thaler & Sunstein, 2008; Zuboff, 2019). On the other hand, our inability to control these actuators, or our exclusion from the pankinetics of ubiquitous actuators that unfolds the hidden orders of a space along their algorithmic arcs, is why we still feel helpless despite our new accessibility to lots of local sensors within our lives. The recent Big Data visualization aestheticizes this asymmetry of human beings between ubiquitous sensors and actuators through the sheer Bigness of data. Whereas its visual complexity translates the scale
and multidimensionality of Big Data into a two-dimensional aesthetic presentation, a subjective form of reception that audiences would easily bring up to this complexity is still the “mathematical sublime”: the awe-inspiring feeling in response to the manifold orders and dimensions supposedly embedded in Big Data, not accessible by audiences who do not have enough means to intervene in these hidden levels (McCosker & Wilken, 2014).\footnote{One machine-learning based approach to these hidden levels could be described as a process to draw an algorithmic arc of sensor-actuator relations across a database. For instance, to detect certain correlations between different types of data, or to extract proper metadata to classify data, a supervised or non-supervised artificial neural network (ANN) filters a database through its algorithmic neurons loosely interconnected along their exchanges of inputs and outputs. These neurons are programmed to constantly reassemble their input-output relations until their improvised network fits into a hidden order embedded in the database, and thus, through having enough training with sufficient sample data, an ANN evolves into a trustworthy network of algorithmic sensors and actuators to map the given database. But, after its individuation is done and black-boxed as a working network, its inner process to fold the database is surrounded by the “opacity” which obstructs the “audit” from the users or even owners of the database (Burrell, 2016).} Inasmuch as the safe aesthetic distance is not tenable in the audiences’ actual immersion in environments, their sublime could easily be convertible into the terror of something out of their reach. “Their awareness of their environment diminishes in line with their ability to do something about it” (Hill, 2013). From this terror-leading sublime, data fetishism or data “solutionism” (Mattern, 2013; Morozov 2013) would emerge as people internalize the ubiquitous gazes and cues from the sensors and actuators everywhere as the solution for hidden, supposedly ubiquitous, problems. From our bodies enclosed by multiple wearable devices to a smart city operationalized by the Internet of Things, the spaces under panoptics—whose ideal of 24/7 omnipresent surveillance is realized by recent technological achievements—appear to be possessed by something problematic once again. Under the lens of data fetishism, the full visibility of a space is not
produced by the mere sum of sensors, but only realizable through the full interoperability of the actuators to unfold all of its implicate orders from the space’s constant transformations. In the recent smart spaces, this asymmetry of human beings between sensors and actuators is what their surveillance networks need to reproduce at each node since this new human condition—overwhelmed by manifold sensors but inaccessible to their actuator counterparts—would be what push us to delegate our natural right to control our surroundings to the smart objects.

Transforming their operational environments—from a body to city—into a topological continuum, the networks of smart objects have developed a new governmentality for the problems supposedly lurking in each different level of the same continuum. Alongside this topological speculation about the problems infinitely implicated in a space, a new strategy of market penetration has also been invented by software companies, representing what Shoshana Zuboff calls “surveillance capitalism” (2019). For the past two decades, these companies have dispatched their algorithmic agents to a variety of human domains, both physical and virtual, in order to translate human behaviors transpiring there into their privately owned Big Data, potentially open to any future attempts at data mining to unfold new service domains of the IoT. Our asymmetry to the problems embedded in surroundings is where these political and economic powers find the justifications for their infiltration of our everyday life.

It is a thesis of this dissertation: powers now exploit our generalized concern about the asymmetry of environments to human understanding. Asymmetry is when something is felt but inaccessible.
Life Digitalized, and its Predictability

Throughout the conceptual development of the Internet of Things, what has first been redefined as a topological object would be the elementary sense of the term *life* as it has appeared to be the foremost domain for smart objects to be embedded. The “re-emergence” of vitalism in recent media theories or the concept of agencies democratized even to the inorganic and non-technological matters has coincided with this trend (Fraser et al., 2005; Olma & Koukouzelis, 2007; Bennett, 2009). Defined paradoxically as “what escape *exact* definition and representation,” life, according to the Western materialist thought since the nineteenth century, has often been mystified as something felt only by its withdrawal from any attempts at scientific measurement and technological intervention. Especially after the concept of “vital force” was dissipated by the early research in reflexology that re-embedded a physiological system of an organism within the outside world of the thermodynamic (Olma & Koukouzelis, 2007, p.2; Patton, 2018, §4.1), the reactionary mystification of life has just functioned to preserve the smallest niche for the anti-materialist discourses of life at the peripheries of biological, neurological, and pharmaceutical discourses. This tendency of life to escape to its unknown terrain is now, conversely, repurposed as the ideological justification for the networks’ further expansion to the finer-grained materialities of our sociobiological life. It happens when life’s infinite withdrawals to the ungraspable territories ironically demonstrate the new frontiers for the sensors and actuators with smaller sizes and higher resolutions to be embedded in order to redirect its elusive fluctuations as novel resources to intensify the networks. The wireless networks of smart objects, flexible enough to encompass any life activities around their finer-grained sensor-actuator arcs, seem to re-summon the ghost of vitalism, which the hardwired sensors and actuators in the early physiology experiments such as Helmholtz’s *myograph* once
drove out to the peripheries of the scientific discourses (Ahn, 2013). The vitalism today instead reappears anywhere machines fail to grasp “a vital materiality” as “the swarm of activity subsisting below and within formed bodies and recalcitrant things” (Bennett, 2009, p.50). Both as the return of the repressed and the ideological justification for the networks’ expansionism, its resurgence redefines life as an object with lots of hidden territories, never exhaustible by its sensor-actuator relations to the existing technological networks, and thus guaranteeing the ever-expansion of the networks (Harman, 2009, p.132), from a local network of experimental apparatuses in biology labs to the citywide environmental and behavioral sensors for the communal level of life activities.

In his study of the twenty-first century’s “politics of life,” Nikolas Rose says that life as a medical and pharmaceutical phenomenon is now populating “a ‘flattened’ world, a world of surfaces rather than depths” (2007, p.130). Since molecular biology appeared in the late twentieth century as the protocol to communicate this natural phenomenon along the assemblages of biotech and pharmaceutical companies, doctors, genetic counselors, genomics researchers, biobankers, and patient groups, life has been re-considered as a boundary-object, whose elusiveness is never fully graspable by any single apparatus, but examinable infinitely through the new communicability between various individual and organizational actors converged at this common level of molecules. At the same time, these actors’ collective and ethical concerns about life, namely its optimizations at multiple levels of individual healthcare, medical research, and pharmaceutical product, have begun to be discussed within a continuum of molecules, that is “only one set of relays in complex, ramifying, and nonhierarchical networks, filiations, and connections” (p.130). Ceased to be “a deep ontological reality” interpretable only from the symptoms on surfaces, life and its mythical depth have been
relocated in multilevel databases with lots of embedded orders and disorders. For its further optimization along these medico-pharmaceutical assemblages, individuals, as potential hosts of disorders, have also become responsible for subjecting their molecular compositions of bodies to the screening of “pre-symptomatic diagnoses” before the disorders erupt with visible symptoms. Their genetic variations, potentially involved in unknown diseases lurking in their bodies, become manageable by the “preventive interventions on a scale previously unimaginable” (p.89).

The advent of wearable and implantable healthcare technologies has accelerated this molecularization of life by providing human hosts with digital shortcuts for their bioethical responsibility of reframing a body as a continuum of molecules. Any anomalous fluctuations of this continuum can now be automatically reported to doctors or genetic counselors as the smart healthcare devices successfully replace the healthcarers’ task of monitoring “physiological parameter and environmental conditions,” often “manually executed by nursing staff” or patients themselves “represent[ing], de facto, an efficiency bottleneck, which could be a cause of even tragic errors in practices” (Catarinucci et al., 2015, p.515). In a future scenario of smart healthcare (Stantchev et al., 2015), the smart objects embedded in a patient’s body and room have been suggested to form a local network termed “fog computing”; whose early detection and transfer of elusive symptoms to “the cloud” of Big Data for a bigger medical network would enable the better prediction of critical states of the patient even before actual interventions from human doctors.

On the other hand, what the recent smart cities aim to digitalize through their distributed behavior tracking technologies is the more communal form of life, whose hosts can be termed “insurgent citizens.” The optimal future scenarios of the new urbanity that these citywide IoT
projects promise seem to arrive opportunely after the failure of the modernist urban planning, and seem to amend its once purely “idealist project of alternative futures” (Holston, 1998, p.38). James Holston says that the modernist planning’s top-down approach to an imaginary city, “present nowhere in the world but existing only in plans,” has failed as it has encountered the insurgent and nonconforming heterogeneity of what had already populated the city. In his “project of rethinking the social in planning,” this insurgence, however, also means a revelatory moment for “a realm of the possible that is rooted in the heterogeneity of lived experience, which is to say, in the ethnographic present and not in utopian futures” (p.41, 53). For nonmodern planning, he says, it is necessary that the planners’ “ethnographic investigation” not only “establish[es] the terms by which residents participate in the planning of their communities” but extracts the most optimal option of possible futures already embedded in the heterogeneity of a city’s material composition (p.53). The futurity of urban civilization and its pursuit of sustainability, after the failure of modernist planning, are, in this respect, also planned from a sort of flattened world: where the optimal near futures are not imposable by the verticality of planning, but emergent from the heterogeneous materiality of urban infrastructures, where all “the insurgent forms of the social” from the grassroots should be redirected and preempted by the planners’ data-driven scenarios. Recently, the wireless sensor and actuator networks of smart cities have provided both planners and citizens with the digital shortcut for this ethnographic responsibility for “tracing, observing, decoding, and tagging” everyday activities. In doing so, our sustainable future has become a problem of optimization by means of predicting and preventing possible negative incidents lurking in the grassroots. The recent research on the convertibility of smart cities into the military infrastructures for counterinsurgence (Michaelis, 2018; Pradhan et al., 2018) can be in this context understood as an alibi which hides the
following fact: the optimal futures that the smart cities promise have always and already been based on a certain militarized understanding of urbanity under constant alternations between insurgent problems and counterinsurgent IoT solutions.

From molecular to urban, the processes of life, neither hidden under surfaces nor programmed from above, have been relocated in a digital continuum. The multiple levels of our life-world have also been redefined from this continuum as software applications re-demarcate the digital domains of our smart clothes, home, office, vehicle, and city from the vital signals collected at multiple levels of molecular-physiological, individual-psychological, and collective-statistical. This continuum lying between micro and macrosocial flows of life has accumulated a multitude of human and nonhuman histories within its flat and ever-expendable surface of Big Data, including individual records of medical history, people’s online and offline behaviors, various indices for global and national economies, and records of environmental changes. The machine learning algorithms, which have appeared to be the most reliable oracles to extrapolate the possible near futures from these traces of the past in various durations, have also embedded lots of virtual objects in the continuum to excavate unknown correlations between these records. No matter how believable this assumption on a multitude of human domains overlapped at this digital substratum and correlated with each other, for the recent software industry, their convergence upon a continuum has been a sort of commercial necessity. It is because the Big Data-driven solutions of human problems the software industry has promised could have indeed attracted venture capital as the following assumption has been persuasive so far: any domains of human activities, seemingly discontinuous with each other, might be in fact correlated through certain parameters currently hidden from our understanding but able to be discovered sooner or later by data-mining; their being together in the world could therefore be optimized further.
Under this assumption, a discontinuity between human domains has been re-problematized by the industry’s attempt to find their hidden correlations to figure out the optimal way to put them together on a continuum. However, as the best of all possible worlds of Big Data where these hidden correlations are all discovered and perfectly calibrated has ever been delayed to come (since it is just an utopian future), the continuum—as the multiplicity of domains complicatedly interrelated—has also been predicted, by the same industrial assumption, to be subject to the recurrent problems in various scales, from temporal information overloads and heavy traffics to cyber-terrorism and global climate change. Eventually, it becomes our common speculation: the future will be catastrophic unless the preemptive interventions of smart networks remove the trigger of this insurgency on the physical side before it really happens.

The Oxford philosopher Nick Bostrom thus warns: “there is some level of technology at which civilization almost certainly gets destroyed unless quite extraordinary and historically unprecedented degrees of preventive policing and/or global governance are implemented” (2019, p.3). Even though it sounds a little paranoid, his Vulnerable World Hypothesis would be still persuasive if we accept that being paranoid is the most certain way to be properly prepared for this catastrophic future, especially when any single incident could be potentially correlated with anything else on this continuum.

Algorithmic Preemption of Futures

Our life-world is now smarter than ever before and will only get smarter. Smartness is ever-renewable inasmuch as its conceptual counterpart, ubiquity of problems embedded in the material reality, is potentially inexhaustible too. Imagined to be full of pattern-recognition problems, this world is, Chris Anderson in Wired says, hardly representable by the “obsolete”
scientific method of “coherent models, unified theories, or really any mechanistic explanation at all.” Scientific representation may even be unnecessary as “statistical algorithms [are able to] find patterns where science cannot,” without having any pre-given theoretical models (2008, June). Technology was once merely instrumental in knowledge production to demonstrate given premises, but it currently occupies a sort of \textit{transcendental} position as its \textit{unsupervised} learning can extract hidden features of data and reconstruct its operational environments, \textit{databases}, into the intuitive form for the further algorithmic reasoning. This “transcendental instrumentality” of technology redefines the current post-Kantian epistemology by making our subjective ends of knowledge production constantly renewed from “procedural or algorithmic reasoning” of technological means. Some scholars such as Luciana Parisi thus suggest an optimistic view that we can take this “as a chance [for humanities] to re-ally instrumentality with a political renaissance of media critique” (2020, p.121). However, reprogrammed by the capitalist ends of market penetration/expansion, this machine-driven knowledge production, ever-renewable through data-mining, seems to function as the new engine of software industry, whose primary goal is to discover a greater number of hidden problems to expand its service domains. As this technoscientific reconstruction of reality with machine-readable but human-inaccessible problems gradually expropriates our transcendental position in Kantianism, \textit{paranoiac} \textit{speculation} about these hidden problems would gradually remain as the only available mode of knowledge production for ordinary human users.

In the now-common usages of the term smartness, \textit{sustainability} and \textit{efficiency} are the two most important criteria to measure how smart a network is at individuating urgent problems of a space and at reassembling optimal sensor-actuator interoperations as the proper solutions (Mohanty et al., 2016, August; Gabrys, 2014). Understanding these criteria differently, the smart
objects temporarily assembled into working sensor-actuator arcs for a given goal should preserve, within the transformed network, a large enough number of alternative sensor-actuator interoperations ready to be mobilized for the other functions. This balance between sustainability and efficiency—also what smart citizens need to internalize as the criteria for their everyday lives—is necessitated by the following assumption: any simple interactions of objects we trigger could be in hidden correlations with all the others either directly or indirectly because they share the same users and operational environments. According to this assumption, an object’s activation that changes the states of its users and environments could changes the probabilities of all other objects’ activations. If we can redefine smartness in the current context as the capability of finding the most efficient route to given goals out of the ecological complexity of correlations, the only smart decision we can make for the urgent needs in our daily life would be to put our life-world under the 24/7 surveillance of smart networks. It is because the non-linear consequences of the choices we make, potentially disruptive to the ecological diversity of other choices available in smart environments, are not recognizable to the naked eye. The smart futures constantly brought forth from these machinic routes chosen as the most efficient for the urgent needs should be simulated first by machine learning in advance to preempt its possible consequence on the ecological diversity of the networks.

In other words, for the sustainable future of our life, its physical stratum needs to be coupled with a digital double that preempts the near future of the original. Since we first agreed with the “terms of use” about the smart objects tracking our daily practices, our everyday life has eventually begun to be overshadowed by this digital double. On the other hand, what the recent virtual assistant applications—such as Apple’s Siri, Google Assistant, Amazon’s Alexa, and other smart advisors for health, fitness, driving—aim to add to this digital continuum is an actual
dimension of time, which no longer just underlies but intrudes into our phenomenological experiences (Dawar, 2018). Their autonomous suggestions for the most optimal way to prepare for the future seem to push us to choose between two different responses to the passage of time, namely human protention and algorithmic preemption. And the rational answer to this either-or question would always be the latter given the asymmetry between humans and artificial intelligences: while the machine learning can analyze even human intentionality as a series of stochastic processes and integrate it into the digital continuum, humans are, unfortunately, blocked to access this continuum.

**Optimization of Human Worlds**

For Rose and Holston, the recent enterprises of life were descriptive of the circulation of this elusive and inexhaustible signal called life along the assemblages of loosely interconnected actors in various scales, and this circulation was supposed to bifurcate many temporal networks as each circuit to optimize life for individual healthcare, corporate expansion, academic research, and governmental control. For the constant innovation to happen and recreate these embedded networks in the assemblages, individuals were deemed to be responsible for molecularizing or digitalizing their own lives according to the protocols of pharmaceutical industries or urban ethnography. In the age of the Internet of Things, we witness that this bioethical responsibility—to communicate life through the networks—provides an alibi to hide an exploitive mode of smart objects as their operation to extract behavioral data from people’s everyday lives pretends to serve for people’s smart citizenship. These devices’ secret transmission of user data, or people’s quantified-selves (Ruckenstein & Pantzar, 2017), to commercial networks seeks for ethical excuses from the fact that to minimize delays in data transmission is a prerequisite for optimizing
people’s life in smart environments. The camouflaged forms of protocols for the devices’ access to people’s quantified-selves may provide another excuse as it is now simplified along people’s everyday practices, such as wearing smart clothes, watches, glasses, using smart plugs for every home appliance, and agreeing with terms of use for these gadgets.

However, the necessity to put our everyday lives under the surveillance of smart objects is not something merely fabricated by consumerist campaigns for the optimal future around the corner. This necessity is rather internalized through our speculation about the changed condition of subjectivity after the revelation of humans’ asymmetrical engagement in the world full of non-linear problems beyond their understanding. For instance, under multiple wearable sensors embedded in our surroundings, what reappear foremost to be populated by these sorts of problems would be our own secret selves, inaccessible by the wearer’s intentional self-understanding. The ethical issue concerning the recent quantified-self may, in this respect, not be simply about its possibility to be sold to the outside parties without user consents. The more significant issue could involve corporates’ possible exploitation of the concerns of audiences about their inaccessibility to their own nonconscious and quantifiable selves. As Cellary and Rykowski point out, one important purpose of service providers in collecting user data is “identifying the susceptibility of a person to arguments and proposals” about his/her unknown needs and problems, which “an aggressive marketing attack” of software industry says their algorithms has already detected (2015, p. S19). The primary goal of the recent data-driven behavioral economics is most of all to target this “consumer vulnerability” (Nadle & McGuigan, 2017). No matter how “annoying and unwanted” their suggestions of life-changing solutions seem to be, to ignore them would be no easy if our consciousness can recognize our own needs only with a significant delay, at least several milliseconds or a “missing half-second,”
the missing time where what Mark Hansen calls “twenty-first-century media” (2015) found its most functional niche for its early warning system for lurking problems.

For the Internet of Things to expand its service domains to a greater variety of people’s everyday activities, it is thus necessary to draw their participations in the network by asking their voluntary delegation of the control over their surroundings. This paradoxical form of user engagement becomes plausible in a certain discursive practice users perform: *speculation about* the world full of hidden problems beyond their accessibility and subsequent *speculative investment in* the preemptive power of smart objects. This discursive and economic process of speculation has recently been internalized and intensified by the following questions the smart technologies seem to ask. Do you still have control over the technologies? Can you still put your surroundings under the changes that you can predict? In short, are you still media users? If we can still say yes to all these questions, it would be only because we have already delegated our rights as tool users, which we have unfairly monopolized for a long time, to the media objects themselves who are smart enough to employ each other for their predictions of our needs (Kahn et al., 1999, §4.2). The modernist planners of life may finally be at home when its smart interior is automatically transformed into the optimal future states that the modernists wanted to bring into reality without having actual physical contact with worldly objects. The personalization of media interfaces has recently realized this modernist dream of spatial optimization by displaying the most probable futures their registered users would purchase or “Like,” such as the promise for the constant lifestyle improvement that the consumer goods Amazon recommends would bring in your life, or your imagined future neighbors gathered around a similar political inclination by Facebook and Twitter. It has however been done through dragging the modernist
planner down to the material bottom where his transcendental subject is dissolved into a multi-dimensional dataset called quantified-self.

Embedded in its social network pages as well as potentially any external webpages, Facebook’s recent Social Plugins, such buttons as “Like,” “Share,” “Send,” and “Quote,” expand its domain for web-personalization even to a person’s online activities outside the platform. Modularizing the Web 2.0-style user participation, these virtual objects on the current internet afford more engaged user experiences through a simple motor activity of clicking. However, what Facebook really intends through this generalized participatory web would be not simply to make the web more democratic, but to train its personalization algorithm further for an imaginary future it has dreamt of: the future where Facebook’s background operation to filter and redisplay the entire web on behalf of its users would eventually substitute for connection-making practices in a Web 1.0 fashion, once performed all by conscious decisions of individual users along the hyperlinks individual web designers created. In other words, “beyond the hyperlink,” the new fabric of the web would be written not so much by actual links formed by user performances but the algorithmic calculation of the probability that the links happen (Gerlitz & Helmond, 2013, p.1358). If this object-oriented approach to personalization has secretly been experimented on the web using virtual objects called Social Plugins, the recent miniaturization of smart sensors, processors, actuators, and their attachment to physical objects such as the “things” in the Internet of Things make this approach applicable to a physical domain too. In a new domestic space called smart home, our idealized smart life would be unfolded by the autonomous interoperations of manifold smart devices, which would substitute for a linear trajectory of a tenant’s roaming around a space for manually turning them on and off. The smart
appliances’ algorithmic preemption of our intention to interact with them would rewrite the fabric of our lives.

Eli Pariser (2011) says the “filter bubble” now encapsulates each media user in one’s new domestic setting. Passing through its filtering, the non-linear continuum of digital signals in the web reappears to be continuous again to the linear trajectory of our online and offline behaviors. In return for this customized enclave in which our still-too-modern projection of futures seems to be compensated, we are responsible for making our everyday activities tracked by flexible rearrangements of smart objects around us. Our degree of freedom is believed to be guaranteed most in this customized inside. However, the freedom measured in quantifiable degrees is inevitably proportional to the number of algorithmic objects available for our interactions. These objects are often hidden in the peripheries of our attention in order to more secretly activate each other according to their prediction of our urgent needs, but, when needed, they pop up in the user-friendly interfaces to sample our novel responses from our fingertip or mouse pointer, drawing a new trajectory as an index of our novel intention as yet unregistered. Our “free will” is constantly displayed into these network figures and fed-back as new inputs to train machine-learning algorithms for their better prediction of our more desired near futures.

Three Sets of Questions

Re-enfolding our everyday routines around their flexible sensor-actuator networks, the smart objects therefore redefine the spatiality of our smart lives. As these networks constantly unravel a thread of optimal near futures out of the non-linear fluctuations of a digital continuum (or the digital footprints of the ubiquitous human-to-machine and machine-to-machine interactions transpiring in a space), the temporality of our smart lives is also redefined. From this
diagnosis of the current state of humanity in the new regime of surveillance and governmentality, this dissertation infers the following sets of critical questions.

1. **Questions on the state of the object as an intersection of intellectual histories of the West**: How has the object-oriented modeling of environments, first suggested as a new paradigm of computer programming in the 1970s, been applied to the real-world through the distribution of smart objects? How has it been chosen by capitalism as a new strategy of market penetration? What is the meaning of its coincidence with the recent philosophical discourses on the object-oriented ontologies?

   Object as the conceptual counterpart of subject has multiple genealogies. Two symbolic moments in its philosophical history can be recalled to elucidate computer science’s recent appropriation of object in such concepts of *object-oriented programming* and *semantic web* (Knublauch et al., 2006). Kantian bifurcation between *noumenon* and *phenomenon*, or the thing-in-itself and thing-to-human, was the moment in the history of Western intellectuality that the human subject officially earned its exclusive right to define objects as subjective constructions. As Daston and Galison point out, since the post-Kantian application of subject/object binary in the eighteenth-century’s scientific practices, objectivity has been understood as something ready to respond to human interventions no matter how many degrees of freedom have been allowed for “a scientific subject”—throughout its changed personae from the “sage” who selects and synthesizes reasoned images of objects, to the “worker” who transfers mechanical images of objects according to automatized protocols, to an “expert” trained for pattern recognition to create interpreted images of objects (2007, p.371). On the other hand, Heideggerian distinction
between thing and object represents an inflection point in this genealogy, from which the objects, once considered mere building blocks in a subjective construction, eventually reveal their thingness or their own way of being in the world to the audiences, who keep an aesthetic distance to the objects ceasing to be instrumentalist of objects (Heidegger, 1967).

Since computer science in the 1970s took object as the name for the algorithmic building block of computer programming, the operational closure of a software application (or its execution for a given problem and turning back to the initial state ready for another problem) has seemed to follow a Kantian tradition. This is shown through the fact that a program’s successful operation has depended on the programmer’s coherent categorization of the objects in a source code in a way that their operations, initiated by their exposure to the environments, namely user inputs or databases, are seamlessly interconnected in the intended order. As the digital avatars of Kantian categories, objects have, in this sense, projected human reason over a digital continuum that was localizable in each hardwired circuit board of a personal computer. On the other hand, the recent liberation of the objects from a hardwired application and their autonomous networking along the semantic web and other IoT protocols seem to operationalize the Heideggerian thingness. It has been raised as an important goal in the recent computer engineering to redefine each object by its own beliefs, desires, and intentions ―at its core,‖ or by its singular “attempt to achieve its individual objectives without being forced to perform potentially distracting actions simply because they are requested by some external entity” (Jennings, 2000, pp.282-4). For instance, the semantic web-based programming aims to design the protocols for the algorithmic agents to “collect, filter and process information found on the Web” to accomplish their own goals “sometimes with the help of other agents” but “without direct human control or constant supervision” (Berners-Lee et al., 2002, p.27). This signifies a
sort of Heideggerian turn in computer science’s ontological modeling of the digital continuum underlying algorithmic culture. Our digitally augmented reality is now constructed not only by the projection of human reason but by the “interobjective relations” generated through the queries and answers the smart objects exchange with one another (Hui, 2016, p.160).

Contrary to the aesthetic disinterestedness of Heideggerian art viewers, this engineering concern for each object’s way of being in the digital world is, however, still instrumentalist as it represents the software industry’s tendency to expand its field of application beyond its previous domain once preprogrammed all by humans. In order to discover more domains, which can be concretized and managed better through the autonomous interoperations of objects, we should beware of impatiently projecting our limited goals upon the networks. In this dissertation’s quest for contextualizing the coincidence of these autonomous objects both in the recent engineering and philosophical discourses, their autonomy in constructing inter-objective realities would turn out to be resonant with the desire of the new media and software industries: the expansion of their service domains even to the hidden realities of objects hitherto thought to be the domains of disinterested and philosophical speculation.

2. Questions on the topological definition of a space and its problematic hidden levels:

How do the object-oriented systems transform their operational environments into the world of ubiquitous problems, inaccessible by humans and thus necessitating the preemptive interventions of the networked smart objects? What is the rational decision for humans to deal with this sort of asymmetry? What kind of techniques do they need for managing selves, resources, and risks lurking in certain environments?
It is now a topological issue how the spaces never fully enclosed by any human efforts (of modernist urban planners, ethnographers, transcendental subjects, and so forth) can, on the other hand, be transformed into many different states as each different set of smart objects constantly re-folds the spaces. As a study on the invariant properties of a space under certain transformations, topology, repurposed as a media theory, focuses on the hidden levels of functional relations a continuum embeds among its elements, and examines what kinds of transformations the sensor-actuator arcs of smart objects bring in the continuum to unfold these hidden levels. In this framework, the latency of problems, which the IoT advertises as what its ubiquitous computing could manage most optimally, can be understood as the embeddedness of the problems in mutually incommensurable levels of the same continuum, or database. Put differently, each lurking problem can be foregrounded as something invariant or orderly-variant under a certain sensor-actuator arc assembled by a specific software application.

The American philosopher Robert Nozick defines objectivity as “a property or relationship … invariant under the appropriate transformations.” In his topological view, the reality is not constructed by any a priori and “independent criterion to specify which transformations something must be invariant under in order to be objective” (2001, p.79). For Nozick, the “stepwise process” that science protocolized for the last century was the process to update or renew the list of more fundamental and “admissible transformations” of reality in laboratories, only the properties observed invariant under which could be survived as still objective. The evolutionary history of science for him is thus the approach to a general set of transformations to survive and be selected as defining the objectiveness in a given scientific paradigm. On the other hand, the current state of scientific methods “better suited to a narrower variety of worlds” seems to break down a single and universal reality, once believed to be bound
by a single general set of transformations, into lots of incommensurable levels, each of which is invariant only under a separate set of admissible transformations in different disciplines (p.80, 115-16). From one level of invariance to another, the actual world stratified by these scientific methods in turn appears to be “linked by manageable problems,” which are “partitionable into separate topics” and thus representable as “questions that can be answered separately” (p.116). This feature of space potentially differentiable into a multitude of problem spaces is what the Internet of Things recently commodifies through its wireless sensor and actuator networks. As a technique to manage ubiquitous problems, the IoT fathoms a space along each different transformation it transmits to make each problem appear invariant and manageable separately. In this sense, humans’ inaccessibility to these kinds of embedded problems is not due to an excess of problems for humans to manage but because humans cannot live all different and incommensurable levels of the space simultaneously.

For a human user of smart wearable health devices, it may no longer be enough to think of her body as a physiological continuum with a single molecular level. She also needs to allow the software applications to access both her body and social networks to re-differentiate the continuum of her body into multiple levels of her nonconscious, conscious, and social habits, accessible exclusively by each different smart application. She needs to assume that there always remains something problematic in the boundary-breaking or symmetry-breaking relations between these incommensurable levels (DeLanda, 2002). In order to be prepared properly for these invisible and ubiquitous risks, she needs to imagine her own body and its surroundings as topological objects with lots of hidden levels that can be constantly re-bifurcated and thus always further optimized through ubiquitous computing.
3. *Questions on the translation between human and nonhuman:* How do the user-friendly interfaces for these smart objects redefine our cultural and everyday activities as the processes through which we reassemble the algorithmic objects available in the surroundings into the networks to achieve our temporal goals, as videogamers habitually do? How does it become a human responsibility to rethink every goal-oriented behavior in terms of networking strategies as actor-network theory teaches us? How does this responsibility, also functioning as the protocol for human-object communications, translate our intentional or purposeless activities into the computational problems of pattern recognition?

This last set of questions is about the state of cultures embedded within a digital continuum. The recent popularization of the intuitive and interactive interface designs is characterized by the proliferation of virtual objects on a screen. Representing each modular function of algorithms, these objects ready-to-hand for our convenient manipulation function to interface the digital continuum beyond our reach back into a local platform for our present goals. However, the self-empowerment that the users experience in an interface is (especially in the recent videogame genre termed *open-world* in Chapter 3 of this dissertation) not realized simply by the huge number of available objects for their instrumental needs but, more importantly, through the potentially unrestricted ways to network and re-network them for different goals. As much as their flexible networkability formally guarantees the end-users’ creative repurposing of assemblages, the actual networks assembled among the objects by user activities also provide the machine learning algorithms with an effective means to translate various goal-oriented user behaviors into recognizable patterns.
These ready-to-hand graphical objects are, as a user attends to them on a screen and responds with input devices such as a mouse, also embedded habitually in the neurophysiological continuum of the user: the continuum black-boxed in-between his/her field of perception and motor responses. The user behaviors these objects afford are, as Lury and Day say, thus inevitably transitive since they are the “activities in which objects are repeatedly attached to persons,” just as it happens even in the simplest communicative act of “Like,” initiated from perceiving an interactive object on a screen and terminated by clicking it (2019, p.28). Through these objects’ embedment in a user’s somatic sensors and actuators, a person’s neurophysiological continuum in the middle is gradually differentiated into a multiplicity of sensor-actuator arcs in different levels; such as reflexive, intentional, cultural, political, and consumerist levels of one’s behavioral responses to the stimuli and information. As the centers of indetermination at each local fold of the digital continuum, humans are in this sense responsible for re-differentiating their own neurophysiological continua constantly into various sub-domains compatible with digital networks.

In this dissertation, the above questions on the objects’ mode of being in different domains—such as source codes of computer programing, a speculative reality in philosophy, and user-interfaces of software industry—are converging upon a common ground called the Internet of Things. From these resurgent and coincident interests in objects, this study redisCOVERS the recent post-humanist theorization of nonhumans, and rearticulates it as a new capitalist ideology in the age of its finer-grained extraction of vitality.

After the wane of the grand-narrative of the Enlightenment and its self-reflexive turn to its own epistemological limit, the reality as a Kantian concept has reached an impasse where its
ideal for the self-closure falls in the constant ruptures and sutures around a slippery object called *totality*—Object with a capital “O,” never fully graspable by any subjective discourses. The autonomy of nonhumans, meaning their own ways of being in the world by constructing their own inter-objective reality, seems to have in this sense been soft-landed as the next big thing in the critical theories, at the end of the post-modernist conclusion on the fate of humanity doomed to be alienated in monadic universes communicating one another only through their failed cognitive mapping (Jameson, 1992; Luhmann, 1992). In this context, humanities’ recent concern for the autonomy of objects, such as the *actants* in actor-network theory, *vibrant matters* in Bennet’s new materialism, and *objects* in object-oriented ontology, could be understood as an apologetic gesture to the nonhumans about our arrogance of having reduced them to mere building blocks for our subjective construction of reality. However, as Andrejevic acutely points out, what these theories hide under their humbleness is the resonance of their emphasis on “the agency of things” with the current popularity of conspiracy theory; in that both provide a convenient shortcut for thinking about the totality beyond human understanding in the time when the inaccessibility to the truth becomes our natural condition for the politics of “post-referenciality” (2013, p.268).

Drawing new attention to another resonance that these theories exert to the *object-oriented ontology as the protocol for the IoT*, this dissertation instead examines how this deadlock of the Enlightenment is actually what many “smart” projects today need to enlighten their consumers and citizens about. Making us believe that our attempt to enlighten surroundings would be inevitably failed is what these smart projects may need to do first in order to divert our attention from *epistemology* to *ontology*. From one field, which the past century of the western intellectuality demonstrated as guaranteeing nothing sure about our knowledge on the world and
self, to another, which begins to be re-written by the intensive machine-to-machine communications suggestive of lots of unknown problems beyond our reach. In short, *ideology is no longer something to believe, but something to speculate.* Speculation about the agency of things is more than an easy answer to the totality beyond human referenciality. It is rather an urgent need, or a rational wager to keep our subjective reality sustainable against hidden dangers asymmetrical to human reason. The object-oriented ontology in the recent humanities discourses has been in this sense popularized most of all as the ideological means to justify the urgency of our rational decision to hand over the right to manage our own body, home, office, and city to these nonhumans, smarter than us when it comes to predicting and preventing the insurgency of hidden problems.

**Chapter Summaries**

This dissertation addresses these genealogical, ontological, and ethical issues of smart objects through four different media examples: an IoT-based intelligent navigation system, smart home, open-world videogame, and a neuro-prosthetic apparatus.

Chapter 1 discusses a smart navigation system AIDA (Affective Intelligent Driving Agent), which MIT’s Senseable City Lab and Audi co-developed, as an intersection of various object-oriented ideas appearing in the recent trends in engineering, philosophical, and consumerist modeling of reality. The Internet of Things in this chapter is examined as the operationalization of what some recent realist philosophers call a *flat ontology*. Departing from the anthropocentric correlationism that stipulates objects only as building blocks for the subjective construction of reality, these philosophers suggest another way of modeling reality in which every object stands on a same ontological footing with equal right not to be “treated as
constructed by another object” and “contribute to collectives or assemblages to a greater and lesser degree” (Bryant, 2012, p.19). As Galloway points out (2013), these philosophical discourses coincide with the recent trend in the automation of algorithmic systems, which drag humans down to a material platform as the hosts of vital signals that machines communicate. This chapter focuses on the Internet of Things as a peculiar commodity form where these nonhuman realities for philosophical speculation and computer engineering intersect.

Chapter 2 searches for the way to redirect topology as a tool to describe the spaces enmeshed by the networks of smart objects. Media studies’ recent interest in topology focuses on how today’s networked infrastructures transform our places of cultural practices into a continuum of digital signals. Interconnecting various physical entities and smart devices in a regional domain, the smart home also transforms today’s domestic interior into a topological continuum. This chapter appropriates the mathematical concept of manifold from Bernhard Riemann’s differential geometry and Henri Poincaré’s group theory to examine how this topological continuum redefines today’s domestic interior as full of problematic relations that can be commodified into the form of smart applications.

Chapter 3 examines the recent videogame genre called *open-world* as a prototype of the cultural interface in the age of the Internet of Things. A game space in this genre is built up of manifold algorithmic objects, from non-playable human characters (NPC) to environmental objects such as animals, trees, rocks and other items. These objects, distributed over a world map and interconnected according to their own way of responding to the surroundings, redefine the rules of videogaming by providing gamers with a greater degree of freedom to network and repurpose nearby objects for their own goals with minimal restrictions from above. An open-
world gamer is thus responsible for operationalizing his/her cultural interests such as narrative or ludic experiences of gaming into a form of network strategy.

Chapter 4 continues the discussion on the state of human subjectivity and responsibility in network culture, but with an unorthodox example of a primate videogamer in a laboratory. Brain-Machine Interface (BMI) is a neuroprosthetic apparatus developed by the Nicolelis Lab at Duke University. As a machine to translate the neural signals collected from the electrodes embedded in a brain into machine-readable motor intentions, BMI as a local laboratory network consists of several human and nonhuman actors: brain cells, electrodes, filtering and pattern recognition algorithms, gaming devices, biological limbs, robotic limbs, and human researchers/trainers. Long before its public debut with a human user in the opening ceremony of 2017 FIFA World Cup in Brazil, the Nicolelis Lab has experimented the adaptability of their brain-machine interfaces to various designs of gaming devices and robotic limbs, not only to translate the more variety of motor intentions from brains into machine-readable signals, but also to translate various interests of social actors outside the lab—such as the patient groups, scientists in multiple disciplines, governments, robot industries, and medical institutions—into the things that would be serviceable through this laboratorial Internet of Things in the near future.

As an actor-network analysis of an experimental case of the IoT, Chapter 4 focuses on the uncertainties that characterized the actual relations between the nonhuman actors right before they eventually have formed a working network. The public demonstrations of BMI as “ready-made” should have concealed or black-boxed these moments of uncertainty. But the expansion of its intra-lab and inter-lab networks for the last two decades have also been repeatedly haunted by uncertainties as the lab has attempted to integrate a greater number of not-yet-ready actors, both humans and nonhumans, into its experimental Internet of Things. Many expected or
unexpected disjunctions have occurred within this laboratorial network, and, for its “economy of hope” to expand to the more variety of its future applications (Novas, 2006), the disjunctions should be properly managed and re-wired constantly.

Taking these disjunctions or intervals between actors—their sensors and actuators—also as what assemble this dissertation, the somewhat arbitrary order of Chapters could be seen as organized along its implicit narrative to follow the discovery of these disjunctions in a smart car, their commodification in a smart home, their being a constructive principle of the open-world in virtual reality, and their becoming building-blocks for our smart future. As Chapter 1 will discuss, the Internet of Things is most of all a network of these ubiquitous intervals, whose open-ended re-assemblages provide the media industries with a utopian platform for their instable hope for more serviceable domains.
CHAPTER 1: HOW ONTOLOGY IS WRITTEN
IN THE AGE OF THE INTERNET OF THINGS

The wide distribution of microsensors, processors, and actuators into our environments during the last decade has changed the information economy of the Internet. According to Kevin Ashton, who coined the term *Internet of Things* (IoT), before the intervention of these small machines, the Internet was “almost wholly dependent on” the data “first captured and created by human beings—by typing, pressing a record button, taking a digital picture or scanning a barcode.” Replacing humans’ “limited time, attention and accuracy,” which are “not very good at capturing data about things in the real world,” the IoT has been developed as a platform for these things to expand their online presence by overcoming “the limitation of human-entered data” with thing-generated data, communicated in frequencies inaudible to humans (Ashton, 2009, June). Through their further miniaturization and attachment to various natural and technical objects, thing-generated data becomes extractable not only from smart appliances such as refrigerators and smartphones responding to users and environments, but from the territorial/migratory behaviors of animals (Gabrys, 2016a) and physiological patterns of human organs (Parisi, 2009). Just as the digital remediates the incompatibility of analog signals through its binary codes (Bolter & Grusin, 1999), the attachment of these smart entities relocates objects from different contexts to the same communicational platform.

At the same time, actor-network theory (ANT) has been introduced in media studies as a critical tool to rethink the conventional boundaries of subject/object, human/nonhuman, cultural/natural, social/technological categories. Actor-network theory has taught us that these categories are not higher orders or contexts that define the legitimate places of things in
hierarchies, and showed us how the categories can be resolved back into each thing’s way of influencing others or their mutual engagements. The IoT’s “new sensor/processor/actuator affiliations” (Crandall, 2010, pp.83-4) expose hidden actor-networks of objects in our life world, once black-boxed by the habitual contexts of our uses of them as the only definitive typology of their use values. As these objects are now enrolled in a non-hierachal communication structure of the IoT, the contexts of their human uses are also “unboxed” and their usefulness is re-measured in a digital network, not so much for their contribution to our self-imposed goals, but for the network’s prediction of human purposes.

Marx thought of the use value of commodities as realizable only through their consumption for human needs at “a terminal point” of exchange (1993, p.89), such as one’s non-smart home. But in the IoT and its domestic application called smart home, value is conversely concretized by the exchange of thing-generated signals between the smart objects, whose smartness is often advertised as the ability to detect the urgent needs of users even before the users recognize their own needs. John Law says that a black box can be reopened only by the appearance of “a stronger adversary, one better able to associate elements” (2012, p.111). According to this “principle of symmetry,” the IoT would also unbox the previous contexts of the human uses of nonhuman beings, or their monopoly of the right to define the functionality of objects, since the IoT is more capable than humans of associating smart objects together into networks that address human needs. The human consumption of commodities “not only as a terminal point but also as an end-in-itself” was for Marx something easily put aside as “outside economics except in so far as it [what they reproduce namely living labor] reacts in turn upon the point of departure and initiates the whole process anew” in the labor market (1993, p.89). This reductionist interpretation of use value based entirely on human “needs as biologically given and
the natural (Dant, 1996, p.501) has been denaturalized by cultural critics such as Baudrillard, whose unboxing of human needs and desires out of “pure, natural, asocial” cocoons has relocated the concept of use value to “a system of relations of difference with other objects” (p.504; Baudrillard, 1981). While this revisionist view of use value as “a fetishized social relation just as much as exchange-value” (504) still defines the social exclusively as human construction, the IoT—as one of the most advanced commodity forms today—pushes its users to agree with its “terms of use,” which suggest why humans should delegate their right to use objects for their needs to smart objects better at activating themselves in the most customized way to human needs. If outside economics in the Marxian sense has been preserved in domestic space for our inalienable right as tool users, this delegation of human right reopens and reconnects these spaces, renamed “smart homes,” to the economy of digital signals. Humans are the only smart beings whose access to this hidden economy is denied; other smart objects freely exchange queries and answers about their not-smart-enough human hosts.

This actor-network description of the IoT and its reversed user-object relation lead us to a “structure of ontological systems” characterized by the radical liquidation of any hierarchies among things: a world-view that recent realist philosophers, or speculative realists such as

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3 Fetishism in this Marxian context has been consistently defined as the misimposed value of object-in-itself, which can be analyzed as the social relations congealed around the object. Arjun Appadurai instead takes fetishism as his methodology for “a corrective to the tendency to excessively sociologize transactions in things” (1986, p.5). But even in his “methodological fetishism,” the values of objects are subject to a multitude of local contexts of symbolic transactions, despite their irreducibility to the global capitalist economy.
Quentin Meillassoux, Graham Harman, and Levi Bryant, call flat ontology.\textsuperscript{4} This chapter instead examines this ontology of objects as something resonant with the recent media industry’s attempt to expand its domains even to the speculative realities of autonomous objects. Despite these philosophers’ inattentiveness to software businesses, the use of the term *ontology* in computer science as the protocol for machine-to-machine communication\textsuperscript{5} indicates a sort of commercial necessity for objects to be defined not by human use and access, but through their mutual nonhuman uses and inter-operations. For these philosophers, the autonomy of objects is required for “absolute truth” and reality to be redeemed from their subjective construction in anthropocentric “correlationism” (Meillassoux, 2008, p.5). But for the IoT, the autonomy of objects is required for problems inaccessible to humans to be managed instead by their environment-sensitive operations. The Internet of Things in this sense provides a starting point for a critical inquiry into the question Galloway once posed about “a coincidence between the structure of ontological systems and the structure of the most highly evolved technologies of post-Fordist capitalism” (2013, p.347).

To re-contextualize this coincidence, this chapter focuses on how the architectures of algorithmic systems have changed over the past few decades as programmers and users have

\textsuperscript{4} For “flat ontology” in their speculative realism see Bryant, 2011; Bogost, 2012. For Galloway’s criticism of flat ontology as the “structure of ontological systems” in the recent software businesses, see Galloway, 2013, p.347.

\textsuperscript{5} Gruber suggests *ontology* as an engineering term for “knowledge-level protocols” between AI systems, each of which is distinguished by its own “symbolic-level” of representation about their own environments. The role of ontology is not to organize a single globally shared theory for all different representations to adjust. It rather aims to provide the languages for an output of a system to be translated into the input for another to maximize the interoperability and communicability between the systems (1991). See Intermission 1 of this dissertation.
delegated more control over a system’s operational environments to its algorithmic objects, which are better able to associate themselves into a more optimal collective state to respond to their environment. It then discusses two cases of algorithmic systems that concern this change: Herman Melville’s *Bartleby, the Scrivener: A Story of Wall-street* and the MIT Sensible City Lab’s Affective Intelligent Driving Agent. The justification for this unorthodox comparison of a literary work and a media application can be found in the story’s problematic character, Bartleby. In Marxist criticism of the last century, Bartleby has been understood as the “perfect exemplum” of dehumanized workers under industrial capitalism, whose existence as living labor has no other choice for realization than to participate in commodity exchange. The story restages this through its algorithmic distribution of “speculative-conditional” statements or the “logic of the ‘if…then’ statement” to define his possible uses in certain conditions of an office (Reed, 2004, p.258). Bartleby’s famous response, “I would prefer not to,” has been interpreted in this context as a gesture “to get out of circulation entirely” to the “space outside or beyond circulation,” never achievable “except, of course, through death” (p.266). However, what this reading of his gesture, delayed by one-and-half centuries, focuses not on his suicidal exit to the “humanity” outside commodity exchange, but on his sneaking into the edges of an employer’s algorithmic human resource distribution. Put differently, Bartleby’s withdrawal to the peripheries of commodity exchange is interpreted “in the era of computerized capitalism” as a gesture to nonhumanize himself as an office object not ontologically superior to other office supplies with which he persists in creating a secret network of nonhumans unseen by the employer (Galloway, 2013, p.362). Redefined as one of these objects whose inter-operations retrieve the office from the human employer’s exclusive use of nonhumans, Bartleby reminds us of the objects that prevail in recent smart offices. As I will discuss in the following section, these
objects are the building blocks of today’s algorithmic culture, which construct both ontologies for those nonhumans and the most customized interface for humans under digital capitalism.

**From Determination to Agencies**

As digital infrastructures become increasingly networked, media studies’ focus on their ability to re-organize media environments has also shifted. Affordance in media studies was once descriptive of media’s function to program “the possibilities in the world for how an agent (a person, animal, or machine) can interact with something” (Norman, 1988, p.18), but it seems more important now to study the way undetermined actions afforded to such agents can update and contribute to the functionality of a network. For instance, in 1986, Friedrich Kittler anticipated that the IF-THEN commands in computer languages would substitute for the symbolic order of human discourses as these “conditional jump instructions” would translate one’s free will into a cybernetic servo-mechanism. For Kittler, the IF-THEN command represents the computational logic of the early cybernetics, which analyzed human behaviors, including language, as “cruise missile”-like variables whose linear trajectories are conditioned by simple feedback loops executable in a linear manner (1999, p.258). In contrast, what Katherine Hayles calls “a cognitive assemblage” describes how today’s technical infrastructures consist of many autonomous “technical cognizers” controlling the objects that behave like “highly mobile and flexible insurgents and ‘terrorists’” (2017, p.132). Distributed in a swarm-like state, the

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6 These objects and object-like users may be modeled best as the actor in the term *actor-network*, not an “individual atom” hyphenated to a network in a deterministic way, but a “circulating entity” that draws many hyphens to “hook up with” each other for both specifying its local agency and organizing global structure (Latour, 1999, pp.17-8). For these actors, “a substrata: something upon which something else ‘runs’ or ‘operates’” is no longer a proper metaphor for infrastructures; rather, technological infrastructures are installed as communication protocols for these circulating entities to modularize their
modularity of these interoperable agents is designed to form an assemblage flexible enough not only to adapt to the changeable environments—like the US military “drone swarms” targeting actual human guerillas—but also to cultivate the things enmeshed by its environmental sensors into the nodes of a potential network. In Frans van der Helm’s media performance MeMachine, for instance, a human body in “a high-tech data suit outfitted with sensors” such as electrocardiography (ECG), electromyography (EMG), and electroencephalography (EEG) is transformed into an object as a source of manifold vital signals that organize these technical cognizers into a network (ARlab, 2013, August 13; Hayles, 2017, pp.129-30). This change in the character of media affordance over recent decades, also coincident with the relocation of humans in digital infrastructures from outside-facing (facing the user) to inside-facing (as hosts for machine-readable signals), has been spurred not simply by the users and objects becoming too elusive to be caught in IF-THEN commands. It rather reflects the media industry’s need to disturb the traditional boundaries between human-subject and nonhuman-object in order to dispatch their machinic cognizers into a larger number of still-unexcavated human problems, and to market their possible solutions through the interoperations of these cognizers. As much as the ubiquitous dangers of guerilla-like intelligences have presented problems to which a military network can respond, smart clothes have conversely transformed wearers’ bodies into things full of ubiquitous problems manageable only through the network computing of microprocessors under their fabrics (Andrejevic, 2005). This twofold goal in engineering, namely to redefine problems to justify algorithmic solutions, has transformed human bodies and behaviors into research objects in the same communicational layer with smart objects and appliances. A

“local practices afforded by a larger-scale technology” into the functions “which can then be used in a natural, ready-to-hand fashion” by others (Star & Ruhleder, 1996, pp.113-4).
peculiar commodity-form called IoT generalizes this engineering scenario even in our everyday practices in order to maximize its use value proportional to the number of ubiquitous risks properly manageable only by the networks of nonhuman cognizers.

The algorithm has been marketed as the commodification of efficient and automatized circuit-change technologies that can be applied to any goal-oriented processes from industrial production to domestic reproduction. Modeled as cybernetic servomechanisms, both human bodies and nonhuman objects were previously thought to be functional units that could be distributed most optimally by the discursive protocols or hard-wired circuits of IF-THEN logic, which controlled their sites of consumption and employment, such as a workplace for bodies to be exploited as the hosts of living labor and a house for objects to be used for reproducing labor power. As part of the IoT’s sensor/processor/actuator relations, on the other hand, they can now be placed in the same digital network, which affords their autonomous operations in swarm-like states rather than assigning them to predefined positions for the programmed goals. This design decision to give higher degrees of freedom to objects may entail inefficiencies in the case of simple goal-oriented processes, which were the most important tasks for the IF-THEN based systems, but its long-term advantage, the versatility of a network, is enough to compensate for these problems. In a typical IoT system such as a smart home, software applications newly added to the system usually reach their full functionality only after certain environmental parameters are detected as changing relative to the interoperation of smart objects. This necessary mapping period conversely promises more possible uses of the network in the long run insofar as more parameters are still assumed to hide in the environment, waiting to be detected by different combinations of smart objects for the applications marketed and purchased in the near future.

From sequential computing to ubiquitous computing, the method of realizing the use value of an
algorithmic system or of operationalizing the meaning of its efficiency has changed from hard-wiring to autonomous networking. This has also been paralleled by the changing understanding of the problems assumed to be embedded in the operational environments of algorithmic systems, from something re-constructible as a cruise-missile-like object in the linear reasoning of IF-THEN sequences to another that can be concretized only through its simultaneous and nonlinear interactions with distributed others.

In computational environments, this change can be described in terms of the shift from the correlationist modeling of early cybernetics to ubiquitous computing’s pan-correlationist modeling, which also distinguishes Hayles’s emphasis on technical agency from Kittler’s technological determinism. Galloway uses the term pan-correlationism to describe how Graham Harman’s object-oriented ontology (OOO) “democratizes” the concept of relation from its monopolized uses in the human construction of reality “by disseminating it to all entities” (2014, November). For Harman, a disciple of Bruno Latour, object-orientation is a philosophical method that restores the speculative autonomy of objects in the world represented by actor-network theory, in which the only definitive evidence for the presence of actors is their mobilizing or being mobilized by each other. For this redemptive mission, Harman instead takes as definitive for its becoming an object each entity’s withdrawal into its own core, which “contains unknown realities never touched by any or all of its relations.” By doing so he achieves two goals. First, he liberates objects from any correlationist others, both humans and nonhumans, who attempt to monopolize all the relations between objects for constructing and expanding their subjective reality or networks of technoscience, because “relations do not exhaust a thing” insofar as it always preserves hidden realities to withdraw further into. At the same time, insofar as relations conversely “rely on” the traces of the thing’s withdrawals, there always remain more
relations to be further extracted between the objects that constantly withdraw from each other (2009, p.132). Galloway chooses the term *pan-correlationism* to expose how vulnerable this endeavor of OOO (to cut all relations away from the speculative inner realities of objects) is to the ideological reprogramming of capitalist relationism. In his reframing, Harman’s assumption of the inexhaustible inside preserved for the objects’ further withdrawals ironically turns out to be what guarantees the inexhaustible correlations ever extractable from the exteriors of the objects as a result of their constant withdrawals from one another. In object-oriented ontology, there always remains “the sensual skin of exchange value” to be excavated from between any interacting objects (Galloway, 2012, June).

As “the structure of the most highly evolved technologies of post-Fordist capitalism” (Galloway, 2013, p.347), ubiquitous computing can be understood as what operationalizes this capitalist repurposing of speculative reality into the reservoir for ubiquitous correlations. In computer science, the object-orientation is a “computational logic” (Kowalski, 2006) that defines each algorithmic agent by its own “beliefs (what the agent knows), desires (what the agent wants) and intentions (what the agent is doing) at its core” (Jennings, 2000, p.288). Re-operationalized through ubiquitous computing, which affords more autonomous and unexpected encounters between these objects, the logic of object-orientation in turn redefines its shared environments as full of hidden data that can be extracted through any objects under interaction, transmitted as inputs to any others, and thus never fully bound by any attempt of linear modeling from a single object, but only concretizable through the constant relation-making between distributed objects. In this sense, the term *pan-correlationism* suggests how resonant the anti-correlationism of the speculative realists is, in fact, with the recent use of the term “correlation” by tech-savvy gurus such as Chris Anderson in *Wired* magazine. For Anderson, correlation is
what manifests the end of “causation” as the human means for “crude approximations of the truth” (2008, June). Correlation for him is anything that can be data-mined between any interactive objects except subject-object relations. If the recent software industry believes in the inexhaustible and ubiquitous problems always preserved for further excavation and commodification, the pan-correlationist modeling of reality promises this ever-exploitable future of the IoT. As the gear-shifting undertaken by contemporary capitalism for its finer-grained value extraction, the concept of object-orientation updates the ontology of previous industrial capitalism, which Heidegger once analyzed by the term “challenging-forth” as the process to reveal “the world, nature, culture, etc. as available for extraction, processing and storing as standing reserve”; the new ontology of software capitalism is, David Berry says, now unveiled by the capital’s “streaming-forth,” to reveal everything as available for data-mining insofar as everything is potentially correlated with everything else (2014, p.96).

For the formal architecture to accommodate this coincidence between the structures of ontological systems and the most advanced commodity form of today, we may need to first examine a programming paradigm called object-oriented programming. As Alan Kay, the architect of the early OOP language Smalltalk, writes, “Its semantics are a bit like having thousands and thousands of computers all hooked together by a very fast network” (1993, p.70). OOP is characterized by its “behavioral building blocks,” objects that “have much in common with the monads of Leibniz” (p.70), as each object enfolds the definitions of its own constituents, data structures, and possible interoperations with others. Put differently, an object envelops its own “tiny ontology,” stating its selective exposures and responses to environments (Bogost, 2012, p.21). To build an algorithmic system for object-oriented programmers is thus to design the recursive inter-operations of these objects to replace cumbersome IF-THEN sequences in the
obsolete procedural programming. In the source code of a program, the objects are distributed as autonomous behavioral units but held in a metastable state or in the “initial absence of interactive communication” until after its execution or compiling for “a subsequent communication between orders of magnitude and stabilization” (Simondon, 1992, p.304). The compiling of a source code begins as its exposure to an environment, namely, a set of user inputs or a database, triggers the response of the object assigned in the beginning, whose behavioral outputs in turn trigger further responses from the others until the intended set of states is singled out from, created in, or removed from their shared environment. Despite their seemingly autonomous becoming as a collective, the inter-operations of the objects during the compiling is designed as a sort of *pre-established harmony*, as a human programmer puts them in designated locations in a source code to make their environmental exposure happen in a predetermined order.

On the other hand, the recent achievements in the miniaturization of digital sensors/processors/actuators to a size attachable to any scale enables these purely algorithmic objects to be transplanted into natural/technical entities in the real world. In OOP, each object undergoes a process of individuation as its interactions with others gradually adjust the parameters in its data structure to niche values. The physical objects in ubiquitous computing undergo a similar process as they are enrolled in its sensor/processor/actuator affiliations. However, their new niches in the networks are not pre-established by human assumptions of harmony, but concretized through corporeal interactions with other sensor-augmented objects in environments. Just as a drone swarm constantly updates its flying formation using the aerodynamic data extracted from each drone’s interactions with others, the operational environment of an algorithmic system is no longer simply a metaphor for “human-entered data” but also for the ubiquity of data that can be extracted from any physically distributed interacting
objects. These objects are virtually all re-locatable to a digital network from their own natural and technical contexts. And insofar as each of these contexts is what today’s commodification of ubiquitous computing advertises as the problem that can be more efficiently managed by its unboxing and tracing the objects’ relation-making in an actor-network-like manner, it is inevitable that the objects once stabilized in their own context will resume the individuation to find their new functional niches in the algorithmic cultures. For instance, one’s heart, muscles, and brain, already stabilized in a psychosomatic context, are now relocated to a digital network under a “smart cloth” outfitted with ECG, EMG, and EEG. Their resumed individuations to the digital niches are not based on the pre-established harmony between bodies and minds under one’s conscious or reflexive control. Rather, they can be harmonized further with other digital objects capable of sneaking under the cloth as new members of the affiliation, such as the Apple Watch or Fitbit. These gadgets, “better able to associate” the organic and machinic elements into more optimal states for different situations, such as working out, sleeping, working, or shopping, begin to teach us what to do, much as the fitness app in your Apple Watch commands you to slow down or speed up. Human organs are no longer particular organs employed in a servomechanism but constantly re-individuate themselves for their temporal niches and uses within the nonhuman networks with which they are newly affiliated. From this changed use of human bodies, Bartleby’s gesture to disconnect himself from any capitalist uses of human beings by saying “I would prefer not to” do anything assigned by the human employer earns a new meaning. His gesture can be reinterpreted as a prophecy of recent smart objects and their withdrawals into the peripheries of human control.
Melville’s narrator devotes the first quarter of this story of a Wall Street law office in the 1850s to describing the functional relations between his employees, which also define the end state for the rest of the story to restore after the disturbance caused by Bartleby. Nonhuman nicknames, Turkey, Nippers, and Ginger Nut, are “mutually conferred upon each other” because they are “deemed expressive of their respective persons or characters” (par.6). It is Ginger Nut’s job to deliver “ginger-cake” to Turkey and Nippers, whose performances of “copying law papers” are complementary to each other because the former is reliable only in the morning whereas the latter works well only in the afternoon. For the lawyer confident in reorganizing their different responses, to make the office operational for his own goal is to distribute these workers along a procedural sequence: “it being morning, Turkey’s answer is couched in polite and tranquil terms, but Nippers replies in ill-tempered ones … to repeat a previous sentence, Nippers’s ugly mood was on duty, and Turkey’s off” (par.45); to repeat in an object-oriented pseudo-code, IF it is morning THEN call Turkey or ELSE call Nipper. The lawyer’s “doctrine of assumptions” is applied everywhere in the office and enables him to predict how the actors will respond in certain conditions and to mobilize their conditional responses “to enlist the smallest suffrage in [his] behalf” (par.155, 46). Following a pre-established harmony assumed by the lawyer, Ginger Nut claims his contribution by circulating ginger-cake, which in turn demonstrates its functionality through “probable effects upon the human constitution” of Turkey and Nippers (par.52), whose functions as scriveners alternate in the morning and afternoon. However, the lawyer’s confidence in mobilizing these switching circuits faces a crisis in Bartleby, a new scrivener. As “more a man of preferences than assumptions,” his becoming a meticulous actor in the office is defined at first by his highly selective response of “prefer[ing]
not to do” any tasks other than transcribing law papers “at the usual rate of four cent a folio” (par.83). In the middle of the story, Bartleby begins to narrow this response further to the extent of preferring not to answer any queries from the lawyer and finally ceasing to produce any readable texts. At this point, the lawyer (as a system builder) has the following conversation with Bartleby:

“Now what sort of business would you like to engage in? Would you like to re-engage in copying for some one?”
“No; I would prefer not to make any change.”
“Would you like a clerkship in a dry-goods store?” …
“I would prefer not to take a clerkship,” he rejoined, as if to settle that little item at once.
“How would a bar-tender’s business suit you? There is no trying of the eyesight in that.”
“I would not like it at all; though, as I said before, I am not particular.” …
“Well then, would you like to travel through the country collecting bills for the merchants? That would improve your health.”
“No, I would prefer to be doing something else.”
“How then would going as a companion to Europe, to entertain some young gentleman with your conversation,—how would that suit you?”
“Not at all. It does not strike me that there is anything definite about that. I like to be stationary. But I am not particular” (par.197-209).

ANT’s principle of symmetry states that “all the elements that go to make up a heterogeneous network, whether these elements are devices, natural forces, or social groups,” can make themselves present as actors only “by influencing the structure of the network in a noticeable and individual way” (Law, 2012, pp.124-6). Conversely, the same principle implies that any actors withdrawing from their current network should enroll in another that is “better able to associate elements” (p.111), unless they prefer not to return any noticeable responses and
thus not to be present any longer to others. Bartleby’s preference *not to do something else* expresses his fatigue over being this kind of element unable to be present at all if not assigned to a new functional niche in the office or in an outside labor market according to the lawyer’s “doctrine of assumptions.” Bartleby’s strategy to respond to the queries by saying that he prefers not to suggests the minimum that an actor should do to stay in a current state. As a *dehumanized* object stuck within the algorithmic human resource management, Bartleby’s gesture to postpone his assignment to particular uses thus unboxes the apparently seamless commodity exchange in the labor market. The lawyer’s subsequent and never-ending IF-THEN questions, “would you like to re-engage in …? Well then, would you …? How then would …?,” reveal the maximum that the employer needs to do to black-box again the formal symmetry of the capitalist uses of human beings.

The lawyer’s efforts to find a new niche for Bartleby, however, always turn out to be undertaken too late, after Bartleby has already declared his preference not to do that work. And when Bartleby is proved not to be handled by the servo-mechanical “logic of the ‘if…then’ statement,” the lawyer discovers a secret network of nonhumans in which Bartleby’s withdrawal finds the smallest niche for his presence: a “bachelor’s hall” that “Bartleby has been making” with things hidden at the peripheries of the lawyer’s attention, such as “a blanket” under his desk rolled away, “blacking box and brush” under the empty grate, “a tin basin, with soap and a

It is noteworthy that David Kuebrich relates this “doctrine of assumption” of the lawyer on the niche positions for each actor in his design of the fully operational office to “the larger culture that there is no inherent contradiction between the dedicated pursuit of self-interest, even when it involves the exploitation of others, and devotion to traditional Christian values” (1996, p.396). According to him, the doctrine “exemplifies the values and attitudes of the Protestant entrepreneur who fused his Christian faith,” such as the faith in the “Starvation and wretchedness … by Heavenly appointment,” with “emerging economic practices in such a way as to legitimate inequality and class privilege” (p.383, 386).
ragged towel” on a chair, “a few crumbs of ginger-nuts and a morsel of cheese” in a
newspaper (par.88). Shortly after Bartleby declares his presence in the office despite his refusal
to accept any of the new positions the lawyer recommends, these objects, once supposedly
governed under the lawyer’s “doctrine of assumptions,” appear to converge instead upon an
alternative network. In this flat network, each thing’s presence is concretized not through the
lawyer’s monopoly of (non)human resources, but through their mutual engagement at the
peripheries of capitalist resource distribution. Contrary to the traditional interpretations of
Bartleby’s gesture as a suicidal disconnect from any social ties, what he really achieves through
his withdrawal is not the redemption of humanity “through death” (Reed, 2004, p.266) but the
retrieval of social ties among nonhumans from capital’s dehumanizing correlationism, which
defines every object, including human labor, as exchange or use value to preserve or increase
capital. The withdrawal of objects into their inner realities “never touched by any or all of [their]
relations” is enough for these objects to be present without necessarily being engaged in the
businesses of others (Harman, 2009, p.132); at the same time, for Harman, this withdrawal also
suffices to enable the ubiquitous distances between these objects to be filled with finer-grained
relations as “the joints and glue that hold the universe together” (2005, p.20). Bartleby’s
disappearance into the peripheries of commodity exchange likewise finds a hidden society of
nonhumans in which his presence in the world stands on an equal footing with everything else.
Through the lawyer’s lost confidence in his assumption as to the possible uses of Bartleby,
Melville’s story dramatizes a conflict between two ontologies: the correlationist modeling of
reality through a human employer in the center as the avatar of old capitalism, and the pan-
correlationist through the distributed nonhumans and their mutual engagements. However, there
are also things his story fails to anticipate, such as how vulnerable these nonhumans are to the
finer-grained resource management algorithms under advanced capitalism, and how the new avatar of capitalism will, 150 years later, appear in the form of these distributed nonhumans called *smart objects*.

**Ontic Principle of Ubiquitous Computing**

Mark Weiser defines ubiquitous computing as the withdrawal of microprocessors from the center of users’ attention towards the peripheries, where they are more correlated with other microprocessor-augmented things such as smart appliances (Weiser & Brown, 1997). Once they stop competing for human attentions to be chosen as indispensable units dragged to a narrow Graphical User Interface (GUI), the devices become more functional to each other in their exchange of the data secretly extracted from humans. Information technologies before ubiquitous computing such as “pagers, cellphones, newservices, the World-Wide-Web, email, TV, and radio” were designed to “bombard us frenetically” to draw our attention and claim their increasing presence in a human-centered network (p.79). Like Turkey claiming his functionality to the lawyer even in the afternoon when he malfunctions by asking “if his services in the morning were useful, how indispensible, then, in the afternoon?” (par. 6), these machines once appealed for their usefulness to human users who monopolized what ANT calls the “Obligatory Passage Point (OPP)” of the network, through which all actors must pass to be assigned and specified as the actors appropriate for the goal of a system (Callon, 1986, pp.205-6). On the other hand, objects in the Ubiquitous Computing (UC) era prefer not to respond to queries from users. Like Bartleby, they stay “calm” in the periphery of attention and maintain the slightest presence in “a confederacy of ‘smart’ objects,” which “whisper information to one another in inaudible frequencies,” not in order to reoccupy the center of attention at the most timely moment for our
needs (as Weiser’s original design intended), but to “conspire to sell us products” in a timely manner (Andrejevic, 2005, pp.113-4).

In their withdrawal to the peripheries where they awaken each other to avoid awakening users, devices spend most of their time performing the minimum for their enrollment as sensors, namely *scrivening* ”unmodulated digital data” from their operational environments. As actuators influencing others, the devices also undergo a constant and creative process of individuation to find the functional niches within their temporal inter-operations (Clemens & Nash, 2015). Unlike the lawyer’s algorithmic IF-THEN instructions, ubiquitous computing as the global intelligence of these distributed devices is capable of and patient with performing this task of never-ending resource distribution to transduce all non-particular objects in metastable states into each individual *in situ*. It does this by calculating the optimal way to weave the devices’ autonomous and oft-conflicting operations and goals into a collective that can be mobilized for a problem at the system level. In this sense, what become ubiquitous in the UC era are not only the symmetrical edges of the network for the smart devices’ horizontal communications but their asymmetries to a collective intelligence that seems to replace successfully the lawyer in Melville’s story and intervene in the stabilization of conflicting devices into the reciprocal and modular functions of the network. As Galloway writes, “no arbiter impedes” these symmetrical individuations of smart objects into the actors influencing each other along the edges of a network, but for their autonomous responses to each other to be gradually realigned in the most efficient and harmonious way to reach collective goals, a sort of “ultimate mystical medium” is still assumed to operate as an invisible hand (2012, June). In the Personal Computing (PC) era, human users performed this arbiter by monopolizing the *obligatory passage point* represented by intuitive user interfaces that enabled them to design the harmonious interoperations of
algorithmic agents for their conscious goals. In the UC era, the mystical arbiters are rather omnipresent in the form of microprocessors that may attach anywhere, more ethereal in infiltration into every edge of the networks; the operations of these smart arbiters are as immanent as marketplaces that have also infiltrated into every corner of our lives, augmented by the so-called smart applications. Harmony is no longer pre-established by the assumptions of human designers but, like the flying formation of a drone swarm, must be constantly gathered and updated from lots of minute discrepancies between each object’s expectation of its environment and its actual operation within the data extracted from others.

Whitehead’s philosophy of actual entities, in this regard, provides another ontological model of “the universe of things” in the UC era that, as Steven Shaviro notes, supplements the “countless tiny vacuums” between objects mutually withdrawing in Harman’s object-oriented ontology with “a finely articulated plenum” of data left by each object’s becoming (Shaviro, 2014, p.39). For Galloway, in my interpretation, the coincidence between OOO and OOP implies the former’s vulnerability to ideological reprogramming; the “unknown realities” preserved and inexhaustible inside each object ironically promise the constant extraction of correlations from any objects under interactions, whose exteriors, or “sensual skin[s] of exchange value” (Galloway, 2012, June), are thus able to create ever-regenerative inter-objective realities. As a critical approach to demystify these worldly relations supposedly waiting to be excavated for ubicomp solutions, we can examine how Whitehead brings the problematic realities that OOO hides inside each object back to the platform for inter-objective communications. Whereas an object for Harman preserves its speculative presence through constant withdrawals, an actual entity for Whitehead lives only for its process of becoming called “concrescence.” Through this process, an entity prehends the universe as a “multifold datum” left by the already finished
becoming of all others until the process is completed with the satisfaction of its “subjective aim” and turned into just another datum for the genesis of others (Whitehead, 1978, p.19, 185). The resources for creations are not hidden inside but scattered all over the world, revealed to be a large data set accumulated from the finished processes of concrescences and given for further data-mining by new actors to come. In this respect, the speculative presence of actual entities in Whitehead provides a philosophical analogy for the algorithmic objects in a source code, which also live only during their exposure to shared environments for processing input data and are then left just as what they processed, namely the changed state of these environments for others to process further. However, in that each actual entity’s concrescence is not determined by any others but performed according to its own assumption on the “harmony” between its “subjective forms” and the objective data it feels (p.27), the source code as the nexus of objects in this analogy should not be based in the hardwired electromagnetic circuits of personal computers. Rather, the technical incarnation of Whiteheadian actual entities is found in the smart objects in the Internet of Things as they constantly re-individuate themselves within their data-intensive environments without predefined orders. Besides this structural similarity, Whitehead’s “secularization of the concept of God” (p.207) as no other than one of these entities provides another rationale for the appropriateness of the analogy. Contrary to those whose concrescences are temporal and short-lived, the Whiteheadian God is characterized by its never-completed concrescence. This God’s subjective aim is “the ultimate unity” between the entire multiplicity of actual entities it senses and its conceptualprehension of their ideal harmony “in such a perfect system” (p.346), and this is inevitably an ever-delayed goal insofar as God cannot determine the courses of other entities’ becoming but only induces them to adjust their subjective aims. Taking the position of this global but not omnipotent agent in the analogy, the aim of an ubicomp
system—the algorithmic calculation of the optimal way for the smart objects to inter-operate for systemic goals—is also a never-completed process that must be constantly updated from each object’s actual operation without any pre-given harmony.

This secularized understanding of God is decisive in order to preserve the symmetry that Harman’s OOO sees in a flat ontology. Shaviro emphasizes that “all actual entities in the universe stand on the same ontological footing,” and even God for Whitehead has “no special ontological privileges” over the most trivial entities “in spite of” the asymmetrical “gradations of importance, and diversities of function,” among entities (Shaviro, 2014, p.29). However, in the emerging universe of things called IoT, these gradations of importance and functionality relocated and persisting in a flat ontology are in fact what make Whiteheadian philosophy a better analogy for the recent smart environments than Harman’s, and also make media studies’ recent interest in Whitehead (Gabrys, 2016a; Parisi, 2009; Hansen, 2015a) more coincident with “the structure of the most highly evolved technologies” of today. The particular entity standing at the apex of these gradations was once called God, but now reappears in the form of ubiquitous computing, and its never-ending concresence as a global intelligence intervenes in all the other entities’ temporal concresence as the nodes of its network. Rather than assigning each entity one-by-one to a specific place already prepared—what Melville’s lawyer attempted but failed—ubiquitous computing encourages the entities to find their own bachelor’s hall within the multifold data transmitted from the actual world by letting them interact according to their preferred responses to environments and in turn enabling their data structures to be coupled optimally to each niche in the ubiquitous thing-generated data. It is not in spite but because of these asymmetrical interventions of omnipresent microprocessors that all other less important but
still functional entities are relocated and “rethingified” upon a flat and symmetrical platform of smart objects (Gabrys, 2016b, p.192).

The “ontic principle” of speculative realism often promotes itself as a democratic principle for nonhumans in opposition to “the vertical ontologies of ontotheology or a humanism” that “trace back and relate all beings to either God, humans, language, culture or any of the other princes.” It suggests “a flat ontology, one made exclusively of unique, singular individuals, differing in spatio-temporal scale but not ontological status” (Bryant, 2011, pp.268-9). The Internet of Things as the commodification of ubiquitous computing seems to operationalize this principle by liberating digital objects from their previous obligation to pass through the mediations of human princes. However, its blatant attempts to diversify the problems that can be detected and marketed along the networks of these liberated objects reveal the ideological undertone of the societal metaphors for objects such as Bryant’s “democracy of objects” (2012), applied to today’s media systems without mention of the primary asymmetry of the network (Hoffman & Novak, 2018, p.1198; Lindley et al., 2017; Mitew, 2014). The ubiquity of smart objects and their autonomous operations translate and integrate each singular reality they locally perceive into a larger data set as a shared environment in which all of them are interoperable no matter how different their narrow world views are from one another. These ubiquitous symmetries for the ubiquitous accumulation of sharable data are, however, also asymmetrically engaged in the quasi-theological individuation of a global intelligence. The pastoral power as the archē of Foucaultian governmentality now employs the IoT as the technological means to justify its exclusive accesses to the confessions of people’s private lives in the form of user data they volunteer to report to the AI. Its “humanly incomprehensible divine sovereignty” is now distributed over the accumulated datasets—data-minable only by the “quasi-
transcendental power” of algorithms (Cooper, 2020, p.37, 45). As the following section will exemplify by examining a scenario involving a smart navigation system, Bartleby’s gesture to non-humanize himself as one of many office objects in a flat and invisible network does not mean his or its liberation from capitalist resource management. This instead forms the condition for a global intelligence system to emerge from its asymmetrical interventions in each symmetrical edge of the network.

**AIDA: A New Bachelor’s Hall**

AIDA (Affective Intelligent Driving Agent) is an in-dash navigation system developed by MIT’s SENSEable City Lab, Media Lab, and the Volkswagen’s Electronics Research Lab. Equipped with several projectors that display a 3D map on the dashboard, AIDA visualizes the most efficient route to a destination as a solution to the possible need of a registered driver (Figure 1.1). Unlike non-smart systems, “AIDA analyses the driver’s mobility patterns, keeping track of common routes and destinations” to “identify the set of goals the driver would like to achieve” (MIT Sensible City Lab, 2009). To provide the driver with the most customized niche not only in a vehicle but in the traffic networks and points of interest (POI) in neighboring areas, AIDA interfaces sensor-generated driver data concerning her implicit needs with the data “pertaining to various aspects of the city including traffic, seasonal information, environmental conditions, commercial offerings, and events” (Lorenzo et al., 2009).

An ordinary object-oriented navigation simply receives the data packets from outside sources, such as GPS and traffic information, in order to remodel its surroundings with algorithmic objects such as a *street, intersection*, or geo-tagged *landmarks*, whose functional relations as nodes in a graph individuate the shortest route on the map to solve the problem of the
“human-entered” destination. On the other hand, as a prophet-like agent smart enough to direct the driver to where she must go to fulfill her current need, what AIDA should individuate foremost is not the shortest route but the most urgent problem of the driver, which has yet to surface but is lurking in the peripheries of her attention as the ubiquitous symptoms filling the car. AIDA’s ubiquitous computing individuates the problem preemptively and puts it in a navigable form that would be solved progressively as she drives the car along the route to a spot it recommended on the map. As an IoT system counterinsurgent to this guerilla-like problem—namely, a human driver demoted to a host of machine-readable vital signals—AIDA populates not only the interior network of the Audi full of interconnected sensors for facial expressions, voices, galvanic skin response, braking/acceleration pressures, seat position, and steering (Figure 1.2), but “a multitude of tags, sensors, locationing devices, telecommunications networks, online social networks, and other pervasive networks … proliferating in cities,” as well as the driver’s social networks.

Figure 1.1: AIDA 2.0
Suppose that Bartleby, hired as a test driver, found his new *bachelor’s hall* in this Audi. After the first week, long enough for the sensor network to be trained to relate the behavioral signals collected from the distributed body parts to his current affective state, AIDA would begin to figure out his “home and work location” and “be able to direct” him to the grocery store that he is likely to prefer. After a month, AIDA could detect his hunger from the signals collected and analyzed through the “historical behavioral collector (HBC)” and “historical route collector (HRC),” and then recommend the restaurant rated highest by Yellow Pages users with similar social networking service (SNS) profiles (Lorenzo et al., 2009). Bartleby may find that he is aware of his hunger only several minutes after the distributed symptoms were identified by AIDA, but may not seriously care about this delay even though it is always long enough to pass the restaurant most customized to his taste. However, after he learns that his too-human consciousness is, as Hayles warns, always behind the non-conscious responses of his body by at least several hundred milliseconds, so-called “missing half-second,” long enough to be hijacked by other non-conscious cues from “the advent of affective capitalism and computational media” (Hayles, 2017, p.191; Hansen, 2015a, p.190), even hunger would become a crisis that should be
preempted by AIDA and immediately visualized as a red route to the restaurant on the map. He
is now responsible for eliminating this route by driving his Audi corner to corner according to
AIDA’s instructions (Figure 1.3). What has occurred in this local network of smart sensors after
a month of test driving is Bartleby’s individuation as a registered driver. But, on the other side of
the interface, where his current physiological and behavioral states are ceaselessly translated into
the red route heading somewhere to be resolved, his individuation appears to have been driven
entirely by another individuation of AIDA into a prophet-like intelligence, ceaselessly weaving a
flat ontology out of many different types of sensor data—such as GPS data, a city’s Points of
Interest and their rankings in Yellow Page, lots of geotagged images of the city, the driver’s and
his neighbors’ social network profiles, and his historical route and behavior data—by folding
them into the pathway he draws (Lury & Day, 2019, p.30).

After these reciprocal individuations, Bartleby on the day of his public demonstration
would see something reminiscent of the compulsive questions of the lawyer in Melville’s story
haunting the dashboard, tuned up for the maximum functionality of AIDA. On the way to the
destination that AIDA would already have predicted from his route histories, Bartleby would
encounter many small pop-up windows and tags on the map referring to places for entertainment,
social events, and other sensor-augmented commodities, claiming to concretize his unknown
desires distributed across his facial expressions, voice, galvanic responses, butt position,
accelerating and braking foot pressures (Figure 1.4). Just like the lawyer in the story, AIDA asks,
“would you like to …? Well then, would you …? How then would …?” Contrary to the lawyer
who failed to keep enumerating all possible niches for Bartleby due to his too-human managerial
skill, AIDA’s recommendation is ever-extendable. Only this global intelligence can access the
problem called ubiquity, and it does not ask him to share his preferences out loud. Bartleby may
already find himself in his most customized bachelor’s hall, which eliminates any possible disturbances even before they actually occur. Now he needs to accept the “terms of use” for AIDA, but what pushes him to agree with these terms—which describe his new human condition as the host of digitalized vital signals—is the dormancy of problems whose symptoms are too widely distributed to be cognized by any single object except AIDA.

Figure 1.3: Recommending a POI  Figure 1.4: Advertising a social event

In critical theories after 9/11, these sorts of omnipresent agents and their asymmetrical interventions in the life of local actors have been justified by the ubiquity of problems. The latency of these problems in the peripheries of each actor’s narrow attention has justified the local actors’ commitments to a collective intelligence that preempts problems before they actually occur. Hardt and Negri claim that “the gray zone of war and peace,” in permanent danger of insurgency and terrorism, justifies the “total mobilization of social forces” for the preemptive strike of a military power that is “in asymmetrical conflicts” over unpredictable “guerrilla attacks” (2004, p.13, 51-2). Massumi also writes that civilian life in this “crisis-prone environment” falls “onto a continuum with war” in which a preemptive power’s intervention
should be “as ubiquitously irruptible as the indiscriminate threats it seeks to counter” (2015, pp.27-8). It is noteworthy that, after 9/11, the effectiveness of the international law has gradually decreased in distinguishing civilians from combatants, based on the latter’s notable feature “of having a fixed distinctive sign recognizable at a distance,” “of carrying arms openly,” and “of conducting their operations in accordance with the laws and customs of war” (Wilke, 2017, p.1042). As Wilke points out in the cases of NATO’s 2009 operation in Afghanistan and the recent “police violence against Black civilians in the US” (p.1050), the new binary of civilians/militants or civilians/insurgents is redefined by the ambiguous distinction between the uninvolved and involved. The domain of the cybernetic counterinsurgency, a city or battlefield, is in turn transformed into a sociopolitical continuum of suspects with varying degrees of involvement: (almost impossible) pure innocents—potentially involved—(completely) known terrorists. Relocated in the wide spectrum of the middle in this continuum, anyone can be potentially involved with “the imminent threat” that must be preempted. The “sweeping techniques of post-9/11 surveillance and data gathering” are often conceived “of a scale appropriate to wholesale calamities like terror attacks and natural disasters, not to ordinary crime or protest,” but, as Frank Pasquale quotes from one state official, after it is taken for granted that your enemies have invisible networks,

You can make an easy kind of a link that, if you have a protest group protesting a war where the cause that’s being fought against is international terrorism, you might have terrorism at that protest. You can almost argue that a protest against [the war] is a terrorist act. … violent extremists could also be identified by bumper stickers on their cars indicating support for libertarian groups (2015, p.48).
Not necessarily based on the wide spaces reminiscent of battlefields, or necessarily generalizing these military environments to the scales of human bodies to be covered by wearable devices and home/office for smart appliances, the Internet of Things invents a novel strategy for its market penetration from this tension between the insurgency of ubiquitous problems and the counterinsurgency of an intelligent system. In a domestic space or as to a human body that the local IoT application redefines as a continuum embedded with small sensors, or “threat matrix” (Pasquale, 2015, p.48), you can still imagine a hidden link of a sensor’s detection of a tiny anomaly, as trivial as “bumper stickers,” to a bigger problem latent in the space. In Melville’s fiction, Bartleby’s symmetry-breaking insurgency was never preventable by the lawyer’s linear management programmed in IF-THEN statements. But, as I re-fictionalized through Bartleby in AIDA, this human inaccessibility to the problem called ubiquity is also the justification for the humans’ participation in the IoT as the non-humanized hosts of vital signals. For its becoming as a collective intelligence from the concrescence of these vital signals with other thing-generated data, the ubiquity of lurking problems should be advertised as the reason why it is time for humans to relinquish their right to the uses of objects that they have unfairly held for a long time and why it is time to hand it right over to the IoT, which can use them more preemptively to maintain a space always customized to our needs.
The IoT represents a new paradigm of algorithmic objects that poses a quasi-theological question on the artificial intelligence: what would enable the artificial intelligence, once a material being akin to the “initial neuronal structure in new-born infants,” to evolve finally into something called artificial super-intelligence (ASI)? The followings have seemed to be taken for granted to continue its evolution: Moore’s law, which guarantees the increase of processing power of digital computers enough to develop a super-intelligence; and the enough supply of “the input and output channels” from existing knowledge systems focused on each separable task, which would train the AI into a general intelligence (Bostrom, 1997). As Nick Bostrom anticipated in the 1990s, the competitive investments of the hardware industry have increased the processing power of computers in accordance with Moore’s law. On the other hand, various input-output channels—enough for the AI’s continuous machine learning—have been supplied through the software industry’s infiltration of people’s everyday lives. Throughout the commercial use of AI for providing customized services to almost every aspect of human users, a super-intelligence would eventually emerge from the *concrescence* of every piece of input-output data that each singular IoT subscriber generates in his/her conscious and nonconscious interactions with smart objects along everyday routine. In other words, its becoming (almost) omniscient about and transcendent from any local training data is no longer simply granted but negotiated through human users’ agreement on data sharing. Just as Whiteheadean God could intervene in the others’ decision-making only by luring them to his goal, the IoT needs to persuade its users of supplying their local data to its global intelligence. In doing so, it persuades
people of the lurking state of problems, which any narrow viewpoint of a single observer never fully clarifies, but which provide inexhaustible resources for smart objects to communicate.

Harman’s object-oriented ontology somewhat reduces these sources of communicability between objects to a secret core of each object. According to its doctrine of fundamental incommunicability, these cores, never fully graspable by each other but constantly withdrawing, are ironically what intensify this universe with partial communications between objects, constructing their own inter-objective realities. As an ideological refraction of this philosophical doctrine, the Internet of Things reprograms the unknown realities of objects, such as human bodies for instance, into the engineering problems, never completely resolvable but able to be optimized over and over again. Generalized as a computational logic for the IoT-driven everyday life, the object-oriented programming calculates this optimizability of the universe by “decomposing problems in terms of autonomous agents that can engage in flexible, high-level interactions” (Jennings, 2000, p.283). The “complex real-world problems,” or the real-worlds represented as full of hidden problems, are in this sense both the scientific discovery and capitalist modeling of reality through which the intelligent system justifies its governmentality.

This ontological re-modeling of reality is necessary for the IoT’s development as the everyday infrastructure for two reasons. First, for its ubiquitous computing to be the most optimal approach to the various real-world scenarios, the world should be imagined to be embedded with manifold unknown problems. Second, to diversify and expand its service domains even within a limited physical area, such as a smart home and car, where everything is already replaced with smart objects, the problems the IoT handle should be such things as are constantly withdrawing from the current makeshift solutions. This sort of speculation about the abundance of unknown problems also justifies another sort of speculation about the “democracy
of objects,” an IoT ideology suggestive of a belief that these problems would be gradually discernible through the interoperations of smart objects. As a cooperative system of autonomous decision makers, this object-oriented democracy is especially useful not so much to a certain number of known problems already registered to the system, but to the unknown problems, simply speculated to be many until identified as associated with certain interoperations of these autonomous agents. In other words, for the more use-values of the IoT to be realized in actual applications, the more degree of freedom should be given to its objects’ interoperations without asking permission from their human users. For their democracy, each local algorithmic agent thus “has beliefs (what the agent knows), desires (what the agent wants) and intentions (what the agent is doing) at its core” and “the agent can attempt to achieve its individual objectives without being forced to perform potentially distracting actions simply because they are requested by some external entity.” As “decisions about what actions should be performed are devolved to autonomous entities” (Jennings, 2000, pp.282-4), their shared environments change into a continuum embedded with lots of problem-spaces, defined by each singular problem communicated by a singular algorithmic agent.

From OOP to ubicomp, the relation between global and local in algorithmic systems has changed in a way in which local agents have gradually retrieved more autonomy from a system, of which they were once just functional parts. The totality of system functions has also been redefined as what would be constantly updated as the sum of re-traceable interactions of local agents out of all other yet-to-be-re-traceable interactions. The classical conceptualization of totality as more than a mere sum is no longer true in this sense. Conversely, individual elements are always in an abundance of interactions not able to be summed into coherent system functions because they are too arbitrary to be yet registered as the units consistently engaged with the
currently known environmental parameters. The heterogeneity of these not-yet-integrated interactions characterizes an ubicomp system and its ontological modeling of operational environments. For this system, Ontology always “comes later” only after some of these manifold interactions are gradually stabilized as the registered and re-traceable interactions (Hansen, 2015b, p.42).

In Alien Phenomenology, Ian Bogost suggests this operationalizing view of ontology with a neologism ontography. In his version of speculative realism, derived from the engineering concept of object-orientation, things in general are defined by their ontographic operation, “a general inscriptive strategy” (2012, p.38) to record “random, anonymous meeting one has in modern environments” into its own “compact modes of representation” that he calls “tiny ontology” (2006, p.73). Ontology for him is not something written in “a treatise or tome” but a modular and recursive function of ontography as a thing’s way of engaging with environments as well as its becoming “the basic ontological apparatus needed to describe existence” (2012, pp.19-21). Even if a huge Ontology comprehensive enough to encompass any tiny ontologies is still imaginable in Bogost’s alien phenomenology, it could not be bigger than mere sum any longer. A big ontology would be rather the loosest and partial sum of manifold tiny ontologies if what it could incorporate within its formal compilation of the most common facts for every singular objective worldview would inevitably be very trivial facts commensurable with any particular local ontologies. Put differently, tiny ontology is prior as each object’s autonomous mode of existence through which they “perceive and engage their worlds” (p.29). The multitude of these tiny ontologies forms a background from which a huge Ontology emerges as a fractal figure of a common world drawn from lots of singular ontographies accidentally encountered with each other.
Whereas the fractal for Bogost is descriptive of an emergent state of objects “held together tenuously by accidents” (p.25), we can take this instead as a metaphor for the maximum interoperability of smart objects in an ubicomp system. The looseness of a huge ontology could then be understood not simply as the consequence of pure random encounters between tiny ontologies in “modern environments,” but a design decision to maximize their functional interconnections. For a greater number of local agents to communicate about common environments, supposedly embedded with the problems they need to handle collectively, the protocols to translate one’s output into another’s input should require only the minimum degree of mutual understanding for interoperation. The primary concern of the IoT system is therefore not to know about each singular worldview of smart objects but to discover a larger number of hidden problems, which may not be perceivable by any singular agents, but accessible through certain combinations of their loose interoperations.

Regarding this ontological commitment of objects to a system’s modeling of a common reality, we may need to examine how the AI research in the turn of the century redefined knowledge systems in computer science, once designed as “isolated monoliths” with each “idiosyncratic [way] of modeling the world,” as those interoperable through “external coupling interfaces” (Gruber, 1991, p.601). In “The Role of Common Ontology in Achieving Sharable, Reusable Knowledge Bases,” Thomas Gruber suggests ontology as the name for the “knowledge-level protocols” for the exchanges of knowledge bases (KB) between different intelligent systems with their own peculiar “symbolic-level” at the core. For him, ontology is not to accumulate the knowledge about the most fundamental features of the world observable from every singular inner representation of local agents. Instead, its function for him should be to provide the algorithmic agents with formal languages to translate their secret understanding of
the world from each peculiar data structure into a formal response to the queries from any other, no matter how incompatible their symbolic insides are with one another. Ontology in this way extracts the “libraries of shared, reusable knowledge” from every edge in a network of intelligent agents externally coupled and interoperable (Gruber, 1991, p.602). The goal of this huge system-level Ontology is however not to maximize the detailed knowledge on a single world, but to maximize the possible external couplings between these otherwise incommensurable inner realities of smart objects through their formal symmetry of query-answer, rather than to enroll them in the production of a unitary reality. Therefore, what this huge Ontology could tell us about the common world is just the most tenuous facts, such as the most common classes of objects and their possible interactions in the world. This “weakest theory” nevertheless guarantees “the most models” about the same world to coexist without being subject to a single coherent meta-model (Gruber, 1993, p.909). Furthermore, in order to mobilize more “ontological commitment” from smart objects with their own singular worldviews, the weakest theory should make “as few claims as possible about the world being modeled” to guarantee their maximum freedom “to specialize and instantiate the ontology as needed” for their own goals (p.910).

Ontology as a knowledge-level protocol for smart objects in this sense prevents a system from stipulating any detailed knowledge about its world as a given matter of fact that could restrict the contents of messages its agents communicate. Conversely, maximizing the wireless interoperability between agents, the system transforms its environments into a continuum embedded with lots of mutually incommensurable hidden realities.

The current IoT ontology, in the same way, intensifies its physical domain with these sorts of hidden realities to commodify them into the future service domains of the IoT. As the smart objects constantly fold and refold a smart space into certain sensor-actuator arcs their
intensive interoperations draw, these problematic realities of a continuum would gradually be unfolded as each singular domain for the advanced smart application. For instance, under the governance of smart objects, a nervous system could be remapped as a neuronal continuum embedded with multiple levels of cognitive functions; a body becomes a physiological continuum with multiple levels of needs and desires; and a smart home or city becomes a domestic or urban continuum with hidden efficiency and security problems. Given that all these continua separable under each different IoT system can also be converged upon a bigger Ontology operating in a same physical domain such as a smart city, we can think of two different ways for the IoT to expand its frontiers. First, the development of new sensors, processors, actuators capable of responding to finer-grained fluctuations of a continuum would expand its syntactic “technological frontiers in sensing.” At the same time, the improvement of the system’s “ability to extrapolate information from the data provided by the existing technology and dedicated sensors” would expand its analytic “frontiers in inferential sensing” (Andrejevic & Brudon, 2014, p.25). The ongoing experiments to embed more “smart dusts” in biological, social, and ecological networks would expand the synthetic frontiers of ubiquitous computing by transforming a greater number of context-specific interactions of these networks into each separable data continuum under “small, focused ontologies customized to the available sensors and sensor data” in each domain. On the other hand, in their convergence upon a single dataset, or Big Data, “the combination and integration of a larger number of such ontologies” would discover more correlations between different domains (Underwood et al., 2015). In this sense, a larger scale Ontology could be assembled from a multitude of small and focused ontologies. For instance, a smart electrocardiography (ECG) registered in the ontology for wireless bioinformatic devices may also belong to the ontologies for the sensor networks in smart home and smart city.
The smart home, what the next chapter will discuss, is one of these local IoT domains, and its own focused ontology is for the smart appliances to communicate about their common world, a domestic space. Still serving human needs even though they no longer straightly ask humans what they need, the world these smart objects are most and only concerned about is that of our unknown needs and desires, or more generally, things to be resolved about us. In short, the universe for these objects, with which we share our daily routine, is a continuum of unknown problems. For each smart appliance or a group of appliances tied in an application, this continuum would appear to be each focused problem space. The next chapter develops a topological framework to describe this feature of the new domestic space, namely its being embedded with lots of problematic realities and its transformability into different application domains.
CHAPTER 2: TOPOLOGY AS NEW GOVERNMENTALITY OF EVERYDAY LIFE IN THE AGE OF THE INTERNET OF THINGS

Re-intensifying a (non-)smart home

Let me begin this chapter with a thought experiment on a non-smart home, filled with lots of electronic devices, not yet digitally interconnected, but physically interoperable. Say they can be redeployed anywhere insofar as their physical boundaries do not overlap one another. A domain that each device’s operation reaches could then be stretched and bent flexibly since they are rearrangeable in many improvised ways. Following the definition of topology as a study on the properties of a space that “remain invariant under bending, stretching, or deforming transformations” (DeLanda, 2002, pp.25-6), this domestic space can be now considered a topological object characterized not so much as a container for separable devices but as a continuum with flexible and complicated inner boundaries, whose topological invariants, namely the infinitely elastic and unbreakable boundaries of devices, describe all the potential interoperations of the devices (Figure 2.1). Each device in this conceptual space is symmetrical to any transformations the house undergoes in that it could operate invariantly in any positions.

However, as a tenant moves in, most of their symmetries begin to break. Her daily routine—waking up, sitting at a table, having breakfast, reading something—is embedded and redeployed to the new niches. Their previous invariance in operating anywhere, in other words, their symmetry to any spatial rearrangements, is broken because they are functional now only by being consistently engaged with a trajectory the tenant draws to refresh her energy.

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8 Symmetry in mathematics is when an object or its property is invariant under a specific transformation the object undergoes. In this sense, symmetry is always symmetry to a certain manipulation performed over the object.
to begin and continue a day. They no longer remain the same under all possible stretching and bending of the continuum but symmetrical only to a linear transformation along the tenant’s daily routine. As DeLanda says, “an undifferentiated intensive space (that is, a space defined continuous intensive properties) progressively differentiates, eventually giving rise to extensive structure” (2002, p.27). Her singularity embeds a line of force or attractor within the continuum and makes “a large number of different trajectories, starting their evolution at very different places in the manifold, … end up” being aligned “within the ‘sphere of influence’ of the attractor” (p.15, 32). Despite the extensive structure the space’s intensive transformation eventually culminates in, this topological description conceptually preserves the undifferentiated continuum beneath the space and, with the introduction of other attractors than the tenant’s daily routine, it could unfold lots of hidden functional states of the space. Topology repurposed as a means to describe the place-binding of a domestic space in this sense rediscovers its intensive proto-territory where manifold functional relations among the entities, often contradictory to one another in realization but virtually co-embedded, are still open to all possible re-deployments prior to any extensive structures.

Figure 2.1: Three topological isomorphs of a domestic space with flexible inner boundaries of devices
This chapter examines the smart electronic devices and their network called the Internet of Things as the technological attractor that re-intensifies this topological potential of our domestic space renamed smart home. Embedded with the multitude of sensors and actuators, or “smart dusts” (Kahn et al., 1999), a domestic interior in its most advanced form is redefined as a topological continuum. As software applications constantly redeploy these smart objects and their intensive interoperations, the continuum folded along their sensor-actuator arcs gradually unfolds its hidden functional spaces. This chapter’s topological approach analyzes how a smart home re-excavates this continuum once buried under our daily routine, and re-differentiates it into as many new service domains of the IoT as the number of smart home applications. For doing so, it borrows the mathematical concept of manifold from Bernhard Riemann’s differential geometry, whose phenomenological meaning will be further examined through Henri Poincaré’s group theory.

**Topology in Culture**

In the introduction to *Theory, Culture & Society*’s special issue on “Topologies of Culture,” Lury, Parisi, and Terranova illustrate the recent “topological culture” as emergent from “a proliferation of surfaces that behave topologically”; the origin of which they trace back to the “20th-century developments in the gridding of time and space, the proliferation of registers, filing and listing systems, the making and remaking of categories, the identification of populations, and the invention of logistics” (2012, p.8). Digital interfaces currently embedded in our everyday life can also be considered as these flexible surfaces that encompass all these early computational modelings of workplace, domestic space, and social geography. For the past decades, these interfaces have registered a variety of objects—from home/office appliances to
consumer goods—to their heterogeneous networks. At the same time, the functional values of these objects have been re-categorized along with online activities of their users, whose quantified-selves have also been registered to the same interfaces as the collections of computable variables: from their demographic characters to the patterns of web-surfing. By topology, these authors thus mean the changed “‘lower level’ principles of invariance or consistency” for the social life of humans and objects in these networked social platforms. Departing from the Euclidean axioms, which have defined objects as something invariant under geometric transformations such as “rotation, symmetry, scale and translation” and in turn defined their movement as the “transmission of fixed forms in space and time,” movement becoming topological is expressed instead in the form of “the ordering of continuity,” or the bending and stretching of a continuum to make something invariant or orderly-variant emerge from its folded surfaces (pp.6-7, 13). Suppose that you are walking around a city with a GPS tracking augmented-realty app. Before everything else, your physical displacement would be expressed as a linear transformation of a geo-data continuum along the trajectory of a data point representing your location. The graphical boundaries of urban objects would, on the other hand, appear in the app’s user interface as nearby Points of Interests (POI) only as the result of the software’s constant ordering and folding of the continuum into the changed data point. In the same way, your social profile would be constantly updated from and improvised through the algorithmic comparison of your pathway across the POIs to what others draw (Lury & Day, 2019). The movement topologically re-conceptualized does not mean dis-placement as the operation of a power ingrained in “pre-given territorial containers” (Allan, 2011, p.286), but expresses the power that makes a place itself emerge from the continuum in which objects should be constantly re-included as those orderly-variant under given deformations.
“Becoming topological” of something in this sense means the liquidation of “the rigidity of the distinction between inclusion and exclusion,” once determining the legitimate place of an object “based on essential properties, such as archetypes, values or norms, or regional location” (Lury et al., 2012, p.5). Its boundary now needs to be constantly re-created through “different kinds of folding and filtering” of the continuum (Mezzadra & Neilson, 2012, p.60). At the same time, the geography reconfigured as a continuum of multilevel relational data also becomes topological as it is assumed to hide lots of embedded boundaries of objects as its “excess” in the background (Lury, 2009, p.80), or “implicate orders” (Bohm, 1980), which could be foregrounded through the software’s alternative ways of folding/filtering in the future. Topology in the recent discourses of cultural geography has described these innovated lower-level principles for the movement of humans and nonhumans “in culture as a field of connectedness,” and their “inclusion and exclusion” along deformable boundaries (Lury et al., 2012, p.5).

By the term topological power, I refer to a new form of power that capitalizes this transformability of human geography converted into a digital continuum. For its further (market) penetration into our everyday life, this power constantly re-differentiates the continuum into a multitude of problem-spaces, which can be managed optimally by its environmental sensors and actuators. There can be various conductors of topological power, such as an active user of self-tracking devices exemplified by the early proponents of quantified-self, a smart watch to which its casual user delegates the job to quantify herself instead of being a data analyst herself, and the governmental and corporate agencies who transform the social dynamics of a city into Big Data. No matter what object these conductors take as their domain, from a body to city, topology expresses their common logic for territorial expansion, never imaginable with the territoriality understood as geometric extension, but with the intensification of existing territories. A space
under topological power is transformed into a relational database with lots of hidden correlations supposed to be discovered sooner or later by embedded sensors and actuators. The objects under its governance are no longer contained in a pre-given space but need to be constantly re-defined as orderly-variant under a certain folding/filtering of the continuum (like hidden health problems or terrorists, distinguishable only by the pattern recognition algorithms of a smart watch or smart city). Topology in this chapter thus describes the intensive infiltration of power into a space beyond its extensive object boundaries, and the tendency to redefine objects as relational problems constantly re-unfolded from the space’s intensive transformations. As the following sections will demonstrate, the technological embodiment of topological power, such as the Internet of Things, is therefore superior to other territorial actors based in a single extensive level of space since the number of objects that a topological actor put under its governance is potentially unlimited as it could unfold hidden levels of the space *ad infinitum*. The more problems are hidden, the more topological their solutions should be.

The expansion of topological power along the digital networks for the past decades has been exemplified by the proliferation of software interfaces attached not only to the surfaces of a city but also human skins under smart wearable devices. Lots of hidden correlations otherwise undetectable have been foregrounded by the wireless interoperations of these objects. On the other hand, the thought experiment on the transformability of a non-smart home in the Introduction of the chapter suggests another direction that topological power recently takes to excavate the underlying continuum of our everyday life. A space’s becoming topological in this domestic scenario is no longer due to the connection to the outside networks. It is instead intensified through the manifold regional interconnections of the devices in the same sense that the term *manifold* means in Riemannian differential geometry a set of “multiply extended
magnitudes … susceptible of various metric relations,” in which “a [Euclidean] space constitutes only a special case of a triply extended magnitude” (Riemann, 2007, p.23). Our not-yet-smart home is likewise topological as it is charged with lots of potential interoperations among the devices that would be susceptible to various functional relations if once again rewired properly to each other. As the technological solution to this quest for becoming topological of everyday life, the Internet of Things embeds miniaturized “RFID and sensor technology” in the objects occupying a space and lets them “observe, identify and understand the world” from their own data points and, in turn, transforms a space into a relational database (Ashton, 2009). We can take this as the new technological attractor representing topological power’s recent shift from global networking to regional intensification.

According to the International Telecommunication Union’s paper for standardization, the things in the Internet of Things are enrolled to a new dimension called “Any THING communication,” distinguishable from other two dimensions of the ICTs in the past namely “Any TIME communication” and “Any PLACE communication” (2012, p.2). The new dimension for machine-to-machine communication provides the smart objects with an ontological platform for their reciprocal presences without being necessarily used in human TIME and PLACE. To realize its ideal for the “full use of things to offer services to all kinds of applications” (p.3), the IoT-based smart home thus needs to liberate its objects from their previous obligation to follow the instructions directly given from humans. Precipitated from this liberation, the intensive machine-to-machine communications would then gradually unfold a space’s hidden relational problems—such as its states not being optimal for a predictable tenant behavior, for instance, going to bed—in the form of parameters manageable by a set of smart
objects deployed for the relevant IoT applications—such as a sleep app to manage the interoperation of a smart thermometer, lighting, phone and watch.

A smart home topology in this scenario is analyzable into three different conductors of topological power in negotiation. First, there is the tenant, so conscious of possible inefficiencies hidden in her daily routine, and thus persuaded to think of her home and own body as an intensive continuum embedded with lots of non-localizable problems. The smart home applications she purchased would then function as technical conductors of topological power to unfold these invisible levels of her daily routine. Lastly, there is a service provider, who owns the Big Data gathered from its smart home subscribers, and constantly re-folds this continuum to data-mine more problems for the companies’ further market penetration into the intensive domain of a smart home. The most optimized domestic space today first needs to be intensified with people’s concerns about something hidden and embedded in their daily routine in order to justify its local governance through smart objects, as much as its enrollment to the global infrastructures outside is believed to contribute to the frictionless digital convergence for the utopian “Internet of Everything” (Evans, 2012) or “everyware” (Greenfield, 2006).

**Manifolds in the Internet of Things**

Kirstein (2016) suggests an architectural abstraction for expanding “the edge of the networks that make up the Internet” even to the not “IP-enabled” objects, such as the devices in our non-smart home scenario. According to him, a typical IoT system consists of two layers. *DeploymentNet*, or the physical lower layer, is for the actual enrollment of smart objects to a physical domain. *ServiceNet*, or the upper software layer, is on the other hand where the virtual objects as the algorithmic counterparts of the physical objects are abstractly defined for their
deployment for the IoT applications. For the regional IoT infrastructure (such as a smart home with several smart devices) to be automatically operational for the applications in the software layer, the semantic technology called ontology needs to intervene in the middle for “the alignment and matchmaking tasks … to identify which smart entities that ‘live’ in [the tenant’s] house are appropriate for the applications/services to function” (Kotis & Katasonov, 2012).9

Replacing the tenant’s habitual deployment of objects for her daily routine, this ontological protocol for machine-to-machine communication enables the smart home to optimize itself for her life. This technological optimization of the space, which the tenant may believe she delegated to the IoT to save the time she used to spend for walking around and manually turning on and off the devices, is however not only serving for her daily needs but following the corporate conductor’s commercial interests, namely to renew the space constantly.

For the tenant in the not-yet-smart setting, to live her daily routine is to transform her surroundings gradually into the symmetrical figure to her everyday practices. Along the multiple sensorimotor pathways from what physiologists call reflex arc to what phenomenologists call intention arc (Merleau-Ponty, 2005), any move she takes at home is followed by her somatic expectation on the transformation that this move would bring in the space. The actual perception succeeding her move would in turn confirm or update this expectation for her future moves. In this sense, the tenant’s living in her not-yet-smart home is topologically isomorphic to the process whereby a spatial continuum is folded along a set of biological sensors and motors

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9 This stratified structure is also typical in other IoT-based system such as IBM’s blueprint for a smart city which consists of the bottom layer of instrumentation “made up of sensors, actuators, programmable logic controllers and distributed intelligent sensors” and the top layer of intelligence for “urban software applications” with the mediation of the middle layer for interconnection (Sadowski & Bendor, 2019, p.551).
interconnected along certain physiological pathways. As Ingold says, “places are formed through movement, when a movement along turns into a movement around” (2008, p.1808). Like the typical residents of modern buildings Pink et al. call “directors of flows,” our tenant improvises “the material configuration and atmosphere of [her] bedtime home as [she] move[s] through” the space for “switching the lights on and off, closing curtains, plugging in things to charge and setting up technologies to ‘work’ while [she is] asleep”; in other words, she makes the home “felt right” to her “bedtime routine” (2016, p.86, 88).

On the other hand, the IoT’s optimization of a smart home is not for stabilizing it into a single “right” level for living. Its stability is bad news for the service provider because that means no more problems embedded for the company’s further penetration. Stability in a smart home should thus be only a transitory equilibrium about to be broken by the new problems the updated application soon excavates. As Kitchin and Dodge illustrate with the term “code/space,” in a smart home, “space is constantly bought into being as an incomplete solution to an ongoing relational problem” namely the maximum optimization (2011, p.71). For this bringing forth of a more optimal space to be repeated over and over again, the physical continuum of a smart home should be full of small problems relational to a variety of predictable tenant behaviors, such as its being not-yet-optimal-enough for having a sleep, doing exercise, or watching TV, which can be optimized further by each different application. Unlike the spatial continuum of a not-yet-smart home, that was folded along the physiologically hardwired sensorimotor pathways, the continuum of a smart home, under multiple sensor-actuator arcs, is not detained within a single level of optimality. Instead, its IoT system needs to keep the continuum intensive enough to be de/re-territorialized by different sets of sensors and actuators for different applications. For doing so, it needs to redefine a tenant not as a director of flows, but a source of flows constantly
disturbing the space. In this sense, we can interpret the two-layered structure of the IoT as a strategic design decision that guarantees the corporate power’s intensive market penetration. While its lower layer for the maximum interoperability of smart objects intensifies the space with lots of relational problems, the upper software layer gradually identifies and commodifies them into its serviceable domains. For instance, Lanzeni observed in a citizen-sensing environment project that the problem of knowing the real cause of air pollution is always engaged with some “other environmental elements” that the current deployment of environmental sensors cannot detect. These others withdrawing from the grip of current software solutions are nevertheless hidden in certain *implicate orders* that would “become tangible” and “bring [the participants] closer to understanding what was causing the pollution” as they redeploy the sensors by “improving firmware or to move to a different technology” (2016, pp.55-6, 60). In other words, smart futures are already embedded in the intensified materiality but able to be brought in reality only through the ubiquitous computing of smart devices because the symptoms of these futures are too widely distributed over the environments to be predicted by the linearity of human reason.

As Dourish and Bell say, “the proximate future vision” of ubiquitous computing has financially justified the “dramatic transformations of technological infrastructure” for the last three decades from Mark Weiser’s early research at Xerox PARC in the 1990s to the recent IoT (2011, pp.24-5). In the topological framework roughly sketched above, this future vision is now interpreted as more than just the rhetoric of Silicon Valley on its “future infinitely postponed” (Ibid.). In-between the intensive lower layer and abstract upper layer of a smart home, the most optimal future for our living is inevitably postponed infinitely because it would stay lurking in the underlying continuum until the software applications unfold all of its problematic levels and, more importantly, because this intensive continuum is always abundant with hidden problems.
Lauren Martin and Anna Secor say about the current use of the term topology in human geography:

In this formulation, topology becomes very much like the ‘base’ to the topographical ‘superstructure’ – except, to be fair, topological space is not defined by a set of given relationships (such as a capitalist mode of production) but rather by the multiplicity of potential relationships that comprise that space” (2013, p.432).

Likewise, the topological continuum of the IoT is the base to the superstructure of each IoT service domain, which is no other than the commodification of one embedded level of this “multiplicity of potential relationships that comprise the space.” While Martin and Secor examine topology in line with the “periodic passions for the appropriation of scientific authority in the social sciences and humanities,” they also raise a question whether its scientific authority has brought “a host of decidedly positivist and even Cartesian assumptions,” which they call “topological desire” (p.433), back to the poststructuralist spatial theory. In the place where these scholars feel something Cartesian again, what I term topological power, on the other hand, redisCOVERs the measurability of space in a more general sense than that once inferred from Euclidean axioms, the desire to measure all embedded levels of space exhaustively.

**Riemannian and Poincaréan theories of symmetrical space**

The promise for the IoT’s never-ending market penetration, even after everything is already replaced by smart objects in our smart home, is thus based on people’s renewed concerns about the multiplicity embedded in their material reality. Topological power is descriptive of how the recent software industry exploits this multiplicity by drawing multiple sensor-actuator arcs over a spatial continuum to unfold its hidden marketable levels. For the conceptual tool to
analyze the way this power creates certain “cuts” within a continuum to unravel its embedded spaces and geometries (Poincaré, 1913, p.54), we can refer to Bernhard Riemann’s mathematical concept of manifold and Henry Poincaré’s group theory.

In the essay on a manifold “at the foundation of geometry,” Riemann devised a mathematical apparatus to demonstrate how this conceptual space of multiply extended magnitudes unfolds a surface with a constant curvature. He assumes that for measurement in the most basic sense to be possible, a length of the line should be independent of its position no matter where it is superposed to be compared with other lengths. He then contrives heuristically an anonymous “one,” who (or which) passes from one magnitude to another to transport “the line element $ds$” as an infinitesimal yardstick to define “metric relations of which a manifold … is susceptible.” This mathematical cursor running across a manifold gradually localizes the nearby magnitudes it passes through into the points fixed by the homogeneous Pythagorean distance function, and consequently, it concretizes one embedded level of the manifold, on which any configurations “distinguished by a mark or a boundary” that the cursor draws appear symmetrical to the group of geometric transformations, such as displacements and rotations (Riemann, 2007, p.24, 26).

Riemann’s differential geometry in this heuristic explanation suggests a mathematical conductor of topological power, which functions to fold the entities infinitely close to its trajectory into the geometric theorem at the expense of breaking all other relations possible in a manifold. In this sense, it provides one possible way to explain how the intensive space of the nineteenth century’s microphysics was re-wired along the Cartesian coordinate by a sort of topological power that aimed to unfold a level of measurability. As the substitute for this purely mathematic conductor in Riemann, Poincaré on the other hand suggested a simple biological
being that senses and moves in its multiply extended intensive environments. In his physiological and phenomenological explanation on the emergence of geometry, what appears to be invariant enough to replace Riemann’s hypothetical line element \((ds)\) is an elementary correlation between two types of state change that this biological cursor undergoes as it moves around the continuum of intensities: namely the changes aroused from its sensors “independent of will” and those “voluntary and accompanied by muscular sensations” (Poincaré, 2007, p.121). An eye, for instance, can be thought of as an intersection for these two types of changes to be intermingled. As a cursor, it may move to the right and left as the manifestation of a motor volition that activates specific muscles; the metric relation between the external sensations which have passed through the retina during the motor activity could then be measured by the amount of the coincident muscular sensations. If there is no other motor apparatus activated in this micro phenomenological experience, these voluntary muscular sensations would be enough to unfold certain spatial relations within the continuum as invariant under the muscles’ repeated activations, whereas the other portion of the continuum would withdraw to the intensive background (p.135). For the physiological system that is multiply extended to its surroundings through its sensors and motors multiply interconnected inside, these elementary sensations can be the alternative to the Riemannian line element, not hypothetically given any longer, but experientially emergent. Along the trajectory this body draws, the surrounding manifold would eventually bifurcate into a phenomenological space symmetrical to a group of transformations that this biological cursor performs through its elementary muscular operations and “all the combinations which can be made of them” (p.125).

For Poincaré, the conductor of power that unfolds a geometric structure embedded in the intensive background is one’s voluntary action accompanying certain muscular sensations, or
what current neuroscience calls *proprioception*, which enables “the sensory cortices to predict specifically how the actions to be taken will change the relations of the eyes, nose, ears, and fingers to the world” (Freeman, 2000, p.33). He also knew that a “sensible space” this biological being inhabits is not three dimensional *a priori* but possible to be folded into “as many [degrees] as there are nerve-fibers” (Poincaré, 2007, p.132). From this feature of a manifold, *which can be bound by many local sensorimotor pathways but inexhaustible by any of them*, the continuum underling the extensive reality is inferred to embed lots of hidden levels within its intensities, each of which can be unfolded separately by different attractors, but never unfolded all together. Geometry for Poincaré was therefore just one embedded order out of manifold others in the world. Geometry is just unraveled as a single stable level on which an anthropomorphic sensorimotor pathway “achieve[s] maximum grip” (Freeman, 2000, pp.120-1).

In Poincaréan group theory, *symmetry* hitherto indicating an object’s invariance under a subject’s observation and manipulation attains a new ontological meaning as it refers to the emergence of the subject-object boundary itself from a continuum under transformation. Symmetry is an event whereby a group of sensors and motors is interconnected along *an arc* through which the folded inside of the continuum achieves a stable grip on a certain level of the outside. In this respect, symmetry is akin to what Karen Bard describes by the term *agential cut*: “topological dynamics of enfolding whereby the spacetime-matter manifold is enfolded into itself” whereby “the marking of the ‘measuring agencies’ by the ‘measured object’” emerges (2007, p.140, 177). This cut is where a continuum is folded in two and differentiated into the symmetrical inside and outside. The cut is, therefore, prior to any boundaries of the

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10 For how Poincaré thought of geometry in relation to an organism’s pursuit to “achieve maximum grip,” see Poincaré, 2007, p.274.
observer/observed, toucher/touched drawn on the continuum.¹¹ As the cause which makes this cut, power does not belong to either of two poles of the symmetry, namely subject and object. The power topologically thought is describable better as a continuum’s fluctuation to make a fold on its own surface, from which something invariant comes to the fore, or bifurcates as an object. This movement is both material and discursive in that the unfolded space not only displays the objects’ invariant boundaries but expresses the group of transformations to which their objectness is defined as symmetrical. Territorialization is the expression of this power.

Riemann’s infinitesimal yardstick is one instance, which folds a mathematical manifold into a measurable space under the maximum grip of the Pythagorean Theorem. Poincaré’s group of transformations is another as it folds an intensive continuum to filter out a livable space on which a living being achieves the maximum grip along its sensorimotor pathway. There is also my own example of the Internet of Things, whose wireless sensor and actuator network constantly refolds the underlying continuum of a smart home to cultivate lots of serviceable and marketable spaces for its perpetual market penetration.

**Two types of power in manifolds**

Symmetry as a mode of relational thinking has been common in social theories since the actor-network theory manifested the principle of symmetry as its democratic agenda. In ANT, symmetry means the equal right assigned bilaterally to both human and nonhuman and “the

¹¹ The force which makes a cut in a manifold involves the operation of apparatuses such as the sensors and motors which constitute a cursor; however, before folded into the cut as a local sensorimotor pathway, these apparatuses are no other than just entities or magnitudes affective to their multiply extended surroundings. As Barad emphasizes, these measuring devices should be understood as “boundary-making practices that are formative of matter and meaning, productive of, and part of, the phenomena produced” (2007, p.146).
same type of explanation” given to “all the elements that go to make up a heterogeneous network, whether these elements are devices, natural forces, or social groups” (Law, 2012, p.124). For this same cause for the formation of the social, “the choice of network” has been discussed as the activity that any entities not identified yet need to do for making themselves present in “a noticeable and individual way” to others (pp.125-6). According to this principle, the evolution of a technical system with many autonomous parts, such as the Internet of Things, has often been interpreted as an actor-network’s gradual individuation or sudden bifurcation into a systemic whole at the expense of breaking all other relations among the actors, once preserved in their earlier contradictory coexistence. However, as Couldry points out, repurposed as the theory of spatialization, this way of explaining the social as emergent merely from the autonomous fluctuations of distributed actors has provided only a limited account neglecting “the long-term consequences of networks for the distribution of social power” (2008, p.101). ANT’s emphasis on the bilateral symmetry between actors is “strangely silent when it comes to assessing whether, and why” asymmetry still rules the network in the long run (p.102), unless it simply points out some stronger actors at the center of the network as the culprits.

On the other hand, the symmetry re-conceptualized in the last section suggests another way to think of the world-making processes in ANT without assuming any actors in distance. Understood as the expression of topological power that stirs the continuous deformations of a manifold, symmetry now illustrates what Barad calls intra-actions: not the interactions between two existing relata, but the movements to fold an arbitrary boundary between subject and object (2007, p.139). Symmetry does not mean the relation between two actors with equal rights but an ontological event whereby a continuum is folded along an arc and something invariant appears
under its transformations. Put differently, symmetry describes a fold as an expression of the power that reveals a livable, perceivable, or measurable world from a continuum’s folded inside.

We can distinguish two types of power that governs the emergence of inter-objective spaces from a manifold according to whether this fold tends to be hardwired to maintain its current grip on a single level of environments out of many, or tends to constantly re-wire to update its current grip to a different level every moment. First, like the eye swaying from side to side, a fold may move along the continuum and then move around in order to enroll what it keeps passing through as the objects re-traceable by its registered or remembered motor operations. On the other hand, there could be another fold, which moves around to the initial point only to initiate each new move-along to the undiscovered territories of the space. The feature of a manifold the first sort of power seeks out is its single symmetrical level bound by the routinized sensorimotor pathways. The second sort, however, does not much concern what is the most stable level but constantly redeploy its wireless sensors and motors to examine all the “nested set of vector fields related to each other by symmetry-breaking bifurcations” (DeLanda, 2002, p.32).\(^\text{12}\)

\(^{12}\) These two tendencies of power can be explained through two modes of technological attractors that science and technology studies call, respectively, “immutable mobile” and “boundary object.” They are not distinguishable as opposite one another. They rather have a common function as technological protocols to organize a network for scientific research. Immutable mobile describes the protocol’s circulation to redeploy its sensors and actuators, not only experimental equipment in a local lab but discursive apparatuses such as the questionnaire, and it functions to stimulate hidden matters of fact (or concern) of space and reproduce their invariant responses (Latour, 1990). On the other hand, the boundary object is characterized by its inherent ambiguity, whose circulation along different labs, institutes, and disciplines constantly reorganizes local sensors and actuators to draw different levels of measurability and discursivity hidden in its ambiguity (Star & Griesemer, 1989).
If Riemann and Poincaré provide the theoretical abstractions of the first type of power that governs the bifurcation of a mathematical or phenomenological space, we can find its application to a social continuum from Brian Massumi’s topological interpretation of Foucauldian *governmentality*. As a neo-liberal form of power “structuring and shaping the field of possible action of subjects” (Lemke, 2002, p.52), governmentality for Massumi is analyzed into the combination of “disciplinary power” and “regulatory biopower” alternating within “the continuum ‘that lies between the organic and the biological, between body and population’” (Massumi, 2015, p.24). This continuum unfolds “the spatial distribution of individual bodies” as “the first effect of power … [that] passes through” the continuum to enable “bodies, gestures, discourses, and desires to be identified and constituted as something individual” (Foucault, 2003, p.242, 29-30). The symmetry of this level of “man-as-body,” on which the disciplinary apparatuses achieve their maximum grip, is however broken as *biopower* re-bifurcates the continuum into “man-as-species” (p.243). In this “second adjustment” of the power, what appears symmetrical is instead population: the “phenomena that are aleatory and unpredictable when taken in themselves or individually,” thus no longer symmetrical to atomistic disciplinary processes, but “at the collective level, display constants” to the networked apparatuses for regulation (p.246, 250). Alternating these different techniques to fold the same social continuum, Foucauldian governmentality devises “a correctional reuptake mechanism for emergent normative variation” to update the norms for the disciplinary power’s further deployment of man-as-body (Massumi, 2015, p.25). Governmentality can be in this sense abstracted as a technique to fold and refold a social continuum to detain its transformation under the power’s maximum grip on its two embedded levels, namely individuals and population, by re-distributing individuals in a way to make their collective figure symmetrical to a population kept under
certain statistical constants and vice versa. In its tendency to detain the social dynamics under the manageable alternation between many and one, this power is topologically isomorphic to how the tenant in the introduction governs her space. Her moving in the continuum of a not-yet-smart home also gradually redeployed the individual devices to the new niches whose collective interoperations would correspond to the constants in her daily routines such as her regular needs and desires to fulfill with these devices.

On the other hand, the second type of power is distinguishable by its tendency to unfold more symmetries hidden in the continuum no matter how symmetry-breaking an attempt to find a new symmetry is to the others already discovered. It does not seek out a limited set of constants to detain the continuum’s dynamics in a single or two-coupled level, such as geometry or individual-population. Instead, the power now draws a whole state space for the continuum to pass through in its recurrent differentiations from one state to another, constantly updating its optimal grip from one level to another. We can think of this type of power also as what appears in the middle of the two layers of a smart home and governs its space-binding. It is revealed through the software layer’s constant redeployment of sensors and actuators. Whenever a new smart home application is downloaded and executed in the high, the smart objects in the low are redeployed to assemble a new sensor-actuator arc to unfold a hidden marketable level of the space. For instance, in an existing smart solution to “the wellness of an elderly living alone,” a set of smart objects including a room heater, toaster, microwave, TV, bed, and chair is deployed by an algorithm that calculates the “wellness parameters,” the measure for the space’s engagement with a person’s health-related routine (Suryadevara et al., 2013). On the other hand, the same set of objects can be re-deployed in other applications to calculate other parameters, such measures as of the space’s engagement with energy-consuming routine (Moreno et al.,
2014), calorie-burning routine (Helal et al., 2009), and so forth. As a semantic protocol to define the types of sensors and actuators in the low and their possible interoperations for the applications in the high, the IoT ontology executes a different kind of governmentality, whose spatial redistribution of individual devices is not to stabilize them as a systemic whole regulated by a finite set of constants. Instead, the ontology as a protocol for machine-to-machine communication is for maximizing the different ways of their distributions for each different level of the manifold, in which a problem otherwise unidentifiable eventually appears to be symmetrical. Re-stirring the continuum once detained by an average routine of the tenant, and exploring all the problematic levels its resumed differentiation could pass through, this new technique for space-binding in turn transforms a smart home into a continuum, or a nested set of problems related to each other by symmetry-breaking bifurcations.\(^{13}\)

A smart home understood as a manifold in this sense redefines the meaning of a domestic space. It is no longer something lived by and organized through one’s habitual sensorimotor activities. A domestic space now is constantly re-differentiated into a specific “problem space.” Under a particular “set of operators” temporarily redeployed to form a measure for a unique lurking problem, this conceptual space progresses from “a set of initial states” to “a set of goal [or solved] states” according to the execution of an application (Newell, 1980, p.5). A

\(^{13}\) Donna Hoffman and Thomas Novak’s assemblage theory approach to consumer experience of the IoT describes this transformation. They categorize the possible interactions that could occur in a smart home as follows: 1) Consumer-centric part-part interaction (such as a consumer experience of a smart object), 2) Consumer-centric part-whole interaction (a consumer experience of a smart home), 3) Nonconsumer-centric part-part interaction (an object experience of another object), 4) Nonconsumer-centric part-whole interaction (an object experience of a smart home). As “a set of nested and overlapping assemblages with different spatio-temporal scales” within a smart home assemblage, these multiplied interactions, each of which can be analyzed into an object-object or human-object assemblage, or a sensor-actuator arc in my term, serve the abundance of computational problems for IoT applications (2018, p.1179, 1183).
human tenant cannot govern these problems optimally not because there are too many of them, but rather because she cannot live all different levels simultaneously. The smart objects thus do not need to be symmetrical to the context of the tenant’s direct uses of them, or human-centered “correlationism” (Meillassoux, 2010). For the larger number of smart objects to be interoperable enough to foreground all the hidden parameters of the space, they should be symmetrical more to the microscopic perturbations of the continuum each other’s operation arouses.

To put this IoT architecture simply, the wireless sensors and actuators in the low intensify the intra-active potential of the space; the ontology in the middle translates this potential into the modular machine-to-machine communications and enables their autonomous redeployment for software applications; the upper software layer, on the other hand, draws a state space, which describes all possible problematic states of a smart home detectable and marketable through the IoT solutions (Figure 2.2).
To define a physical domain of the IoT as a multiply extended manifold is not only an engineering solution to the ubiquitous problems in our everyday life but also a marketing necessity for its state space to expand ever to the new marketable states of the intensive space. As early as the 1950s, the American architect Charles Eames anticipated that the future architectures would approach their new state of the art “based on handling and relating of an impossible number of factors.” His early vision for cybernetic architecture required the architects to control “the effect of and affect on many simultaneous factors” insofar as they are responsible “to use such a tool” that “could make possible the inclusion of more factors—and could make calculable the possible results of relationships between combinations of factors” (Halpern, 2014, p.134). About a half-century later, Mark Weiser in the 1990s suggested ubiquitous computing as this kind of tool to integrate lots of human and machine-generated databases in one’s home and office. However, emphasizing its withdrawal to the peripheries of human attention, what the ubicomp’s slogan of “calm technology” promised was not to enable humans to process more computational elements, but to liberate users from their responsibility for multitasking in the PC era, namely to symmetrify lots of technical objects to their conscious goals (Weiser & Brown, 1997). Finally, “in [our still] coming age of calm technology,” we witness that the withdrawals of the smart devices into our intensified “periphery” are mobilized by the corporate conductors of topological power, enabling every human problem environmentally dispersed to be potentially symmetrical to and thus orderly manageable by their smart applications. The state space the IoT lays over our intensified smart home redefines these problems as what we cannot access since they are too dispersed and embedded, but we still need to pay for their algorithmic and preemptive solutions.
The market potential of a smart home is, therefore, proportional to the number of problems assumed to be hiding in its intensive space. To justify the IoT’s interventions, these problems should remain undistinguishable until their urgency is measured by each different software application. Under this commercial necessity, a smart home is defined as what Massumi calls a “crisis-incubating environment,” where the crises are concealed in the forms asymmetrical to a Poincaréan observer, or our human tenant, who recognize the problems too late after the crises already disturb the symmetries of her daily routine. In this environment, “[t]he crises are tailored to justify solutions” (Sadowski & Bendor, 2019, p.553). What the recent smart home applications and other regional smart environments incubate foremost as this sort of crisis is the inefficiency in the tenants’ energy uses (Moreno et al., 2014). No longer merely being a problem of our bad habit, the inefficiency is now embedded in the imperceptible fluctuations of a space that our non-conscious behaviors precipitate. “The preemptive power” of the software layer thus needs to be always ready to “counter the event-driving force of accident if it catch it in the before of incipience,” in other words, before you commit the bad habit once again (Massumi, 2015, p.40). As Massumi says, the power in this sort is environmental as it “alters the life environment’s conditions of emergence,” but different from how biopower detains a continuum within “a territory, grasped from the angle of its actually providing livable conditions for an existing biological being” (p.40). Instead, the preemptive power of the IoT resides in “a prototerritory tensed with a compelling excess of potential which renders it strictly unlivable” (p.40): such as a world of smart objects an ideal IoT ontology defines, in which every object perceives any tiny fluctuations everything else arouses in a continuum. Tensed with these fundamental symmetries among the objects and their unlimited interoperability, the IoT’s crisis-incubating materiality also cultivates its smart futures, which could be brought in reality as
proper sets of smart objects eventually discovers hidden parameters for each unknown problem. Following Massumi, we can call this topological power *ontopower*. As he exemplifies with the battlefields of modern warfare embedded with “the proteiform ‘terrorism’” (p.11) and as Howe (2019) exemplifies with Iceland’s glaciers with the intensified “environmental precarities,” the “continuum in space/time/matter” this power operationalizes is characterized by its excessive *implicate orders*, asymmetrical to the “human-centered” sensing practices, but symmetrical to the sensing practices of “other-than-human entities” (Gabry, 2016). As the domestic counterpart to these post-9/11 battlefields and Anthropocenic environments, a smart home also incubates its own problems asymmetrical to our everyday sensorimotor activities and re-symmetrifies them into serviceable problems through its IoT-driven ontopower.

Ulrich Beck said in the 1980s that “the ‘logic’ of risk production” would replace the “logic of wealth production” in late capitalism where the risk distribution, not the wealth, becomes the most urgent problem for the still on-going project of modernization (1992, p.12). Under the “conditions of ‘scarcity society,’” the function of techno-science as the engine of modernization was, he says, for “opening the gates to hidden sources of social wealth.” On the other hand, under the condition of a risk society where “for many people problems of ‘overweight’ take the place of hunger,” the hidden source for this techno-scientific monetization is no longer “obvious scarcity,” but invisible side effects of modernization, such as harmful chemicals and pollutants, which “escape perception and are localized in the sphere of physical and chemical formulas” (pp.20-21). These threats, detached from “any possibility of perception,” are “not only transmitted by science, but in the strict sense are scientifically constituted” (p.162). In this respect, modernization’s self-referential turn to its own side effects, or modernization risks, has formed a vicious cycle of self-intensification, which has constantly generated new side
effects no matter how many solutions have been accumulated to the known problems so far. As he said, “the insatiable demands long sought by economists” have been discovered from our inexhaustible concerns over the life-threatening side effects in the techno-scientific second nature while the material demands from the first nature, such as hunger and basic needs, seem to be sated and satisfied in the welfare-states of the West (p.23).

As the local demonstration of this risk-cultivating second nature, a smart home however shows that some of the most urgent problems hidden in our not-enough modernized ways of life are still rooted in the first nature of our biological self. In this new domestic space reflexive of its own resource consumption, our biological needs as much as the sociocultural are revealed to have never been satisfied optimally by the consumerism of the past century insofar as our self-recognition of problems entails inevitable delays and inefficiencies. Unlike Beck’s expectation, the fields of science from which the most number of invisible problems have been commodified for the new economy in the last decades would be in this sense neither chemistry nor environmental science but the studies on the too-human-inefficiencies in our biological first nature, such as behavioral economics and ergonomics (Nadler & McGuigan, 2018). Beck says that the excessive specialization of measuring method and devices in each discipline of technoscience has embedded the “shunting yards of problems” in the intensified material reality of the modernity (p.179). Algorithmatizing this web of procedures to measure a variety of hidden problems, the Internet of Things has expanded its service domains in our everyday life.

**Self-knowledge and self-symmetrification**

In the topological framework I developed in this chapter, what Dourish and Bell call “the proximate future vision” of ubiquitous computing or its “future infinitely postponed” is
reinterpretation (2011, pp.24-5). The infinite postponement between the diagnosis of our current state as full of hidden problems and the future of their complete resolution no longer debunks the promise of ubiquitous computing. This gap is, instead, what attracts the constant re-bifurcation of a more optimal future from the intensive continuum of the IoT.

If this ceaseless bringing-forth of better futures is the ultimate goal of a smart home, the human’s intentional and reflexive temporality would be the problem that needs to be symmetrified first to the IoT’s algorithmic temporality. It is because the most optimal future would mean the future ready to accommodate anything we intend to do. We can think of our quantified-self as a topological solution to this problem. As the digital shadow of one’s everyday practice, the quantified-self implies how the presence of human “bodies, minds, and daily lives” is now translated into the imperceptible perturbations of space detected by “various self-tracking tools and applications, including emotion trackers, food trackers, and pedometers” (Ruckenstein, 2017, p.402). Like other embedded problems, these human-caused perturbations display certain constants at the collective level that signifies her “wants, needs, and goals … individual diversity in areas such as sleeping, eating, drinking, or exercising” (p.411). However, occurring as nonconscious processes in the first place, these problems would remain no other than just fluctuations of a physiological continuum (namely one’s body or brain) until they appear, at best several milliseconds of missing time later, as something intentional or (un)conscious to one’s self-understanding.14 If it is true that intention is not the cause of our agency, but the consequence of lots of distributed actors in the smart home, these too-human milliseconds of delays in self-understanding would be already long enough to make an intensive continuum of

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14 For this “missing time” between nonconscious and conscious, see Hansen, 2015, p.90; Hayles, 2017.
our body—yet to be bound by our mind—felt as a crisis needed to be preempted by \textit{ontopower}. Given the inefficiency embedded in this delay of human conscious, your home should be under the control of the IoT applications to make it always and already optimal to your imminent intentions and desires. For instance, even before you find you want to go to bed, the environment should be symmetrified to the actions to come by dimming the light and warming the room. In short, the tenant needs to have a sort of open-mindedness as a new technique of self-management, which I term \textit{self-symmetrification}: to render one’s nonconscious more connectable to various smart devices, which outrun humans in managing the most optimal state of their physiology. This does not require a tenant to re-engineer her whole body and behaviors but live her life in accord with the daily protocols the IoT suggests. Sometimes, these protocols ask her to act as naturally as possible as if nothing unnatural or machinic operates in the background. Don’t talk “to Alexa in a stiff, awkward manner” but “relax when … [talk] with Alexa” so that it could learn more about your particular self. Don’t use “Alexa in a restricted and stunted way,” otherwise you would feel “reduced as a person, even robotic, when [you talk] to Alexa.” Don’t let yourself locked-in an assemblage “repeating the same interactions because of the limitations of” user data, which “constrains what the consumer, as part of the assemblage, is capable of doing and experiencing” (Hoffman & Novak, 2018, p.1179, 1187).

As Foucault already pointed out in 1979, the concept of \textit{homo economicus}, or the economic human, since B. F. Skinner’s behavioralism, has been redefined and, under the recent behavioral economics, our smart home tenant is this economic human not because she is a rational decision-maker but because of her “systemic responses to the variables of the environment” (Millner, 2019; Foucault, 2008, p.270). For the behavioral economists, human rationality is something enhanceable by modifying these variables in the environment, as
exemplified by its “nudge” policies, which redesign the environment as a “choice architecture” by redistributing conscious and nonconscious cues secretly intervening in people’s decision-making. Their “libertarian paternalism,” which Richard Thaler and Cass Sunstein declare in *Nudge: Improving Decisions about Health, Wealth, and Happiness*, suggests the new symmetry between humans and environments. In “the libertarian aspect” of their mission, humans still feel their “freedom of choice” guaranteed or even increased in the new choice architecture (Thaler & Sunstein, 2008, p.5); but, at nonconscious level, they are in fact guided by this architecture and “choice engines” (Thaler & Tucker, 2013).

Let us consider the smart home this chapter described as one of the most advanced examples of these nudge architectures. The tenant now rediscovers herself not symmetrical to her own self-understanding, but as a host of manifold vital signals traceable by smart devices’ “power of countless observations of small incidents of change—incidents that used to vanish without a trace.” However, contrary to how the tech-savvy gurus in *Wired* Magazine once willfully “delegated” the practice of “data-gathering” and “record-keeping” “to a host of simple Web apps,” the tenant’s movements in a smart home are more silently tracked by the ubiquitous sensors, which quantify “every facet of life, from sleep to mood to pain, 24/7/365” (Wolf, 2009, June). She is no longer a *director of flows*, but a *source of flows*. If the smart home’s promise for the “commitment to continual lifestyle improvement” is proportional to the number of connections that the tenant has with the devices, the only rational decision left for her is no longer to symmetrify the devices to her everyday uses, but symmetrify herself more to the new devices. It is always true in the IoT: “more (convenience, comfort, entertainment, security) is better than less” (Strengers, 2016, pp.67-8).
INTERMISSION 2: ON HUMAN RESPONSE-ABILITY

In the new smart environments, we are free from the previous responsibility of PC users, namely to rearrange all algorithmic objects in the forms symmetrical to our conscious goals. We are required instead to symmetrify our conscious or nonconscious activities to the ubiquitous computing in the background through the everyday protocols camouflaged in very mundane practices such as wearing smart clothes, watches, glasses, using smart appliances, or using smart plugs even for non-smart appliances everywhere. What I term *self-symmetrification* is in this sense a practice to transform one’s own body into a multi-nodal figure within a network, or to black-box its physiology and neurology as the indeterminate middle within multiple sensor-actuator arcs each smart application organizes in a smart home. Its effectiveness in optimizing our surroundings to our psychosomatic state and vice versa is however not relevant at all to the behavioralist reductionism, which defines a neurophysiological continuum of a body as a simple sensory-motor mechanism similar to a Skinner box. Its promise for the ever-optimizable near future is rather based on a topological feature of the continuum that bifurcates as many different sensor-actuator responses as the number of smart applications.

In the previous chapter, a smart home was discussed as the new domestic space that encloses a human tenant within its black-box. The wireless interoperability of smart objects and their constant re-assemblages were considered what enable a smart home to bifurcate each different problem space every moment to stabilize the most urgent perturbations that happen in the building’s hidden physiology and neurology. As Deleuze says about the logic of the “societies of control,” a smart home functions “like a self-deforming cast that will continuously change from one moment to the other.” The tenant, or an undifferentiated inner circuit of this
black-box, is also redefined topologically as her conscious and nonconscious responses to the ubiquitous smart objects are not fixed along a single sensorimotor arc, but under constant transformations “like a sieve whose mesh will transmute from point to point” (Deleuze, 1992, p.4).

The discourses on human responsiveness to a technical system in media studies have traditionally found its prototype in the operator of Whirlwind radar, a Cold War-era digital computer developed for the U.S. Navy. In this real-time early warning system of the 1950s, the job of a human operator in front of a CRT monitor was to make the “man-machine interaction” continue through the repeated “input-output relationship” between the operator and computers. For instance, it was a typical role of a human operator shooting “a light gun” at a small flashing dot on the monitor to identify potential enemies or “taking various push button actions” to the data that the computers put “in varying display format” (Rowell & Streich, 1964, p.539). For this military system to detect the ongoing enemy attacks in real-time for their permanent deterrence, the operator should be trained to perform each specialized task to close a gap between a monitor and switch panel through his semi-mechanized behavioral responses (p.539). In short, the operator should be a Skinner box.

In the age of the Internet of Things, this model of human-machine interaction is updated to a non-Skinnerian version as the system’s sustainable operation in current smart environments is no longer achievable simply through the deterrence of known problems, but through the preemption of the unknowns. The responsibility of a human operator is not to put their neuroplasticity in the cast of automatized input-output relations, but let it transform, like a “sieve,” into lots of different potential networks. The problematic future that we need to prevent is not a nuclear holocaust or defeat in market competition. The futures to be preempted are
involved with different kinds of problems such as ubiquitous dangers of terrorism or unsustainability of market system itself. As the proactive means to prepare for these unknown enemy networks, or to re-network the markets around unknown needs, smart objects require their human users always to preserve some extra response-ability for the new sensor-actuator arcs that they would pave for the breakthroughs of the current impasses. Until these innovative pathways emerge, our black-boxed neuronal connectivity should remain plastic.

As Catherine Malabou distinguishes, the neuronal “flexibility” as a brain’s ability “to receive a form or impression, to be able to fold oneself” was enough to train the human operator of Whirlwind through its software manuals or protocols for input-output interconnections. But our new responsibility to reassemble ubiquitous intervals between smart objects is no longer trained in a disciplinary process but performed in our living through everyday protocols, which renew our “neuroplasticity” as “the resource of giving form, the power to create, to invent or even to erase an impression, the power to style” (2008, p.12).

In his genealogy of human responsibility from the Whirlwind operators in the 1950s to the early videogamers in the 1970s, Claus Pias (2011) summarizes how the users before the PC era were integrated into the machinic rhythm of algorithms by responding to the “ping” computers sent with the “pong” as human answer. Ping is a symbolic term he derives from the same name of a software utility for network administration, which functions to send a small data packet to a particular address in the network to see if it is ready to answer, like a sonar technology to detect responsible objects in the dark of oceans. Pong, another term derived from the name of an early videogame, on the other hand, describes the condition of a gamer, responsible for exchanging a virtual tennis ball with a computer across a net and thus need to be in the right place at the right time to continue a rally. The pair of ping and pong for Pias thus
represents the necessity to close the loop between humans and computers to “prolong the playing” itself. If this reflects the meaning of sustainability in the early cybernetics whose radar network was responsible for constantly delaying the threat of total devastation translated into “symbolic death of the player and an end to all communication” after “Game Over” (p.73, 76), we can extend this genealogy further to the two other periods of algorithmic culture. First, during the PC era, the sustainability of networks for software industries meant the stable functional loops between a user’s multitasking and several software applications on a “desktop.” The stage-based videogame design in this period redefined the gamer responsibility as to develop each different strategy to the different goals from stage to stage: to continue the rally of ping and pong for each separable goal of the stages. Second, in the UC era, the sustainability now means the system’s capability to preserve enough sensor-actuator correlations within its network, which can be mobilized for their timely repurposing into the solutions to the ubiquitous problems not yet specified.

The following chapter examines the recent videogame design called “open-world” as an illustration of the changed gamer responsibility corresponding to the UC era. Enmeshed by a network of algorithmic objects in a virtual reality, the neuroplasticity of the open-world gamers are responsible for drawing multiple lines of correlations among the objects to individuate lots of hidden stories, events, puzzles, and other encounters embedded in a playable world.
CHAPTER 3: TARGETING AS TRIGGER FOR THE ACTOR-NETWORK IN THE OPEN-WORLD VIDEOGAMES

Targeting and Videogame Objects

To aim a crosshair at an object, or to target it, is the most rudimentary skill you have to master in many videogames. From a first-person shooter gamer (FPS) caught in a killer instinct for shooting every enemy to a third-person role-playing gamer (RPG) obsessive about searching hidden clues to continue a quest, targeting is the first step to map a gamer’s chance encounters with objects. There are lots of targetable objects such as non-playable characters (NPC), humans, animals, plants, and items. Each of them has a different degree of concreteness according to its way of becoming in a virtual reality—whether assigned to certain locations when a map is generated, like the bosses and treasure chests in The Elder Scrolls V: Skyrim (Bethesda, 2011), or randomly generated in certain areas as a player character steps in, like the citizen NPCs in Grand Theft Auto V (Rockstar North, 2013), or produced by a player such as healing potions made of other ingredients. Even for an object existing from the very beginning with concrete properties defining its existence (such as the coordinate of a position and predefined behavior patterns to environments), it is only through targeting that this object is dragged out from its initial isolation and begins to interact with others and eventually reoccurs as an event a gamer experiences as a part of a story or play. In other words, targeting realizes an object’s operational values by drawing its interactions with others, whose collective interoperations would progressively unfold certain stories, challenges, and quests hidden in a videogame’s virtual reality. In a recent philosophy of videogame design called open-world, the number of targetable objects and their
different responses to a gamer’s targeting are determinant for the number of possible events that the gamer’s interactions could unfold from a videogame.

Targeting is in this sense a supplementary action to fill the gaps between the pure signifiers called objects. Under the conditioning of a game engine’s object-oriented programming, these objects are generated in an open-world as individual paradigmatic elements belonging to each different class of objects with different properties and responses to the environments. On the other hand, as the only un-programmed source of uncertainty in this open-world, a gamer’s targeting functions to create actual syntactic interconnections between objects and converts them into the events happening. However, neither being a parolē to anchor a signifying chain at an instance of storytelling, nor an intentional noetic activity, targeting in videogames often happens during a gamer’s meaningless wandering over objects as well. For these algorithmic beings, a gamer’s ludic wandering—that Aarseth calls a gamer’s “extranoematic responsibilities” comparable to a reader’s “eye movement and the periodic or arbitrary turning of pages” (1997, pp.1-2)—is indistinguishable from his/her noetic-narrative acts, the targeting intentionally performed to make a story unfold. No matter what a gamer intends, his/her behaviors are, beyond a user-friendly videogame interface, fed-back as undifferentiated motor inputs for the objects to initiate their interoperations. These motor inputs are classifiable as either noetic narrative action or ludic wandering only secondarily as the responses of objects are either serialized as an algorithmic simulation of a story-arc or intermittent as mere chance encounters. In this sense, the recent design decision for the more playable values or replayability in videogames—by making a story unfold in many different paths to multiple endings, hiding more sub-plots, or making even simple encounters enjoyable—can be re-analyzed at the algorithmic level. Designing an open-world in a videogame involves an engineering question on how to make algorithmic objects
more communicable so that their interoperations could evolve into creative assemblages for multiple story arcs or more playable values even from a gamer’s “emergent strategies” that are “neither anticipated by the game designer, nor … easily derivable from the rules of a game” (Juul, 2002).

This figure-ground switch in videogame design foregrounds a symmetric engagement between gamers and objects, which the ludologist/narratologist debates of the early videogame studies have concealed in their obsession at the authentic cultural value of gaming blind to the algorithmic values generated on the flip side of the interface. As much as targeting is a gamer action with a strategic value over objects, the machine also induces and mobilizes this gamer action for drawing motor inputs to instantiate its technical agents, objects, into specific operational units. For instance, the audio-visual cues objects radiate and the auto-targeting that makes the crosshair automatically attracted to objects are not only to help gamers reassemble objects into certain discursive or playable orders, but for these objects to target back to the gamers’ attentions to extract the resources for their individuation. As another example of this figure-ground switch, we can examine the recent studies on gamer behaviors in massive multiplayer online role-playing games (MMORPG) (Kafai, 2010; Lee et al., 2011; Chan et al., 2009). On the other side of these studies’ attempts to analyze log-files as algorithmic inscriptions of so-called ludic or narrative gamer behaviors, we can rediscover lots of cryptic network figures assembled from the interactions of objects, which are generated from, used for, killed by, thrown towards, transacted with, transformed into, and operated upon others, all triggered by a gamer action, targeting. Contrary to Aarseth’s definition of narratives’ “hypertext epiphany” from a videogame space, which he supposes to be all rooted in “a planned construct rather than an

\[\text{15 For this debate and its focus on theorizing the purity of videogames as cultural forms, see Keogh, 2014.}\]
unplanned contingency” (1997, p.91), these objects in the open-world are planned to be flexible enough to create certain functional networks even from the unplanned contingency of gamer actions. For all those objects to be relocated in a world played, gamers’ prolonged hours of aporia are necessary as their “disoriented movements … looking for fresh links in a hypertext labyrinth” (pp.78-9).

As a recent trend in nonlinear game design, an open-world that MMORPG exemplifies best is characterized by its lack of invisible walls, which used to restrict the number of objects interactive with a player for each stage in the game’s overall story-arc. Commonly used in a linear level design, these walls were given to objects (including the gamer’s avatar) as redundant rules from above to prevent certain interactions from happening, especially those which would be controvertible to the story, such as an avatar’s leaving for a quest even before a princess is kidnapped. On the other hand, designing an open-world without this sort of transcendent rules means that the “task of defining and ordering the [collectives] should be left to the actors themselves” (Latour, 2005, p.23). In other words, an ideal open-world is potentially open to any controversial interoperations of objects insofar as a space their networking unfolds is still playable, no matter how short-lived its story-arc is or how distracted with too many interruptible events to close an arc.

In this sense, the recent narrative games simulate an actor-network through their open-world design in more than a metaphorical sense. Not just as a method in science and technology studies, but as an ontological concern for the “world-making activities” of objects under research, actor-network theory and its nonhuman turn ask researchers “to define the social not as a special domain, a specific realm, or a particular sort of thing” such as “invisible and unaccountable social forces.” The social in ANT is instead defined from “a very peculiar movement of re-
association and reassembling” traceable only through “following the work done to stabilize the controversies” by objects themselves (Latour, 2005, p.57, 7, 53). In the open-world design in videogames and its emphasis on objects’ autonomy, the “notion of social force” is also dissolved and replaced “either by short-lived interactions [as mere chance encounters] or by new associations [extended as multiple story-arcs]” (p.66). The social appears twofold in this videogame genre. First, the rules for interactions, once given as redundant “invisible walls,” are now emerging from the interoperations of objects whose uneven distribution on a game-board is enough to influences on the probabilities for their encounters to happen in certain orders. Second, gamers’ ludic or narrative interest in objects, which the log-file analysts assume as a sort of invisible force outside to put objects in certain network figures, now turns out conversely to be retraceable along “the summing up of interactions” between objects (Latour, 1999, pp.17-8), whereas a gamer’s avatar is no more than just another object whose irregularity in targeting initiates the others’ interoperations. From the actor-network perspective, the macro state of object networks is thus neither narrative nor ludic a priori, nor algorithmic translation of cultural prototypes outside, but ceaselessly engineered as the summing-up of many micro encounters. As McKenzie Wark says in Gamer Theory, “The moral code of the storyline” is in this sense “just an alibi for the computer code of the game,” not vice versa (2007, par.148). At the same time, gamers’ ludic or narrative interest, supposed to over-code the progress of an object network into either a story-arc or game-board, becomes an alibi hiding the objects’ interest in the resources for their own becoming from the motor inputs that a gamer’s avatar exerts within the network.

The actor-network analysis of videogames, one possible model of which this chapter suggests, thus re-operationalizes narrative and play: two human forces in the social, once discussed as if their representational structures or rules of game have already been transplanted
in a videogame space, either to assign certain roles to objects, or to define their possible moves on a game-board. These two cultural forms are however now re-emerging only as the summing-up of what objects have done to stabilize the uncertainties an avatar arouses in an open-world. If Wark is correct in saying that “The gamer is the new model of the self” that becomes “a function of an algorithm” (2007, par.148), the actor-network analysis could show how this functional self is also summed-up from what one’s avatar does: targeting, an operational form of voluntary or involuntary attention to the objects in the open-world.

For modeling an actor-network as an alternative framework for videogame studies, this chapter examines first how the algorithmic paradigm called object-oriented programming (OOP) simulate various cultural goals and interests from its end-users through the networks of its algorithmic objects. It then investigates actual gaming objects in the videogame genres that I call object-oriented puzzles and recent open-world videogames, and traces how the objects in these games reassemble gaming subjects and their cultural experiences of gaming.

**OOP: Object-Oriented Programming/Puzzle**

In 1970s, Alan Kay, the creator of an early OOP language Smalltalk, anticipated the nonhuman turn that his “object-oriented design” of programing would bring about, as he “had a very McLuhanish feeling about media and environments: that once we’ve shaped tools … they turn around and ‘reshape us’” (Kay, 1993, p.30). Since their appearance in the mid-20th century, high-level computer languages have functioned to install a user-friendly linguistic layer upon “the computational real,” bits or mere differences of voltage fluctuating on system boards, and translate these ephemeral signals in circuit boards into human-understandable data-structures and their functional relations (Joque, 2016, pp.351-2; Yoran, 2018). Before OOP, the high-level
language was “constructed as a sequential set of commands that followed one after the other” (Joque, 2016, p.341) and consequentially abstracted the artificial intelligence(s) of the time into a sort of mathematical mind ruling over the machine codes at lower levels, reminiscent of professional programmers with exclusive accesses to the mainframes in big institutes at the time. On the other hand, developed not only for experts but various end-users of the PC era including even children, *Smalltalk* for Kay was to map the same computational real on motherboards of personal computers with collectives of autonomous agents called *objects* “all hooked together by a very fast network” communicating *small talks* to each other (Kay, 1993, p.3).

In Kay’s personal historiography, the emerging object-oriented philosophy was foretold by the shift in his academic interests, which he describes as the shift from his undergraduate math major “centered on abstract algebras with their few operations generally applying to many structures” to biology minor “with its notions of … one kind of building block able to differentiate into all needed building blocks” (pp.5-6). This analogy between OOP’s appearance in the 1970s and that of cell-biology suggests the changed approach of the algorithmic culture to re-territorialize the digital signals about to infiltrate into every cultural sector of the Western world. During this incipient stage of the PC era, the domestication of binary signals in offices and houses was not achieved at once by marketing computers as *desktop* technologies, but requires a transitional period of negotiation for the unspecified end-user purposes in the grassroots to come to the fore as the problems to be remapped upon its new linguistic layer. Meanwhile, the algorithmic solution of OOP to translate cultural practices on human sides into a plane of binary matrix on machinic sides was modeled after “the notions of 20th century physics and biology,” which re-territorialized the natural with “the recursive composition of a single kind of behavioral building block” (p.3). The “algebraic patterns” functioning to over-code bits into
mathematical variables in a linear programing were replaced by multitude algorithmic agents, which transmit these binary signals into each different object with its own data structure and functional operations, not necessarily over-coded by a supplementary dimension over and above. The networks of objects loosely-assembled along these bits-messages on a system-board began to be considered as a solution for any general tasks through their multiple and “inexhaustible” ways of re-assemblage (Yoran, 2018, pp.130-132).

The benefit of this paradigm shift for Kay was not only its efficient compiling but its intuitive way to map the real-world problems with monad-like objects that hide “[their] combination of state and process inside and can be dealt with only through the exchange of messages” (p.3). As much as these black-boxed objects were what programmers needed to adapt in the changed condition of the algorithmic culture, a variety of end-users and their peculiar purposes also appeared to be the complex real-world problems that OOP needed to remap within its object networks. As observed from children’s playful use of Smalltalk to model “amusement parks, like Disneyland, their schools, the stores they and their parents shopped in” (p.23), something ludic and narrative was what this educational computer language redisposed first upon its network topology in order to enroll these future programmers to its object-oriented philosophy. Many purposeless coding exercises such as the famous “Hello world!” example in programming textbooks still show that what a novice programmer has to learn first even today is to assemble these algorithmic objects into a hypertext architecture for a sort of interactive storytelling. The McLuhanish feeling which Kay once had about his own creature becomes more ordinary in the “human-computer symbiosis” (p.7) of the PC era and it reflects the necessity of translating cultural experiences of programming, its playful small talks, into something able to be mapped upon a network of objects. To rephrase in actor-network terms, the objects in OOP
exemplify what ANT calls *immutable mobiles*: the protocols to relocate the peculiarity of a matter under research into a common abstract space. As immutable data structures, which can be incarnated into many different instances, the objects are capable of transposing peculiar end-user purposes on one side to a network topology being drawn by their interoperations on another side. It is however not so much when these objects are defined as stable building blocks but when they are assembled into as many different figures as an indefinite number of user purposes that they eventually begin to translate local interests of their allies, users, into the problems only resolvable through the networks that OOP affords against the obsolete procedural programing (Callon, 1986).

In Kay’s retrospection, the early “interactive computer graphic” applications such as Ivan Sutherland’s *Sketchpad* (1963) were the first to concretize this object-oriented philosophy as the graphic designer’s means to instantiate different geometric figures from the same topological object abstractly defined. (Kay, 1993, p.7). As another instance of graphical objects responsible to capture the generality of end-user purposes, we can examine videogames and their role in popularizing OOP as an ontological and aesthetic style of problem-solving in algorithmic cultures, which has integrated more and more cultural activities and their singularities into the networks of general-purpose objects. For the previous two decades, the digital’s remediation of culture has provided an alibi for the digital’s penetration into private spheres along the domestic assemblages of circuit boards embedded in ubiquitous computing devices. On the other hand, the user-friendliness of videogame interfaces for the same time has provided the end-users, gamers, with an effective but nonprofessional means to domesticate these ephemeral and intangible

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16 For Immutable Mobile, see Bruno Latour, 1990, pp.44-5; for a topological space of actor networks, see John Law, 2002.
materialities in digital infrastructures into the agents objectified or personified (Johnson, 1997, Ch.6). These objects have not only served for fulfilling gamers’ cultural interests but mobilizing their actions oscillating between ludic *aporia* and narrative *epiphany*.

![The Incredible Machine](image)

**Figure 3.1: The Incredible Machine**

The Incredible Machine

Kevin Ryan’s creative puzzle game *The Incredible Machine* (1993) shows how a simple object-oriented game design realizes the general purposeness of personal computers. The goal of this puzzle is to make a literal *machinic assemblage*\(^\text{17}\) performing a simple task (such as “pop all the balloons,” “drop the cage onto Mort the Mouse”) using everyday objects available in each stage. For this goal, a gamer needs to drag and drop each object in the inventory on the right to a

\(^\text{17}\) DeLanda defines *machinic assemblages* by their components aggregated through “relations of exteriority,” which can be flexibly “detached from it and plugged into a different assemblage.” *The Incredible Machine* literalizes this theoretical entity with the autonomous objects coupled to each other for a common goal (2006, p.10).
niche position within a main frame, in which simple operations of the redisposed objects would miraculously fill the missing links of *the incredible machine* (Figure 3.1).

Each stage begins with a number of objects distributed on the frame and most of them have specific interactions with or reactions to others. For instance, a bulb lighting on a lens burns the fuse of a dynamite; a ball hitting one end of a seesaw triggers a gun roped to another end; a motor connected to a conveyor belt catapults a baseball on it. Simple rules govern the machine’s operation: when a gamer clicks “START MACHINE” on right-top, the objects responsive to environmental parameters (gravity and air pressure) such as balls and balloons move first. If they collide with others, their direction and speed change according to the game’s physics engine and the collided object also implements its operation if the condition is met (for instance, when a ball falls on a switch, the flashlight is on). When there is no more extendable operation, the machine stops. To make the machine keep operating until the assigned task is done, a gamer therefore has to redeploy each object in a way in which it would, after the machine’s execution, gradually evolve into a niche in a machinic assemblage that successfully fulfills a given task. The role of the gamer as an engineer of this incredible machine is thus to re-adjust the initial state of objects’ reciprocal orientations to the condition that Simondon calls *metastability*, “the initial absence of interactive communication between them, [but] followed by a subsequent communication between orders of magnitude and stabilization” (1992, p.304). For Simondon, “individuation” of technical objects from their abstract to concrete states involves not so much some invisible forces outside, but a sort of selective pressure that works across their uneven distribution in each solipsistic state. Metastable objects “have no effect on the other elements” at first, but gradually interoperate one another in “a multitude of reciprocal causalities” (1980, pp.13-4; Yoran, 2018). This ostensible stability of an assemblage, or its metastability, which hides its potentials to
progress into another level of stability through its further individuations, also expresses the state of what Latour calls *plasma*, entities “not yet socialized, not yet engaged in metrological chains,” but charged with potentials for an indefinite number of actor-networks to come as novel connections are made among them (Latour, 2005, p.244). The *Incredible* character of the *Machine* in this puzzle game is this metastability that keeps its loosely-assembled components, objects, always potent to evolve further into different networks with functional stability.

In popular OOP languages such as C++ and JAVA, the autonomy of objects is symbolized by their boundaries “{ }” defined separately from those in the “main{}” function in a source code. Whereas the “main{}” provides a platform for “objects{}” to be assigned as operational units for the goals defined at a system level, each object{}’s peculiar operation and its recursive combination with other objects during compiling replace the cumbersome sequential commands in procedural programing. Enfolding the definitions of its own constituents and their data structures as well as its possible operations upon other entities, an object envelopes its own “tiny ontology” stating its selective exposures and preferred responses to environments (Bogost, 2012, p.21). In *The Incredible Machine*, the main frame for the machine to be assembled provides a user-friendly interface substituting for the “main{}” function in OOP as it serves the platform for the objects to be assigned and instantiated from the inventory on the right, in which objects available for each stage are defined in a decontextualized state just as abstract classes of objects in OOP has to be first defined outside of main{}function. For the object-oriented programmers and puzzle gamers, to design an algorithmic system or a machinic assemblage is therefore to allocate these objects into certain metastable states, from which they would be, in every single execution or “START MACHINE,” instantiated into niche parts of a logical or mechanical circuit operating in changeable environments. The variability of the environments,
which are databases or human inputs, could condition one or some objects into different initial states and thus subsequently induces the whole system to be individuated in completely different ways.

![Figure 3.2: The basketball in a metastable state (modified by author)](image)

**Figure 3.2:** The basketball in a metastable state (modified by author)

In this puzzle, the metastability in which objects are trapped is expressed in an unexpected aesthetic form when the machine malfunctions. It becomes visible, for instance, when an object is stuck between two others as shown in the case of a basketball in Figure 3.2, unable to be bound out from one end of a seesaw because of being blocked by a pipe. If the physics engine imitate the physical laws exactly, the ball fallen in between should be gradually relocated in a stable state after several oscillations. However, in the game, even if the momentum of the ball is the minimum detectable by the engine, it still maintains that minimum even after collisions and thus keeps oscillating between the obstacles until the game stops the machine forcibly. The physics engine is, to put it differently, biased towards keeping objects metastable and always containing at least the minimum potential for further interactions rather than stabilizing them into non-operational stasis. As the expression of an object’s resistance to the exhaustion of its operational values, this tiny agitation is fed-back to the gamer as a signal
referring to the necessity of the ball’s relocation into another niche in a next trial for its further individuations.

Alongside a campaign mode in which a gamer plays each stage with each pre-defined goal and set of available objects, *The Incredible Machine* also provides an extra stage called the “FREEFORM MODE” where a gamer can use and manipulate all objects and environmental parameters without having any specified goal. In this mode, the metastable vibrations of objects exemplified by the basketball are potentially mobilizable for the machine’s individuation into an indefinite number of playful tasks and purposeless performances. Whether the machine is working for an arbitrary goal set by a gamer or just for experimenting unexplored momenta hidden in everyday objects the game simulates, the experimental function of this mode considers the assemblage in the making as a general translation machine able to capture any particular goal-oriented gamer intentions and even purposelessness into its object-oriented network. The general-purposeness of the network is preserved as the game’s physics engine preserves the minimum momenta in objects for a variety of their possible interoperations even in the objects currently employed for a specific mechanical task. On the other side of this claimed flexibility of the incredible machine, the gamer may have “a very McLuhanish feeling” as a her freedom in playing with a machine is reshaped as a number of networking strategies she could take in targeting the machine’s components.

Before “START MACHINE,” the assemblage in the game exists as mere “*summing up* of interactions” of the objects distributed over the space with each environment-sensitive momentum. (Latour, 1999, pp.17-8). After “START MACHINE,” however, these objects begin to couple with each other according to their autonomous responses to given environmental parameters and their assemblage re-appears as a network for a specific goal. As Bogost says
about the paradigm shift in the algorithmic cultures to OOP, *The Incredible Machine* in this sense simulates “a new kind of system: the spontaneous and complex result of multitudes rather than singular and absolute holisms” (2006, p.4). The longevity and sustainability of this system depend on whether the programmed metastability would remain intact even in the changeable environments. Insofar as the changeable in the game’s environments refers only to human inputs and uncertainties caused by gamer activities, the miracle of machinic assemblages this game symbolizes is about the incredible transformability of an object network, sustainable even in unpredictable environments of the human-caused.

**The Perpetual Motion Machines in *Portal***

In *The Incredible Machine*, the gamer’s targeting intervenes only in the initial states of objects before the physics engine implements their attractive and repulsive forces. On the other hand, today’s 3D puzzle-platform games such as *Portal* series put a gamer’s avatar on the same platforms in which other game objects are distributed in metastable states. On these immanent game-boards with no transcendent intelligence designing a puzzle playing from above, a gamer’s targeting and consequent interoperations of metastable objects are triggered by another object relatively unstable, namely an *avatar*. Being the only object capable of generating truly random behaviors, an avatar introduces *an unplanned contingency* to the object-oriented labyrinthine of the game in which a path to the exit is individuated only as certain interoperations between objects are triggered by this contingency. For instance, an exit in *Portal* (Valve Corporation, 2007) will appear when a cube is transported to a distanced platform and placed upon a button on it. But, for the cube and button to be interoperable, the avatar should fire the *portal gun* to create two portals to transport the cube from here to there. In a typical single-player campaign where
most tiles on the walls and floors are connectable through the portals, the avatar has to shoot the tiles to unfold a path to the exit out of the surfaces of distributed objects in order to escape from this laboratory-labyrinth created by a mad scientist in the game’s story.

**Figure 3.3:** A perpetual motion machine in *Portal II* (DoctorMelon, 2011, June 26)

Despite their being narrative-based, shooting in the *Portal* series is often performed regardless of the goal and story of each stage. As many user-performed *Portal* experiments on YouTube show, for the gamers whose primary concern is to create their own labyrinths using the “Puzzle Creator” mode, a FREEFORM MODE in *Portal II* (Valve Corporation, 2011), rather than to solve puzzles, the avatar’s playful wandering in labyrinths is not a painful experience of deferred “desire for [narrative] closure,” which Aaserth means by the term *aporia* (1997, p.92). Shooting the tiles in these experiments is conversely a desired purposelessness to examine more ways of tunneling between objects and twisting their spatial relations to unfold a greater number of transformable labyrinths hidden in the assemblages. In *Portal*, one interesting experiment in this purposeless tunneling happens when an object falls into a portal on a floor that is tunneled to another portal on the ceiling directly above. Since the physics engine conserves the momentum
of an object when it passes through portals, this object perpetually falling between portals is gradually accelerated by gravitational force until it reaches the maximum velocity available and eventually meta-stabilized into a sort of perpetual motion machine (Figure 3.3). Contrary to the tiny vibration of the basketball in The Incredible Machine, this freefalling entrapped between portals shows another instance of an object’s metastable fluctuation that gradually accumulates its momentum to the maximum in this case.

Even though this sort of perpetual machines is often exhibited on YouTube as purely experimental as it violates physical laws (DoctorMelon, 2012, June 26) or purely aesthetic as visualizes an unimaginable dimension (Arctic Avenger, 2011, April 27), building up an object’s momentum within this loop also has a significant strategic value in the game’s campaign mode as it allows a gamer to reorient this object, a cube or avatar itself, to a farther platform not reachable in an ordinary way (Valve Corporation, 2007, in-game developer commentary, #12, 48). For instance, while a cube in Figure 9 falls between two portals on the floor and ceiling, the avatar could fire the portal gun and make a new portal on a distanced wall; then the cube fallen into the portal on the floor would come out from the new one with the maximum momentum conserved through the portals. In this way, a metastable object in perpetual motion within a closed-circuit necessitates the gamer’s intervention, targeting, as the trigger for its reorientation from the abstract freefalling to the actions for the gamer’s goal, escaping the labyrinth. While the gamer plans this escape scenario, a network topology being drawn by objects under interoperations eventually appears as a diagram for an emerging artificial intelligence. This abstract diagram decomposes “problems in terms of autonomous agents that can engage in flexible, high-level interactions” (Jennings, 2000, p.283); flexible enough to map not only the gamer’s creative goal-oriented behaviors but their purposeless creativities as it can be.
transformed into an indefinite number of labyrinth structures responding to both planned and unplanned contingencies from a human gamer.

Programming the Open-Worlds Metastable

In the previous section on the puzzle gaming, targeting was discussed as a human-caused trigger for a network solution of objects to a given task of each stage. On the other hand, the open-world setting in today’s narrative games usually contain these object-oriented puzzles as the parts of storytelling. From the first Legend of Zelda to the most recent Legend of Zelda: Breath of the Wild, puzzles in this RPG franchise have functioned to embed certain temporal orders in a game space’s becoming a world explored by the player character, Link. In the first Zelda (Nintendo, 1986) where Link has to explore the eight dungeons in the world for searching the eight pieces of an ancient relic called Triforce of Wisdom supposedly to lead him to Death Mountain where Princess Zelda is kidnapped, the number of ways for this simple rescue narrative to unfold through his dungeon networking is restricted by the existence of specific objects, whose operations can be triggered only after Link follows certain orders, such as the gate of the seventh dungeon appearing only in response to the melody of Recorder acquirable in the fifth dungeon. In this early open-world RPG game, the linearity of the story oriented to a fixed ending, the rescue, can be stretched and bent in an indefinite number of ways according not only to the paths that Link draws among eight dungeons, from the most straight to the most convoluted, but also to his unexpected encounters with monsters which interrupt his labor for networking. At the same time, on this immanent game-board with no outside rule except interoperations between objects, these object-oriented puzzles—given to gamers as an explicit or implicit instruction saying “operate an object upon another to make an event happen”—function
to impose certain invariant structures on the narrative-arcs unfolded from the assemblages of objects. Some significant inflection points of the arcs, such as “the sixth dungeon ought to be opened after the fifth dungeon,” should be kept intact by these puzzle elements for the integrity of the story despite its flexibility to bend and stretch freely. The classes of interoperable objects defined by the game engine and their uneven distribution on the world map are thus determinant of the types and probabilities of the events capable of being triggered by the gamer’s goal oriented or purposeless motor inputs during the gaming.

The spaces in these games are, as Galloway says, individuated both by the machinic agents and the contingency of human operators, which “work together in a cybernetic relationship to effect the various actions of the videogame in its entirety.” He classifies “gamic actions” thus along the axis of machine agent—human operator, which is intersected by another axis of diegetic action—nondiegetic actions as Figure 3.4 describes (2006, p.5).

![Figure 3.4: Galloway’s classification of gamic actions (2006, p.37)](image)

It is notable that, even if a player character’s encounters with objects in an open-world are the things to be logged as parts of a story, their probabilities and consequences are often conditioned by certain actions performed outside the story, such as turning on auto-targeting, changing difficulty in the setup, and calibrating certain environmental parameters in physics...
engines. These actions, defined as nondiegetic-operator actions in Galloway’s diagram, intervene in the cybernetic unfolding of a story by conditioning the probable transformations of object networks by changing not just the number of interoperable objects such as enemies, but the patterns of their behaviors to environments. For instance, if you select “difficult” in the setup, an enemy’s momentum preserved in its metastable patrolling would be re-oriented to the search for the player character when it discovers certain environmental objects, shrubs, wavering by something behind. But if you select “easy,” it would not respond to any environmental signals and kept in passivity. In this sense, the shape of a narrative arc unfolded from the ubiquitous objects in an open-world is restricted by the asymmetries implicit in the two axes of Galloway’s classification. First, the initial metastability of objects in machine actions requires the instability from the actions of a human operator to release their accumulated momenta for unfolding certain events. Second, as the local occurrences of chance encounters, these diegetic events between a player character and objects are under the probabilistic control of non-diegetic actions from the game engine that governs all the chances of possible events on a game-board.

Figure 3.5: Gamic actions in open-worlds

In open-world games, targeting as an operator action over machinic objects can be thus re-diagramed as the gamer behavior conditioned by a game-board as a network of algorithmic
objects. The object called *avatar* is in a state of permanent oscillation between goal-oriented and purposeless actions as it is conditioned doubly by nearby objects and the game engine. On one hand, in-game nearby objects mobilize the gamer’s targeting, which would trigger their individuations into *epiphanic* local events. On the other, the game engine keeps an open-world in more *aporias*, open to lots of unexpected chance encounters with random objects that would delay the revelations of the solutions to local puzzles and quests. In this new diagram (Figure 3.5), the diegetic end of the vertical axis shows how the gamer’s targeting tends to relocate objects to each niche position that would make their network a spatial revelation of a narrative arc. For instance, in the typical treasure hunting quest in *The Elder Scrolls V*, the item acquired from a boss battle always accompanies a new marker on the map for the location of another object, a NPC or depository, to which the item originally belongs according to the story of the quest. The topology of markers on the map thus translates the trajectories the player character has to follow to complete the story of the current quest. On the other hand, the nondiegetic direction of the same axis alludes that the gamer’s narrative-oriented actions can be delayed by purposeless but still playful chance encounters with other objects under the probabilistic control of a global agent, game engine. The player character’s way to the depository can be, in this case, deferred by unexpected encounters with enemies and other quests. According to this diagram for the open-world gaming, the narrative and ludic characters of a game space are corresponding to the local and global features of a same network. An object at each node of the network is, being touched by an avatar, instantiated into something happened in a quest told by the gamer’s diegetic-operator actions (just as the momentum maximized by the perpetual motion in *Portal* should be reoriented through the avatar’s shooting). At the level of a whole network, the game engine conversely keeps the inexhaustible minimum of momenta between its nodes (that the tiny
vibrations of an object within *The Incredible Machine* symbolize) for their further individuation into different quests, not only for the more degree of freedom to the gamer but more ways of the networks’ topological transformations. On this axis, an object’s metastability, or its hesitance between becoming an actor for a specific task and remaining undefined to be multipurpose, is expressed by its oscillation between the local affordance for *epiphany* and global conditioning of *aporia*.

In recent open-world games, this metastability within the diegetic-nondigetic axis of the network is noticeable in forms of colorful auras surrounding objects, visible through the special skill an avatar activates. In *Witcher 3: Wild Hunt* (CD Projekt RED, 2015), Geralt, the player character, uses his “Witcher Sense” to switch from a stable geometric field of view (FOV) in his normal state to a distorted superhuman perspective detecting the momenta hidden in environments through the auras effused out of objects. In *Batman: Arkham Knight* (Rocksteady, 2015), Batman wears an in-game HUD device, “Detective Vision,” to make the movements of networkable objects stand out through the technologically augmented auras (Figure 12). As the actions in the middle of the diegetic and nondiegetic, or the nondiegetic disguising as diegetic (*Jørgensen*, 2012), using these skills or gadgets is what the games’ tutorial instructs first to the gamers as a way to access an abstract space of metastable objects; which adumbrate the nodes of a network that the avatar needs to mobilize as a solution for the given object-oriented puzzle or quest. Driving out all the less interactive objects to the peripheries of attention, this space extracts small ties from objects visualizing the momenta for their further interactions, which anticipate the narrative arcs or object-oriented puzzles capable of being unfolded from a space. Even though some objects could move by themselves like enemies patrolling designated areas in *Batman: Arkham Knight*, these metastable objects rarely communicate each other but walk
around in each closed circuit unless they step out to track the actions taken by their arch enemy, Batman. Put differently, without the player character’s intervention, their routine movements are left in a mere aesthetic metastability which Galloway calls “ambience act.” Even if these “Things continue to change” in their metastable routines, “nothing changes that is of any importance” (2006, p.10). These games’ aestheticization of ambient movements of isolated objects, however, implies something much more than just a pacific look of their seeming stasis as it also brings about a thrilling feeling for the emerging actor-networks. Magnified under the higher resolution of Detective Vision, objects appear to be full of “charged expectation” (p.11) about its possible future interoperations, which could cause catastrophic chain-reactions among the objects across an open-world as the avatar’s targeting transmits uncertainties. In this sense, Galloway’s statement about the ambience act as that in which “No significant stimulus from the game environment will disturb the player character” (p.10) could be rephrased. The lack of significant stimulus from the game environment will really disturb the player as long as this anxious metastability of an open-world makes it intolerable for him/her not to hit or shoot the objects.

![Figure 3.6: Witcher Sense (CD Projekt RED, 2015) and Detective Vision (Rocksteady, 2015)](image)

Encountering these abstract spaces, the player-character no longer occupies a center of perspective as a simulated Cartesian subject. Like Detective Vision activated at the edge of the
screen, or Witcher Sense causing distortions in a geometric space (Figure 3.6), the avatar’s transcendental position in the normal field of view is retreating to the oblique glance from peripheries as an animistic world of metastable objects emerges. In this moment of a perspectival withdrawal that suspends a geometric grid’s overcoding of objects, the gaps between objects’ tenuous membranes are filled again with their minute ambience acts, which preserve inexhaustible potentials for each thing’s own object-orientation for heterogeneous network making. Insofar as some of their networks are supposed to reveal certain narrative arcs for quests, solutions for object-oriented puzzles, or hidden trophies and achievements, the gamer is responsible to target an object as soon as possible to break the ambience with the epiphanies of those individuations. At the same time, the gamer should also be careful not to shoot every target too quickly lest the network becomes too stabilized to the extent of having no more metastable objects for the further transformations to reveal other quests, puzzles, trophies and achievements.

These conflicting responsibilities that a gamer feels encountering the ambience of an open-world can be expressed most clearly in two extreme strategies of gamer action, namely Speedrun and Seeker Achievement. As a way to traverse a space along the simplest labyrinth structure with one shortest path from an entrance to an exit, Speedrun lets no single moment of ambience act happen. For instance, you may attempt to draw the fastest and most straight route to rescue Princess Zelda in The Legend of Zelda: Breath of the Wild (Nintendo EPD, 2017). On the other hand, individuating the same space into a labyrinth with lots of secret caves to the extent that all possible links and operations between objects are experimented, Seeker Achievement does not let any single object remain isolated in its initial metastability. You may in this case discover every area on the world map, explore every dungeon, open every chest, cook
every recipe, tame every wild horse, take pictures of every creature, and do every possible thing in the game before rescue Princess Zelda.

Given the extreme difficulty in achieving a new world record in *Speedrun* and extremely long play hours required for *Seeker Achievement*, these two gamer strategies seem located in the two extreme ends in our diagram as the two least probable worlds the linkages of distributed objects can unfold. At one pole, the most concise diegetic world is unfolded while, at another, the same network is ceaselessly complicated until all interoperable objects are convoluted with the gamer’s itinerary. Given the extremely low probabilities for a gamer’s chance encounters to occur in specific orders for these boundary cases, most diegetic-operator actions in videogames might be expected to happen along the path in the middle of these two. However, many posts in the online gaming forums about gamers’ challenges for these almost impossible goals show the opposite (Speedrun.com). As the two poles defining the limits of a network’s topological transformations, *Speedrun* and *Seeker Achievement* attract the gamer action, targeting, towards two extreme subjectivities imaginable within the networked societies of algorithmic objects.

Going back to the studies on gamer behaviors mentioned in the beginning of this chapter, what we now rediscover in the flipside of the *cryptic networks* of objects in the log-files is these afterimage of gaming subjects, stretched between the most linear story teller drawing the shortest escape plan on the one hand, and the nonlinear and ludic dungeon dweller complicating the networks over and over again on the other. Their ludic and narrative interests do not exist outside as invisible social forces to bind the objects into these network figures. Instead, their subjectivities are unfolded from their engagements with objects through targeting.
Targeting in Object-(Re-)Oriented Realities

By giving their own object-orientations to the algorithmic objects, the open-world videogames transform their game-boards into a sort of animistic planes for these nonhuman actors to stretch out their metastable ties for communications. As shown when it happens through the Witcher Sense and Detective Vision, targeting is a gamer’s means to connect to the solipsistic autonomy of these reanimated objects by tuning the avatar’s magically or technologically augmented sense to the tiny agitations of the objects. In a sense that it also extracts an object “from the spatiotemporal coordinates” of the normal field of view and exaggerates as “an autonomous entity” larger than before (Doane, 2003, p.90), we can compare targeting with another technological perception well-studied in the past decades of media studies, the close-up.

As a moment in which an object’s “perfect, seamless face, the unwavering stare” is revealed to audiences, the close-up has been discussed in the framework of narrative cinema as what exemplifies the metastability of a thing temporarily isolated from a diegetic network. Its solipsistic autonomy has been thought of as what makes audiences “impossible not to project thought, emotion” by connecting it to an imaginary signifying chain over other filmic objects “although the face itself gives no indication of either” (pp.104-5). For cultural critics with their exclusive autonomy from the objects under perception and research, a close-up’s oscillation between isolation from and subjection to the chain of signification has been somewhat non understandable without simply stipulating it as the fetishistic character of a media object. From the self-claimed human autonomy in cultural production, which also makes the log-file analysts presume human gamers as isolable narrative and ludic agents outside, the metastability of a closed-up object has been interpreted as either a misrecognized human product or an abject other
arousing castrating hallucinations to a subject; either human-produced or human-lost; just as “the Modern repertoire keeps anything from happening in the middle” even though the close-up in practice, as much as targeting in videogames, always “happens in the middle” (Latour, 2010, p.19).

On the other hand, the objects magnified by Witcher Sense or Detective Vision enforce the gamer’s avatar to withdraw from its normal geometric view once built upon the Modern “ideal of detachment from every [metastable object] that brought it into action” (p.65). A gamer is now relocated to the non-Modern middle in which the objects’ autonomy regains its meaning as “the right not to be deprived of ties that render existence possible, ties emptied of all ideals of determination, of a false theology of creation ex nihilo” (p.59). Removing the lines of perspective projection, these ties of the emerging actor-networks allow the gamer’s shooting to unfold stories, quests, quizzes, and meaningless events from the interoperations of the objects her shooting initiates. The fetish-like character of objects reappears in the forms of tiny agitations but it is neither reaffirmation of what human lost nor human projection at distance. Rather, for these object to persist as the actors in the network, their momenta should be constantly reoriented towards others by the avatar’s interventions as much as the gamer’s individuation into a narrator or dungeon dweller is also the network effect of the avatar’s constant targeting.

As Andrejevic says about “various ‘smart’ objects that will come to populate their lives,” the “fetishes of yesteryear” once debunked by the criticism in the last century have recently found the “technologies for their silicon reincarnation” not only in the open-worlds simulated by videogames but in the real-worlds augmented by small wireless sensors and RFID tags (2005, pp.116-8). Attached to any kinds of cultural and technical objects, these smart dusts extract the unexamined momenta of the things to make them interoperable with others
intensively once again. For instance, a light bulb is now connectable to any electronic devices in a smart-home as experimented in *The Incredible Machine*. The commercial buildings and services geo-tagged as operational points-of-interest (POI) in a smart city and other smart infrastructures reveal their hidden interoperability to urban dwellers through the augmented-reality (AR) apps reminiscent of Batman’s Detective Vision or location-based apps similar to the world maps in open-world videogames (Figure 3.7).

![Figure 3.7: Nokia’s City Lens (Ponder, 2012, May)](image)

In these AR interfaces, the real-world objects begin to exhibit their metastable agitations or communicability, ready to be dragged by a person’s fingertip to a network in the making as the solution for the peculiar interest of the end-user. People’s “operations of citizenship” in this real-world is redefined as the technique to connect these reanimated objects in “sustainable and efficient” ways for a general-purpose of a city and home (Gabrys, 2016a, p.203, 185). Given the emphases put on the efficiency and sustainability of these object-(re-)oriented domestic and urban spaces, citizens’ being smart also involves two networking strategies that this chapter examined in the context of videogames. Either to draw the shortest and least energy-consuming route to a goal, or to explore all possible operations of each object in a network to individuate
more alternative ways for the goals. If becoming a smart citizen, or smart network-builder is the alibi for a human’s participation in these gamified environments, what the alibi conceals behind would be the following fact: for its sustainability and replayability, a network needs to cultivate more marketable and playable relations among its nodes, while a gamer’s ceaseless paying-attention, which targeting operationalizes, is serving as the trigger for those perpetual re-cultivation of the network.
The algorithmic objects, overwhelming the physical domains of the recent urban landscapes, operationalize topology as a new form of governmentality. As discussed in Chapter 2, topology is a mode of power optimal to manage the relations supposedly hidden everywhere but undetectable until foregrounded as the parameters orderly variant under certain transformations a space undergoes. Enmeshed by these hidden relations, our life would be, as the IoT warns, subject to the constant threats of unsustainability unless we surround our life with the manifold sensors and actuators in the background, in other words, unless we symmetrify ourselves.

In Massumi’s interpretation, Foucaultian governmentality is “a correctional reuptake mechanism,” which constantly folds and refolds a social continuum into man-as-body and man-as-specie. For Foucault, the sustainability of this continuum is achieved by detaining its differentiation within the two-coupled level of individual-population. His governmentality thus needs to interface two technologies operating in different geopolitical scales, namely “disciplinary apparatus” and regulatory “state apparatus,” which bifurcate the continuum respectively into the series of “body-organism-discipline-institutions” and that of “population-biological processes-regulatory mechanisms-State” (2003, p.250).

On the other hand, revisiting “the new techniques of environmental technology or environmental psychology” that Foucault mentioned briefly in the 1979’s lecture (2008, p.259), Jenifer Gabrys examines ubiquitous computing as what embodies Foucault’s “environmentality” in the recent urban transformations. She gives a hint as to how this new form of governmentality re-interfaces individual and population by reprogramming our environments through the networks of algorithmic objects “above and beyond direct attempts to influence or govern
individual behavior or the norms of populations” (Gabrys, 2014). These objects are now embedded in our domestic and urban landscapes and reveal their hidden agency through various augmented reality apps for houses, schools, offices, and the city, where they redesign “the rules of the game” for our smart participation (Foucault, 2008, p.260). In the ideal “open-world” characterized by the lack of “invisible walls” restricting players’ moves from above, these rules are emergent from the uneven and strategic distribution of interactive objects, which can be re-networked with the neighbored objects for a variety of gamer goals. For ontology as the semantic protocol to maximize the interoperations of smart objects in the open-world, a social continuum remapped by the environmental sensors is thus not simply to be stabilized in a sustainable alternation between identifiable individuals and manageable population. Under the governance of ubiquitous computing, the sustainability of the continuum rather means its plasticity capable of continuously unfolding numberless hidden levels for registering them as each new problem-space of an IoT application. In other words, between the most individualistic level of man-as-body and the most collectivist man-as-species, a multitude of hidden levels should be re-bifurcated and re-commodified.

A framed set of algorithmic objects such as that in a smartphone screen may be the most simplistic example of the machine for this environmentality. These graphical objects are functioning to govern the social continuum of users (individuals-population), and interface it with another continuum of digital signals. Their operations are however neither for simply training individuals how to use each object for each different task nor for updating the normative variation of users as a whole from each reported irregular user behavior. The recent interface design, on the other hand, as often happens in open-world gaming, allows users to customize certain subsets of objects frequently used for their self-defined goals. As “an environmental type
of intervention instead of the internal subjugation of individuals” (Foucault, 2008, p.260), this customizability provides the users with the means to represent their urgent needs as something resolvable through the networks of objects they draw with their fingertip or mouse point. For doing so, the screen re-embeds the algorithmic objects it encloses, such as smartphone icons, in a user’s field of perception as the things close enough to touch, click, and target, just as it happens when we scan a smart city with augmented-reality apps in our smartphone. Through this user-friendly interface, the user is black-boxed in the middle between what s/he perceives on a screen and how s/he responds through input devices, and a neurophysiological continuum of her/his body unfolds the inexhaustible sensor-actuator interconnections. In a smart space where this rectangular frame of icons is expanded into its blueprint embedded with smart objects, the PC and smartphone users’ conscious trajectories of the mouse point and fingertip are replaced by their nonconscious daily routines. Through our living according to the everyday protocol of the IoT, the human neurophysiology is black-boxed in-between what our skin feels and how our body walks through, and it is readily interfaced with the underlying digital continuum as one of the other input-output circuits that construct an IoT ecosystem altogether. However, contrary to the other smart objects with each limited perceptibility and actionability, the human circuit could bifurcate as many sensorimotor responses as needed for these nonhuman others to relay further for many different IoT applications.

Warren Neidich (2003) describes our “visual landscape” as “a network or field” of “phatic signifiers,” the objects that have survived throughout their evolutionary histories as the result of humans and other organisms’ “neural selection” of them as the stimuli or environmental cues relevant to the imminent cultural and physiological needs. According to him, “the invention of smaller and smaller microprocessors to run smaller and smaller computing devices” in our
smart environments changes the way in which our field of perception is constructed by these phatic signifiers. In a current software interface, artificial stimuli “engineered to have superior attention grabbing capabilities beyond their naturally created counterpart” are not naturally selected through our habitual perception of geometric objects in a field of perception. They are rather registered as important objects on both sides of the interface for different reasons; first, users select them as representing their personal goals that they intend to do with these objects, while software reproduces them as the means to translate a variety of user interests into the networkable variables. In this way, the networks of algorithmic objects, Neidich (2003) says, “become the stencils upon which the networks of the brain are modeled.” As another metaphor for the Internet of Things that encloses the human mind in-between its technological inputs and outputs, stencil describes how the plasticity of the neuronal continuum of a brain is mobilized for the formation of certain sensor-actuator arcs with the environmentally distributed algorithmic objects.

Ubiquitous computing reactivates the neuroplasticity of our brain and exploits this plastic continuum for expanding its governance further to our hidden neuronal realities. An experimental example of the Internet of Things the next chapter analyzes, Brain-Machine Interface (BMI), is, roughly speaking, a device to stretch this plastic brain out of a skull and biological body to the smart objects, such as microsensors, computer algorithms, and robot arms, which construct a machininc assemblage for the futuristic neuroprosthetics. The chapter examines how the interfacing of BMI differentiates hidden neurophysiology of human or animal mind into multiple levels of motor intentions, and examines how the device exploits these intentions, cultivated in a lab in the first place, as the resources to develop a greater number of brain-powered sensors-actuators for the future industrial uses.
CHAPTER 4: BRAIN-MACHINE INTERFACE AS 
THE ACTOR-NETWORK AFTER THE INTERNET OF THINGS

The version of new materialism that I developed in this dissertation is a little tricky in that its new materiality seems not only to be reasoned from the concept of topological continuum but also assumed as a sort of sufficient reason. The renewed understanding of materiality is an urgent need for the current capitalism and its venture capital to ground their speculation about the abundance of correlations, data-minable, and thus commodifiable. The groundlessness that the humanities in the past century had discovered from its critique of Enlightenment and its culmination in the rupture of the subjective enclosure of the modern world might also have necessitated another sort of sufficient reason: the nonhuman ontology, what the humanities in the impasse cannot help but jump into.

For this dissertation, this new materiality, infinitely communicable by nonhumans but never exhaustible by any of their communications—the materiality properly termed only as intensities—was, in this sense, something that should be self-sufficient as the common solution for both worlds of capitalism and Enlightenment. As a conceptual assemblage of recent materialist thinking, the topological continuum (of these intensities) thus shares many properties, which other new materialists have speculated as what should be embedded in our hidden realities as the sufficient reason to compensate our failure to enlighten them exhaustively. For instance, this continuum is akin to what Karen Barad’s agential realism calls “spacetime matter manifold” upon which an “agential cut” is made by the intra-action, not the interaction between two entities but the transformation of the manifold to draw an arbitrary boundary of observing and observed upon its surface (2007).
The sensor-actuator arcs that the interoperations of smart objects drew in Chapter 2 were to unfold multiple domains of measurability from this manifold underlying a new domestic space. According to Manuel DeLanda, the manifold is embedded with singularities, something virtual, whose influences are nevertheless real as the attractors to hold the transformation of the continuum within their “sphere of influence” (2002). The problems, which the ubiquitous computing re-problematizes as things supposedly embedded everywhere but never fully resolvable, are the practical redefinition of these singularities this dissertation suggests. The ubiquity of embedded problems, paired with the expandability of software applications in the cloud, was to re-differentiate a smart home into each singular problem space. The continuum also describes what Jane Bennett calls “a vital materiality” or “the swarm of activity subsisting below and within formed bodies and recalcitrant things” (2009, p.50); or what Bruno Latour calls plasma, gaseous and highly conductive entities not yet congealed into actors nor networks (2005); or the mysterious entities constantly withdrawing from any correlationist understanding of human subjects and even from any pan-correlationist network-making of nonhumans (Harman, 2005). This tricky materiality is, for the recent humanities discourses, what should remain after and thrive within the ruptures of our subjective realities so that the universe with numberless intervals is still convertible into a plenum for creative evolution. In this dissertation, this materiality is, on the other hand, also the condition for the software industries to discover a plenum of data for its further commodification.

In an article on the public opinion and activist response to the Snowden leaks in June 2013, Lina Dencik and Jonathan Cable (2017) report how “feelings of widespread resignation” that people have towards the governmental and corporate practices of surveillance have had them accept “a system of ubiquitous data collection” as an unavoidable reality their “surveillance
realism” describes. This recent version of “capitalist realism” (Fisher, 2009), or realism in general, is, for Dencik and Cable, no longer the question of people’s viewpoint as the means to correlate themselves with the world. The reality of ubiquitous surveillance is rather what people cannot help but accept facing the asymmetry through which they are engaged with the invisible material practices underway in their surroundings. Data collection is secretly done all over our daily activities, and we can feel it only obliquely. However, the maximum expression of our discontent at this hidden reality would still be resignation as long as we are not accessible to the language of “national security” and analytic tools for the hidden danger of “terrorism and crime” (Dencik & Cable, 2017). Peter Benson and Stuart Kirsch (2010) studied how tobacco and mining industries have, for perpetuating their harmful pursuit of profits, mobilized resignation from people by preempting possible criticisms to their practices and proactively manage their relationship to the critics. Resignation is the affective response to the impossibility of an alternative future to the status quo of capitalism.

Recently, the “corporate cultivation of digital resignation” has also perpetuated the exploitive mode of corporate data-mining (Draper & Turow, 2019). If digital resignation is an expression of reactive privacy concern against the untrackable hidden realities of one’s behavioral data (the most active form of which is the practice of obfuscation, to make them further untrackable even by surveillance networks (Brunton & Nissenbaum, 2015)), the affective response that the capitalist realism in this dissertation cultivates from the people stuck in-between the ubiquitous sensors and actuators is somewhat proactive rather than reactive.

The new materiality, which people may feel anywhere massive data collection occurs, such as their own bodies, homes, and cities, also suggests a hidden reality of inexhaustible correlations. People’s speculation about its promise is however not because there is no
alternative but because it is the only alternative to break through the status quo of capitalism, humanities, and their self-optimization. Industrial capitalism might at some point fill the world with people’s resignation about its exploitive mode despite the bad feeling about its unsustainability. It is now filled instead with people’s speculation about the hidden resource, the ubiquity of data, ever re-minable, and thus sustainable. The intervals between sensors and actuators of the IoT are where our hope for the smart sustainable future is cultivated.

In this respect, the realism now is neither what we naively believe nor a subjective construction. It is what we need to wager on for the continuous exploitation of the world. The realism of brain, or neuro-realism (Gruber, 2017), is one example of this recent realist thinking that has been aroused by the brainwaves becoming streamed as real-time digital signals through the advanced sensor technologies such as fMRI, EEG, and the Brain-Machine Interface that this chapter analyzes. A brain may be the smallest physical domain of the IoT as it is scanned by hundreds of small sensors and easily stimulated by a variety of actuators embedded in one’s daily routine. Relocated within this interval the IoT inscribes, a brain cultivates potentially inexhaustible correlations between sensors and actuators, which redefine the exploitability of our brainpower in the smart future. In this chapter, actor-network theory is used as a tool to describe this cultivation of resources within the ubiquitous intervals of a network.

**ANT, IoT, and Brain-Machine Interface (BMI)**

The word *network* has been popular in social theories since the emergence of the World Wide Web as a communication infrastructure in the 1990s. For the actor-network theorists who once advertised their network concept as descriptive of a “series of transformations—translations, transductions—which could not be captured by any of the traditional terms of social theory,” the
Internet’s apparent “access to every piece of information” without deformation seemed to make their once revolutionary concept as mundane as a readymade term (Latour, 1999, p.15). In “On Recalling ANT,” Bruno Latour imputes the criticisms that have been raised against the “managerial, engineering, Machiavellian, demiurgic character of ANT” to a misguided understanding of “actor” and “network” as separable terms. According to him, “actor” misunderstood as a stand-alone term has made ANT’s actual application focus exclusively on how strong “male-like” actors mobilize their wider accessibility to networks to fulfill their own interests. On the other hand, conceiving of “network” as something social above all actors below leads to a critique of ANT for “its apparent dissolution of independent actors with morality and intentions in a ‘play of forces’ in which no change through human intervention seems possible” (Gad, 2010, p.61). Lost in these misunderstandings is the “freshness” of the network concept, which hinges on the hyphen in “actor-network,” not simply signifying the epistemological limit of a subject in a node of networks, but as an ontological entity in itself, which the actor-network theorists called “translation.” Translation for them is not a byproduct of an actor’s interaction with another actor or their interoperation for creating a network, but something akin to what Karen Bard calls “intra-action,” from which both networks and actors are generated (Barad, 2003).

In 1999, the same year Latour recalled this early freshness of ANT, “the Internet of Things” (IoT) was suggested to name the new technological infrastructure, which would catalyze more intra-actions within the traditional Internet, refreshing it (Ashton, 2009, June). Throughout its development, the ubiquitous computing of the IoT has integrated a variety of smart objects embedded with small digital sensors and actuators. But the process of their becoming actors with noticeable influences in the new Internet has not been simply through their registration as ready
to function. It has rather been through these smart machines’ adaptive learning, or human users’ new adaptability to smart infrastructures through their augmented sensor-actuator responses.

“Thingification,” a process that has taken place in our urban environments, has been, contrary to what Barad originally meant by this term, not simply meaning the “turning of relations into” the interactions between “‘things,’ ‘entities,’ ‘relata,’” things already fully individuated as autonomous actors before the interactions (Barad, 2003, p.812). Conversely, thingification the IoT re-initiates is to refresh the relation-making processes, or intra-actions, whereby machines, humans, animals, and objects in both real and virtual worlds are constantly re-drawing their new sensor-actuator relations to one another (Gabrys, 2016b).

The goal of this chapter is to renew the actor-network theory as the practical tool to analyze an experimental example of the Internet of Things. Brain-Machine Interface (BMI) is an idea for the futuristic neuroprosthetic devices that Miguel Nicolelis and his neuroengineering lab at the Duke University have developed since 2000 and one version of it was publically demonstrated at the opening ceremony of the 2014 FIFA World Cup in Brazil. Compared to other cloud computing-based IoT applications, the entities that Nicolelis Lab has mobilized for constructing BMIs, such as human/animal neurons, biological/robotic limbs, and computers, have been small in number and usually put together in a small laboratory setting, rather than being distributed as widely as the sensors in a smart city. Nevertheless, cloud is still a working metaphor because what Nicolelis Lab has experimented is not so much the seamless and well-defined interoperation of these biological, mechanical, and algorithmic objects, but their unexamined networkability, the nebula of relations aroused from their experimental juxtapositions. Freed from hardwired or habitual contexts of neuronal interactions, and not yet stabilized into a simple sensorimotor interaction, these objects have been cultivated as the things
ready to be mobilized for a variety of sensor-actuator relations that the lab has advertised as the evidence for the various future uses of BMI.

The Missing Times

On June 12, 2014, Juliano Pinto, a 29-year-old former athlete who lost the use of his legs after a car accident in 2006, entered the Corinthian Arena in São Paulo, Brazil, as part of the opening ceremony of the 2014 FIFA World Cup. Pinto was wearing an exoskeleton which looked “as if came from the ‘Iron Man’ movies” and was accompanied Nicolelis’s staff who had supervised the development of the exoskeleton over two years, relying on about fourteen million dollars of funding from the Brazilian government. After Pinto’s name was announced, the exoskeleton took its historic first step as its electroencephalogram (EEG) cap scanned the action potentials from his motor neurons and transmitted them to its robot legs. As the foot of the exoskeleton touched the grass, tactile stimuli sensed by the artificial skin of the soles were fed back to his arm skin instead of his paralyzed feet. Based on tactile perception transmitted through a millisecond-long interoperation between neurons, robots, and the grass, Pinto (or his motor cortex) could design his/its next move. After a couple of steps, he finally kicked the official ball.

An event completed and broadcasted for only a few seconds at the beginning of the ceremony, soon buried by the spectacle of other events.

For the last few months prior, Pinto, along with seven other patients in the Nicolelis Lab, trained to adjust his motor cortex to the way a machine interacts with its surroundings. In these training sessions, hundreds of his motor neurons were scanned by an EEG cap, which registered, or re-thingified, these neurons as laboratory objects transmitting their ambiguous action potentials to operate other lab devices. To find niches for his neurons to settle in to form a
working sensor-actuator loop with his robot legs, the control system of the exoskeleton also needed this time to learn human kinetics. These intervals of time—required for both the patient and machine intelligence, and their mutual adaptation to form casual relations—were however easily black-boxed in short sentences within the “method” sections of papers according to the conventions of scientific publications and public demonstration. Information about the lab’s practices was updated every day on social media starting sixty-nine days before D-Day, and partial close-ups of a working exoskeleton were released to arouse curiosity, but most other parts of the lab were still black-boxed.  

Before the actual training began, the exoskeleton, initially developed in France, was transported to the Nicolelis Lab in São Paulo, where it was re-coordinated by an engineering professor from Munich so that it would be ready to respond to the neurons in the lab de-contextualized from Pinto’s conscious motor intentions (Sample, 2014, April). Leading up to this, more than one hundred scientists from different countries had already organized a consortium named the Walk-Again Project, designing a lab setup in which neurons and robot limbs could

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18 Since sixty nine days before the World Cup opening, images of a mysterious rectangular banner, literally a black-box, were posted to Nicolelis’s Facebook page. While the information about the participants and their training were kept secret on his page, a short clip showing only the lower part of an anonymous body walking in the exoskeleton was the only one shown online to stimulate more curiosities from the followers about the scene behind the screen. It was, on the other hand, just after Pinto’s kick-off was aired worldwide and Nicolelis tweeted “We did it!!!!” that several videos of volunteers, highlighting their struggling but hopeful faces, were posted all at once. See the post on 22 May 2014, “Historic moment: eighth volunteer walks for the first time with the exoskeleton and enjoys the feeling of walking again.” Available: https://www.facebook.com/207736459237008/videos/801662049844443/?comment_id=801675696509745&comment_tracking=%7B%22tn%22%3A%22R9%22%7D
achieve stable connections. The idea of Brain-Machine Interface had in this sense been concretized through the years-long negotiations of manifold interests from scientists, patients, and governmental officials. These parties believed that BMI would provide a means to demonstrate the validity of their scientific hypotheses, showcase the recent achievement of their ‘national science,’ fulfill their desires to walk again, or to draw public attention, justifying the government investment in their projects.

Compared to this long duration for the formation of an intra-lab network and inter-lab cooperation of complicated interests, “Pinto’s few seconds of fame” did not seem worth all of those costs. It was only during the short seconds of the very beginning of the opening ceremony that neatly coordinated neurons and robot limbs were temporarily aligned with Pinto’s conscious motor intentions, while at the same time aligned with the angles of the broadcasting camera, as well as with the lab’s and government’s interests in drawing public attention to this media event. Nevertheless, this short exposure was sufficient for Nicolelis Lab to mobilize as its allies some news outlets who were willing to argue, in favor of Nicolelis, that “the historic event” signifying “the beginning of a future in which people with paralysis will be able to leave the wheelchair and literally walk again” was not given the attention “it deserved during the opening ceremony” (Boyle, 2014, June; Martins & Rincon, 2014, June).

From this specific example of a flickering constellation of things and their interests, we can identify three time intervals, or missing times, which were endured by both human and nonhuman participants in the Walk-Again Project—such as neurons, robots and algorithms, individual scientists, patients, labs, and a government—until their dissimilar interests were all aligned along a common technological invention. First, to form the working sensor-actuator loop between neurons and robots, the BMI needs to manage an imperceptible delay in its algorithmic
prediction of a person’s motor intention. There has usually been a several-milliseconds of interval between this intention created in the form of neuronal firing and its manifestation through actual body movement or the person’s conscious recognition of it, (Hansen, 2015a), and the machine’s scanning the relevant signals and preemption of a motor intention should thus be done within this interval so that the wearer would not feel a significant delay. Besides the milliseconds spent to renew the sensor-actuator loop for each new motor intention scanned from a brain, two other longer-term intervals have also been necessary in order to make this loop represent the intentions of individual and institutional actors both inside and outside the lab. The second missing time omitted in the BMI’s public presentation involves translating the heterogeneous interests of scientists, government officials, and individual patients into a specific disposition or diagram of things inside a lab. The third, happening behind closed doors in the lab, involves the hours of training of animals and human subjects, to make them not only capable of living with the BMI but believe in the hope it promises, namely “walking again.” This chapter explores these three missing time intervals, which the lab has simply obscured behind its narrative of natural adaptations of subjects to smart infrastructures, and suggests how these intervals become prevalent in the twenty-first-century media’s re-thingification of human brains.

As Steven Brown and Rose Capdevila write, re-situated within these missing times of “electronic networks,” actor-network theory functions as a tool to investigate “the space for subjectivity and what is left of ‘the human’” (Brown & Capdevila, 1999, p.45, 47), in other words, what is left of human intention, occurring first as neuronal firing and digital transmission.

This chapter examines news articles and the Nicolelis Lab’s scholarly publications about the BMI since the prototype of this robotic prosthetics was first developed in 2000 with primate brains connected to robot limbs, mediated by computer algorithms. I will also examine how the
scientists mobilized the mutual adaptability of these organic and technological entities to create a closed-loop of artificial sensor-actuator responses, which have not only demonstrated the validity of the lab’s scientific principles, but also promised that the heterogeneous interests of actors around “Walking Again” could be manifest by this invention.

Some ontological implications of actor-network

Before its actual application to describing a science lab, the relationship between two seemingly incompatible variables hyphened in the concept of the actor-network should be clarified. First, there are actors whose presences are noticeable only through their behaviors or consistent responses to the lab’s attempt to communicate with them via either discursive or technological means. On the other hand, a network is something global not representable as a mere sum of these clearly-defined local actors. In order to resolve this contradictory paring-up, we usually rely on the so-called relational definition that the hyphen in actor-network may signify: an actor can be defined only by how it makes relations with others, whereas a network describes not so much the connections between independent actors but those relations in the making. Each actor’s autonomy thus turns out to be something misunderstood, but the effect of relations in constant making and remaking, or intra-actions, prior to their being black-boxed, or congealed into two separable actors. However, this convenient definition also has a problem as it tends to dissipate the analytical usefulness of the term “actor” in an abstract network potentially applicable to any haphazard relations, even to those that look too unstable to be localized as relations between noticeable actors. To overcome this, we might try to restrict our use of the term actor-network only to certain detectable and patternizable relations. But, in this case, we would make another mistake and reduce any haphazard relations simply to the background of a system
being studied. This problem of defining the actor-network suggests some ontological implications.

First, actors are not independent entities that a theory presupposes as building blocks for its theoretical system to explain given problems. Rather, actors are “those entities that exert detectable influence on others” (Law, 2012, p.126). Their presence is empirically inferred from recurrent influences but only in the presence of observers, both humans and nonhumans, “able to propose their own theories of action to explain” the causes and effects by imputing the immediate influences they feel to certain actors in distance (Latour, 2005, p.57). An actor-network is therefore when certain entities—not yet actors—are juxtaposed and begin to influence one another in a long-term sustainable way, so that they serve as “heterogeneous but mutually sustaining elements” of a system (Law, 2012, p.115). In other words, an actor-network (and its actors and network) appears only in hindsight to an observer after an amount of (missing) time spent by those entities to stabilize their interactions with others in sustainable ways. This does not necessarily mean that only those entities with detectable influence in the association of a given network could be called actors. We could suppose the existence of other entities that might dissociate from the network under observation because they prefer to associate with “other actors in the environment in the course of the inevitable struggles.” As John Law writes, the features of these others, constantly creating invisible networks conflicting with the networks “being built by people,” such as the laboratory, are often branded as the “obduracy” of Nature (Law, 2012, p.124). Therefore, missing times are not simply spent for association and stabilization, but also spent for struggle and switching between networks, one under techno-scientific construction and many unfavorable others black-boxed as mere natural environments by this human project.
Via this explanation, we can assume that there were some neurons in Pinto’s motor cortex not firing towards the exoskeleton during the demonstration because they were more strongly associated with other kinds of neuronal sub-networks relevant to behaviors other than kicking off and to the stimuli other than tactility. They might struggle against the EEG cap’s re-thingification, namely its operation to switch them from previous enrollments in habitual neuronal contexts to another in the making under its algorithmic system. Insofar as their denial to fire meant their obduracy in being associated with other sub-networks of Pinto’s brain, the actor-network in the World Cup demo did not operate simply in a natural environment. Rather, there might be many struggling networks, which denied sending detectable signals to the observers—scientists, engineers, or audiences—who were also obdurate in their enrollment to this invention, or media event in broadcasting. In this sense, actor-network theory does not presuppose a rigid dichotomy between systems and their environments, as long as environments mean the heterogeneity of networks just black-boxed conveniently as the “obduracy” of Nature.

Second, the successful operation of a science laboratory as an actor-network thus depends not only upon the design decisions of scientists to distribute those entities, but also upon those entities’ ability to fill the gaps within their disposition to form an actual network. In this sense, the role of scientists is better described as creating “juxtapositions” rather than “associations.” According to Michel Callon, “it is from these juxtapositions that the associations draw their coherence, consistency, and structure of relationships that exists between the components that comprise it” (Callon, 2012, p.89). In a laboratory setup, the coherence of these relationships the components sustain for a long enough term is evidence of the validity of the lab’s hypotheses; however, more importantly, the juxtaposition of components should be first a proper spatial translation, or diagrammatization (Ahn, 2019), of the rules of statements which
define valid variables and restrict their possible interactions. Therefore, what is demonstrated through an experiment or training session is most of all the validity of the theoretical variables and experimental parameters, as well as their communicational protocols, exemplified by the Nicolelis Lab’s “principles of neural ensemble physiology” (Lebedev & Nicolelis, 2009); or the validity of the hopes, which various stakeholders of the research have anchored on BMI. The good managerial skill of scientists thus requires them to be capable not only of maintaining these hopes until the gaps in an abstract diagram are fleshed out with actual connections between small lab objects, but also constantly re-distributing these gaps to draw more hopes around their diagram.

Though it was just a few seconds of the opening ceremony, the 2014 World Cup demonstration allowed the Nicolelis Lab to show off that ensembles of neurons and robots—whose plasticity to form lots of different sensor-actuator loops for different motor tasks the lab had experimented for a decade—could also create a closed-loop with an exoskeleton walking outside. In the demo, a local network of these organic and machinic things did not just validate the lab’s scientific hypotheses, but that their design can serve to mobilize more hopes for the BMI’s medical, academic, industrial, and commercial uses beyond the physical boundary of human bodies.

A Description of BMI

Since Nicolelis designed his first BMI involving a rat in 1993, his lab’s BMIs have evolved through several different forms, varying according to the species of the animal subjects, numbers of registered neurons, methods of scanning action potentials, types of motor functions simulated by the machines, and the pattern-recognition algorithms used to predict a subject’s
motor intention. It was in 2000, after an experiment with an owl monkey named Belle, that the lab began to refer to BMI as the future of “neuroprosthetic device[s]” which “could be used to restore basic motor functions in patients suffering from severe body paralysis” (Nicolelis, 2003, p.417).

![Figure 4.1: A prototypical description of a BMI (Nicolelis, 2003)](image)

As described by Nicolelis in his 2003 *Nature* article (Figure 4.1), this early version of BMI was comprised of three major actors. First, there was a monkey wearing a head-mounted device, consisting of a hundred “Teflon-coated stainless-steel microwires” implanted in the neurons in several regions of the monkey’s motor cortex. The monkey was located in front of a monitor to operate a fake joystick with her right hand to win a videogame and receive a sip of fruit juice as a reward. Second, placed alongside these interconnected neurons and microwires were a device for data acquisition from neuronal firing, called a Harvey Box, and computers for real-time pattern recognition algorithms (linear and artificial neural network (ANN) algorithms).
These computing devices were able to “properly sample, filter and amplify neural signals from many electrodes” that had been evenly distributed within the subject’s motor cortex, and integrate these parallel signals—scanned every 50 to 100 milliseconds from multiple neurons—into a linearized input for machine learning. Further, there was a robot arm, operating a real joystick responding to instructions from the computer, which predicted the monkey’s motor intentions in milliseconds. As the robot operated the real joystick in the same moves that the monkey did with the fake one, a cursor on the videogame monitor moved as though the monkey was controlling it. At the same time, information about the robot’s grip force was fed back to the “small vibromechanical elements attached to the animal’s arm” (Nicolelis, 2003, p.419).

When the monkey moved her joystick, believing it to be the real one, the kinetic patterns of her arm movements were captured from “infrared markers” attached to each joint and calculated into machine-readable “motor parameters (such as arm position and velocity, or hand gripping force).” These parameters were then used in the pattern-recognition algorithm, which determined a set of coefficients for a proper linear sum of the multiple neural firings, matched to the linear change in the motor parameters observed some milliseconds after. These filtered brain waves were then properly linearized to reproduce the patterns of “subject’s voluntary motor intentions,” allowing the computer to operate the robot arm to play the game on behalf of the monkey, so that she could get a reward (Lebedev & Nicolelis, 2009, p.531). As information about the robot arm’s performance was “relayed back to the animal” in the form of visual and tactile feedback, “a closed-loop control BMI” was formally completed (Nicolelis, 2003, p.419). However, for its actual operation to be seamless, some intervals within the loop should be stabilized. First, between the monkey’s mind and brain, her goal-oriented intention to win the game must be successfully relayed into manifold paralleled neuronal firings. On the other hand,
between a brain and computing devices, these paralleled neuronal firings from the cortex must be linearized again to be paired with linear changes in the monkey’s arm movements. At the same time, the linear movements of the robot arm must be translated into “proprioceptive feedback” signals, which were re-distributed to the monkey’s paralleled visual and tactile receptors. Between the abstract juxtaposition of these lab entities and their transformation into an association or working actor-network, the entities facing each other across these parallel-serial junctures were supposed to create actual connections for mutual adaptations.

**Defining Actors**

The monkey, computers, and the robot have been identified as the three major actors, but they did not exist as independent components prior to their association being networked. John Law defines an actor and its agency as “an effect generated by a network of heterogeneous, interacting, materials” (Law, 1992, p.383). This relational definition requires us not to carelessly localize actors into a small number of influential things or nodes. However, to explain how these distributed influences keep circulating in and sustaining a current form of a network, it is still practically required to assume that certain actors have more agency than others in the network. In the above description of parallel-serial junctures, the three major actors are localizable as each of them is capable of mobilizing the many small entities in the parallel side of a juncture for its linear goal in the other side. In Latour’s terminology, this function of junctures to integrate and transmit many is called translation, a process through which scientists or experimental instruments represent the heterogeneous responses from voiceless actors and mobilize them as the resources to fulfill their own interests (Latour, 1987). In other words, these major actors have more agency because they can represent voiceless others latent in the network.
Thus, we can define the monkey in question as one of the major actors, as she can translate the interests of manifold neurons into her interest in winning the game and translate their “neuronal ‘vote’” of action potentials into her highly trained skill to control a fake joystick (Nicolelis, 2001, p.404). The Harvey Box and computers comprise another major actor that translates the “activation of large distributed populations of neurons” into their algorithms (p. 404), “inscribed with certain interests” of the researchers, namely to demonstrate the operability of their neurophysiological principles (Johnson et al., 2014, p.17). The robot arm becomes an actor as well, as its design represents the researchers’ interest in restricting the monkey’s arm movements to certain motor parameters, and as it translates the predicted motor intentions of the monkey into an actual operation of a joystick, making her more addicted to the game as she believes she really controls the cursor.

However, even for the observers in the lab, these major actors were identifiable only in hindsight after “a few nerve-racking, nail-biting, soul-searching moments” during which their dissimilar and conflicting interests were negotiated and properly re-aligned within the parallel-serial junctures so that their mutual mobilizations became stably measurable (Nicolelis, 2011b, p.144). This missing time was however easily black-boxed by Nicolelis who simply writes that “nothing out of the ordinary happened” in these confusing moments.

In this sense, the “long-term training” required for both the monkey and computers to form a closed-loop through their mutual adaptation was also necessary for the actor-network to reach “a favourable balance of power,” by which Michel Callon means a state in which all “the concerned actors” eventually align their interests with the researchers’ project (Callon, 1986, 1986)

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19 It is noteworthy, in his book Beyond Boundaires, how careful Nicolelis is not to describe one of his experimental monkeys (named Aurora) simply as a mere laboratory animal, but to introduce here as a sophisticated social being who was willing to cooperate with the project (Nicolelis, 2011b).
During the repeated trials for the monkey to learn how to mobilize her motor neurons for the motor parameters that the joysticks involve, some of the microwires became more strongly enrolled to the sorting algorithm of Harvey Box while other unfavorable ones were detached from the juncture and withdrawn to the background of the loop. From the 2001 prototype to the 2014 human application, this favorable balance was promoted in news articles and the lab’s publications as one of the most important achievements of their BMI, presented as though it had naturally been achieved by the “monkey’s thought,” “only her brain activity” and the “[m]ind-controlled exoskeleton” (Blakeslee, 2008, January; Smith, 2014, June) or by “physiological adaptations at the level of neural ensembles,” the “ability of cortical ensembles to adapt to represent novel external actuators,” and “adaptive algorithms that continuously update the model parameters while the subject trains” (Lebedev & Nicolelis, 2009, p.534; Lebedev & Nicolelis, 2006, p.541; Lebedev et al., 2011, p.30), rather than being engineered within a disposition of artificially-juxtaposed things. The balance in this closed-loop was supposedly automatically and naturally maintained as “[b]rain cells that ceased to influence the predictions significantly were dropped from the model, and those that became better predictors were added” as the result of their mutual adaptation (Nicolelis & Chapin, 2008). While the three nonhuman actors were foregrounded in the lab’s public presentations, the managerial work of the scientists maintaining the loop was hidden in the background, alongside other neurons that disagreed with being enrolled any longer in the network.

**A Closed-Loop or Favorable Balance of Power**

The balance, *naturally* achieved “between the brain and artificial devices,” was important in promoting BMI’s future use in noninvasive neuro-prosthetics, with the promise that patients
could naturally adapt to the BMI without recurring interventions by engineers for brain-machine calibration (Nicolelis, 2001). With respect to the BMI’s function in scientific experiments, the closed-loop was also taken as the evidence for the internal validity of the lab’s scientific principles (Cicurel & Nicolelis, 2015, Ch1). Superficially, the algorithmic predictions of the monkey’s behaviors from the randomly sampled neuronal firings show that the lab’s principles of “distributed coding,” “neuronal mass effect,” and “plasticity” are valid in the given cortical areas and motor parameters (See Table 4.1). Insofar as this closed-loop continues between a limited number of actors over a long period and the exchange of influences between actors could be black-boxed by considering it “a unified whole” (Latour, 1987, p.131), the lab’s principles would remain true, but only within the given cortical areas and motor functions.

**Table 4.1:** Principles of neural ensemble physiology (Lebedev & Nicolelis, 2009)

<table>
<thead>
<tr>
<th>Principle</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distributed coding</td>
<td>The representation of any behavioral parameter is distributed across many brain areas</td>
</tr>
<tr>
<td>Single-neuron insufficiency</td>
<td>Single neurons are limited in encoding a given parameter</td>
</tr>
<tr>
<td>Multitasking</td>
<td>A single neuron is informative of several behavioral parameters</td>
</tr>
<tr>
<td>Mass effect principle</td>
<td>A certain number of neurons in a population is needed for their information capacity to stabilize at a sufficiently high value</td>
</tr>
<tr>
<td>Degeneracy principle</td>
<td>The same behavior can be produced by different neuronal assemblies</td>
</tr>
<tr>
<td>Plasticity</td>
<td>Neural ensemble function is crucially dependent on the capacity to plastically adapt to new behavioral tasks</td>
</tr>
<tr>
<td>Conservation of firing</td>
<td>The overall firing rates of an ensemble stay constant during the learning of a task</td>
</tr>
<tr>
<td>Context principle</td>
<td>The sensor responses of neural ensembles change according to the context of the stimulus</td>
</tr>
</tbody>
</table>

In the actual development of the BMI, this prototypical closed-loop has however been significant for another reason because it could be occasionally re-opened to accommodate other as yet untested experimental objects, such as different neurons, algorithms, and robot designs.
The plasticity of the loop has promised that the validity of the lab’s hypotheses could expand to other unexamined brain areas and motor behaviors. Once the initial network reached a state of autonomy, scientists could change “the feedback information that the animal receives” and “the kinematic properties of the motor actuator (robot arm),” as long as these newly introduced parameters were still adaptable by existing actors (Nicolelis, 2003, p.419). They observed whether the actors would keep enrolled to their project after they changed the location and size of the cortical areas used to sample neurons (for instance from the primary motor cortex to the posterior parietal cortex, in order to demonstrate the “neural degeneracy principle”) or added some new motor parameters such as three-dimensional arm movements (to demonstrate the “neuronal multitasking principle”). In other words, after the loop was achieved, the lab design obtained strategic advantages in negotiating with the outside actors interested in the BMI’s more general application to various fields, even though every new negotiation required a few hours or days of training.

As long as new elements were contiguous to those already included and this contiguity was enough for existing actors to adapt to, the lab’s scientific principles could be vindicated farther to the various cortical areas relevant to the more variety of motor functions integrated into the research. Exploiting these actors’ adaptability and plasticity, the closed-loop has integrated many endurable changes in subsequent experiments. Consequently, the inner network of Nicolelis Lab has been intensified in terms of the number of voiceless actors, re-thingified by “Teflon-coated microwires,” “wireless electrodes,” and “EEG devices,” which made their action potentials farther beyond a monkey’s cortical areas in order to generalize the lab’s principles towards more unrestricted uses.
Though many individual neurons once enrolled in the loop were dropped from the junctures as the BMI evolved into many different forms to integrate various experimental parameters, they were never simply withdrawn to anonymous and unfavorable backgrounds. These neurons remained associated with other latent sub-networks of the brain, often mutually incommensurable with one another, and thus not detectable in a network in the making, but already catalogued in computer data and publications. These neurons have been preserved as a sort of reserve army of networks, ready to be re-mobilized anytime soon. Throughout the loop’s expansion, a brain’s “complexity,” meaning lots of paralleled sub-networks embedded in its topological continuum, has been re-inscribed in the form of what Shirley Strum and Bruno Latour call “complications,” which means the sum of linear translations of paralleled complexities. Each sub-network once integrated to the BMI has been archived as “a succession of [machine-readable] simple operations” as a part of these complications. Responding to the unfavorable environments of the multitude struggling networks within a brain, the “greater stability” of BMI and its applications to a variety of kinetic functions could be acquired “only with additional resources; something besides what is encoded” in a current loop, namely the neurons kept in a database as the reserve army for the BMI’s future applications (Strum & Latour, 1999, pp.119-120).

**Closing the loop to become beyond boundaries**

Just after the first BMI with a primate brain succeeded in 2000 in predicting and imitating how Belle, an owl monkey, “intended to move [her] natural arms,” Nicolelis Lab set to work on a new BMI to replicate their previous success with three macaque monkeys whose “brains contain[ed] deep furrows and convolutions that resemble those of the human brain” (Nicolelis &
Chapin, 2008). Once a favorable balance of influences between a monkey and a robot arm was formed again, Nicolelis changed the BMI design by removing the fake joystick from the right hand of Aurora, “an elegant female” macaque monkey. This symbolic action disabled Aurora’s bodily extension and Nicolelis expected that she would adapt to her new physical condition with a new strategy allowing her neurons to operate the robot arm, this time without moving her hands.

After being puzzled, Aurora gradually altered her strategy. Although she continued to make hand movements, after a few days she learned she could control the cursor 100 percent of the time with her brain alone. In a few trials each day during the ensuing weeks Aurora did not even bother to move her hand; she moved the cursor by just thinking about the trajectory it should take (Nicolelis & Chapin, 2008).

This success with a disabled monkey was quite consequential, offering much more than what it seemed to simply offer to her, namely her “out-of-body experiences” in the lab. Promoting the similarity of monkeys and their human relatives and Aurora’s physical condition similar to a human patient, the actor-network inside the lab claimed to represent the interests of humans outside the lab, not only those aiming to renew “hope of restoring mobility to people who are paralysed,” but also those trying to develop “the conduit through which our brains control all our tools, to extend our reach, presence and communication with the universe” (Nicolelis, 2011a). As Nicolelis said in the interview with the Washington Post, in order to mobilize “enough political will and investment” for his project, the lab had “to galvanize people’s imagination” about the expandability and applicability of BMIs (Powel, 2013, May).
In closing this loop between a brain and a virtual body using BMI technology, we now know the primate brain can operate beyond the boundaries and physical constraints of its body and interact with any world presented to it (Nicolelis, 2011a). Here the target happens to be a robot. It could be a crane. Or any tool of any size or magnitude. The body does not have a monopoly for enacting the desires of the brain (Blakeslee, 2008, January).

The plasticity of the BMI allowing it to close a loop with various motor apparatuses including even readymade technologies, such as a crane, was suggested as what would enable this network to be free from any physical constraints of the lab and bodily boundaries of experimental animals. This also means that, for the loop to extend beyond those boundaries, it should be continually re-opened to accommodate new experimental parameters, translating the public interests in the BMI’s social applications. A favorable balance of influences needs to be renegotiated in every new training session so that the actors can re-adapt. Throughout the lab’s publications, the BMI’s performance has been measured in terms of how seamlessly its diagram could enclose more complex motor parameters and different types of robots into its loop. In Nicolelis’ book, *The Relativistic Brain*, this capability of enclosing a variety of motor functions is discussed as the BMI’s possibility as “a biologically-inspired hypercomputer,” functioning like a biological version of a universal Turing machine, potentially capable of controlling every “artificial, real or virtual actuator” (Cicurel & Nicolelis, 2015, Ch7).

While the capability of BMIs to wield their action potentials beyond typical physical and biological boundaries has been explained as “what a naturally evolved brain can produce” with its “self-adaptable (i.e. plastic) elements,” a number of questions remain unanswered, or even unasked. What happened to Aurora and other unnamed macaque monkeys during the “few nerve-racking, nail-biting, soul-searching moments” of missing time in which they might feel not
only just “being puzzled,” but disabled? What was the “special care” that the scientists mentioned they needed to do “to keep experimental conditions controlled and restricted to specific task requirements” (Kim et al., 2006, p. 159)? As long as these interventions from human observers in training sessions are omitted from their publications, the closed-loop becomes more black-boxed as the product of the natural progress of a system.

Figure 4.2: Janus’ dicta in Science in Action (Latour, 1987)

However, when we shift our focus to the inside of these “nerve-racking” hours, in which the intervals within the loop should be filled by the physiological and algorithmic adaptations of things, what previously appeared natural reappears to be problematic. As Latour, in Science in
Action, writes in the voices of his Janus, whose faces represent two different perspectives on science (one from the outside seeing science as a readymade product, the other from the inside where it is in the making) (Figure 4.2), the so-called natural progress of neural ensembles—which the lab promoted as “the cause that allowed controversies to be settled”—appeared, in the moment of network making, to be “the consequence of the settlement” between conflicting neurons in a certain design engineered as a spatial abstraction of the lab’s principles. Whereas the BMI as readymade science expanded its influences upon the public by convincing people outside of the future that this naturally-inspired hypercomputer promised, the BMI in the making could begin to work only “when all the relevant” actors—neurons, computers, and robot limbs—were convinced by this design’s re-distribution of their biologically or algorithmically programmed interests within the loop. From this perspective of the network in the making, the lab’s principles of neural ensemble physiology—which are supposed to mirror the natural phenomena that the BMI imitates—are no longer “the [natural] cause that allows projects to be carried out,” but what need to be naturalized by the network’s inner densification (in terms of the number of relevant actors enrolled to a closed-loop) and outer expansion (in terms of a variety of social and individual interests in the “Walk-Again” that the BMI promises). In other words, these scientific principles have functioned as an abstract diagram that has realigned the heterogeneous interests of outside actors with a local loop of small entities in the lab. They are not the natural causes science discovered, but the protocols or manuals to re-distribute a variety of actors both in the lab’s physical and social environments according to the ontology it draws (Latour, 1987, p.10, 99, 175).

In the interval between the two faces of Janus, which also represents the missing time between the nonconscious mutual adaptations of small things in milliseconds and the awareness
of humans and animals of their agencies beyond boundaries, the experimental subject as a conscious being also reappears as an ambivalent figure. In the World Cup demonstration, Pinto was introduced as a readymade subject, already trained to know how to control and exploit a network of these small things for his interest in overcoming the boundaries of his handicapped body. The monkey’s perceptual consciousness and motor intentions were, on the other hand, significantly restricted in the lab by a specific juxtaposition of things. The artificial sensor-actuator circuits emergent from this juxtaposition determined the ranges of possible perceptual stimuli and cortical responses the monkey could engage with.

For the lab’s sustainable expansion, BMI needed to gradually re-cultivate a subject’s heterogeneous motor intentions and desires for rewards into machine-readable and predictable forms. What Donald MacKenzie once wrote regarding the role of scientists as system builders is also true for the sustainability of Nicolelis Lab and its scientific principles:

No laboratory development is ultimately self-sufficient. If the environment is not right or is not made right by the system builders, any line of laboratory development will lack external influence and may indeed cease altogether. (MacKenzie, 2012, p.208)

Expansion of a Network and Mobilization of Interests

Since Nicolelis Lab’s BMI reached its first closed-loop with Aurora in 2001, the loop has been continually reopened to experiment with the range of its plasticity and adaptability, accommodating more actors and experimental parameters. The number of neurons in the loop has increased from about 100 to 800. The simple task of controlling a joystick directed left or right has been replaced by three-dimensional reaching and grasping tasks (Carmena et al., 2003), walking on a treadmill (Fitzsimmons et al., 2009), and bimanual arm movements (Ifft et al.,
The motor parameters scanned from infrared markers on the bodies of animals have become more complicated from the triad of hand position, velocity, and gripping force with small degrees of freedom to the simultaneous muscle activities of biceps, triceps, deltoid, extensor digitorum, measured by the surface electromyographic (EMG) (Santucci et al., 2005), “Muscle Geometry” consisting of “the insertion point, origin point, and line of action of each muscle group” adapted from the field of biomechanics (Kim et al., 2007), and “walking parameters” such as step time, step length, foot location, and leg orientation (Fitzsimmons et al., 2009). The robotic-prosthetics operated by brains have also been changed from a robot arm to the locomotion apparatuses of a humanoid robot (Nicolelis & Chapin, 2008), and to “a realistic, virtual monkey avatar” (Ifft et al., 2013). The physical range of the closed-loop has extended from a single laboratory in North Carolina to a network of two laboratories: one located in Kyoto working on the humanoid robot part of the loop, another in North Carolina taking the brain part, transmitting its action potential to Japan through a high-speed internet link “literally expanding that primate’s brain reach to the other side of the earth” (Nicolelis & Chapin, 2008). The physical medium implanted in a brain has also been renovated not only to send signals wirelessly (Schwarz et al., 2014), but also to receive proprioceptive feedback from robotic prosthetics in the form of intracortical microstimulation (ICMS) without sense receptors attached to the skin’s biological boundaries (Brain-Machine-Brain Interface, BMBI) (O’Doherty et al., 2009). Throughout these experimentations on the BMI’s adaptability to other readymade apparatuses, including a treadmill, humanoid robot, EMG, Muscle Geometry, and noninvasive EEG used in the World Cup Demo, computer algorithms have also been updated from using linear modeling, such as Wiener filter, LMS adaptive filters, gamma filter, and subspace Wiener filters, to
nonlinear models, such as time-delay neural networks, local linear switching models, and finally the Unscented Kalman Filter (Kim et al., 2006; Li et al., 2009).

Figure 4.3: Brainet of three monkey brains (Ramakrishnan et al., 2015).

In more recent research, Nicolelis Lab juxtaposed three monkey brains with a virtual monkey avatar instead of a physical robot, experimenting with the possibility of the Brain to Brain Interfaces (BtBIs). The lab reported that, after “several weeks of training,” the three monkeys and one avatar eventually formed an organic computing device which they named Brainet, “a self-adapting computation architecture capable of achieving a common behavioural goal,” such as a three-dimensional reaching and grasping task in virtual reality (Ramakrishnan et al., 2015, p.10; Pais-Vieira, 2015). In this new setup, each monkey was in a separate room watching a computer monitor displaying a two-dimensional projection of an avatar shown from
each side and trained to operate only one side of this three-dimensional avatar (Figure 4.3). As the collective firings of three separated brains eventually succeeded in operating the avatar in the space of higher dimension than the space each belonged to, the researchers declared: the “shared BMI allowed multiple monkey brains to adapt in an unsupervised manner.” Black-boxed as a “self-adapting computation architecture” (Ramakrishnan et al., 2015, p.10), the BMI, redefined as an inter-brain network, is now capable of expanding its promise to the problems supposed to be higher-dimensional than the world in which its users live.

Throughout the evolution of the BMI, scientists have selected experimental entities to include in the loop driven by their interests in expanding the loop to the bigger neuronal, geographical, interdisciplinary, and industrial networks. Whenever those entities were chosen as possible contributors to the lab’s expansion, the publications described them as representing new hopes that people outside could anchor on the BMI. From rats (as an umbrella species for the whole upper vertebrates) to owl monkeys (New World) and macaque monkeys (Old World) and then to human patients, experimental subjects have been chosen by how similar the anatomical structure of their brains was to their human relatives (Nicolelis & Chapin, 2008). The motor parameters involving the behavior of monkeys—from simple arm movements and reaching-grasping tasks, to bimanual and bipedal movements, to the control of a virtual avatar—have been chosen by how they “could be used in human neuroprosthetic applications” and “contribute to the development of future clinical neuroprosthetics systems” (Santucci et al., 2005: 1537; Ifft et al., 2013: 8; Li et al., 2009). The wireless electrodes implanted in brains instead of microwires used previously were expected to “reduce the risks of infection introduced by the use of cables that connect brain implants to external hardware” when applied to human patients (Lebedev & Nicolelis, 2006, p.540). The three monkey brains connected through the BtBI were supposed to
provide other scientists with “the core for a new type of computing device: an organic computer” (Pais-Vieira, 2015, p.1). As the geographical distance between the brains in the Nicolelis Lab and the robots in other places are extendable through the internet protocols such as TCP/IP (Wessberg et al., 2000, p.363), the BMI eventually becomes a machine for a long-standing desire of humans in general, namely their telepresence “beyond boundaries” (Nicolelis & Chapin, 2008; Nicolelis, 2011a).

The more variety of biological and technological actors the loop enclosed inside, the more interests Nicolelis Lab promised to the actors outside. The more this loop looked adaptive to the new experimental setups in “an unsupervised manner,” the more credits Nicolelis Lab earned from academia, patients, government, industries, and the audience of the World Cup demonstration. These interests, raised by the lab’s “promising too much,” (Miller, 2014, May) required Nicolelis to be a skillful manager not only as an organizer of an international consortium, but also as a supervisor, determining how to exploit the adaptability of small things to a new laboratory design that embodied the various interests of big actors outside. Put another way, mediating between the interests of small things and those of big things, Nicolelis needed to manipulate the missing times successfully; by translating the confusing and ambiguous moments of intervals full of relations as yet un-stabilized into the delayed hopes and promises for the future, everything is possible.

Designing the BMI has for Nicolelis been to draw a diagram capable of realigning along its closed-loop the heterogeneous interests of the relevant actors—such as the physical (neurons and muscles), technological (filtering algorithms, robots, and brain scan apparatuses), and the societal (patients, a scientific consortium, media, and the Brazilian government). Their interests
should be passed through the mediation of this diagram to be represented as what the future applications of BMI promise and, in this respect, the diagram, as a spatial abstraction of the scientific principles, has functioned as what Michel Callon calls “obligatory passage point” (1986, p.7). As long as the diagram’s flexible and constant re-distribution of small objects inside the lab could translate the heterogeneity of interests outside, the BMI could attract more interests from supporters and exploit them as the resources for the lab’s expansion. Throughout the missing times between the diagram’s re-distribution of objects and their becoming a working sensor-actuator loop, or an actor-network, the subjectivity of experimental animals and human patients has also been reprogrammed and re-enclosed into the loop. Necolelis Lab’s promotion of future subject, supposedly capable of becoming beyond boundaries according to “what a naturally evolved brain can produce” (Kim et al., 2006), has however concealed the real condition of experimental subjects in the lab. Their actual attempts to reach out beyond their biological boundaries have been continuously subject to the system’s scanning and filtering to measure how compatible their hopeless motor intentions are with the outside actors’ interests in the BMI’s commercial uses.
CHAPTER 5: THE HORROR OF FOUND FOOTAGE
AND THE SPECULATIVE ECONOMY OF ATTENTION

The case of the BMI provides a novel way to analyze the recent networks of smart objects as the juxtapositions of intervals. As the operational elements of an actor-network, these intervals describe what happens in the junctures between many and one, actors and a network, or parts and a whole during the missing times of network-making. Within these intervals, some of small entities have eventually become actors by contributing to the formation of a temporal sensor-actuator loop seamlessly working for a given task whereas many others have withdrawn from the intervals to the background as the complexity or manifoldness of unknown networks mutually asymmetrical. Topological continuum was the concept this dissertation suggested for describing this background with manifold hidden networks. A human observer was said to be somewhat too obdurate to discover them in holding on a habitual network organized along his/her hard-wired sensor-actuator practices with everyday objects. On the other hand, fold or cut in Chapter 2 was the concept to foreground these intervals, hardly black-boxed as stable functional circuits any longer in the current smart spaces where the seamfulness between objects is not something to be sutured or concealed but to be preserved for culturing the networks’ multifunctional transformability. The intervals within these networks are open to lots of different interoperations between smart objects insofar as Ontology as the machine-to-machine protocol guarantees their maximum interoperability no matter what their interoperations intend. This openness of networks also enables application developers to redesign the sensor-actuator interoperations of objects for the new IoT applications. Nicolelis could promise almost any imaginable future uses of the BMI by exploiting or exaggerating the plasticity of small things—
biological neurons in one’s brain and artificial neurons in machine learning algorithms—to form any sort of working sensor-actuator loops. Likewise, the developers of IoT applications are exploitive of the unexamined interoperability of smart objects, which withdraws from the current uses of sensors and actuators, but would be re-employable for a new way to enclose a space around its new parameters, in other word, to re-bifurcate it constantly into different problem spaces for ubiquitous computing. However, for this sort of speculative job—namely, the ceaseless mining of hidden parameters—to be acceptable as still endurable by the IoT subscribers despite the fact that they already paid enough for their new digital infrastructures, they should become convinced about the futures that the IoT promises. In other words, to justify the smart objects’ infiltration of a greater variety of our everyday activities and to reassure us about our being stuck in their intervals, certain discursive formation needs to be paired with the expansion of smart networks. As exemplified by Nicolelis’s discursive strategy to manage people’s hopes and speculations in the ambiguous futures of BMI, this discursive formation has functioned to do more than simply defining what is inclusive in the current form of networks and thus what is perceivable to the current system and its observers. In short, the discourse is no longer an epistemological issue. Rather, the discourse about the hopes and futures has the form of speculation about the totality never graspable by a single network because its massiveness and heterogeneity mean the complexity of networks lurking in the background, most of which prefer to remain silent as anonymous actors to one another. Instead of reconfirming a subject’s epistemological limit to access the whole, the totality for these ontological discourses justifies our speculation about the other worlds constructed by invisible nonhumans. This sort of speculation is justified as the nonhumans withdrawing from our phenomenological world are still believed to be exploitable for our human goals if we have a better means to negotiate with them.
In this respect, the recent *speculative realism*, which Chapter 1 discussed as something resonant to the recent object-oriented worldview of the IoT, is an example of this new discursive formation for the *speculative economy*, which ventures its capitals on the risky missions to data-mine the hidden correlations among the complexity of ecological beings in the background.

According to the previous chapters, this speculative model of economy has discovered its niche market from the intervals between smart agents, both humans and nonhumans. These intervals, until reassembled into working sensor-actuator interoperations, are where we project our ontological concerns about the worlds beyond our accessibility. A smart vehicle is an example of this interval where a driver’s concerns for his nonconscious desires are graphically re-individuated along a red route to a Point of Interest (POI) that AIDA suggests on a screen. A smart home is another interval where a tenant’s concerns for invisible efficiency problems in her everyday routine are re-individuated into certain parameters of a domestic space that smart objects communicate. An open-world in a videogame is an interval that hides lots of stories, puzzles, and encounters among its virtual objects ready for a gamer’s targeting. Nicolelis Lab is where the intervals between neurons and robots are constantly redistributed to cultivate more sensor-actuator connections between them for various future uses of BMI. Despite the confusing moments of the intervals, they were all discussed as the places worth staying, even at the risk of disabling oneself as the monkey did in Nicolelis Lab, or at the expense of enduring a long time of nothing happened just as many open-world videogamers usually do. Our endurance of these confusing intervals and disoriented staying are the new forms of labor that we perform according to our routinized everyday protocols and this affective labor generates the resources from which the ubiquitous computing excavates further hidden correlations. There is always a plentitude of others within the intervals and they are constantly withdrawing from a network that humans
construct. As a technique to trace their withdrawals, what actor-network theory urges us is an ontological turn in our understanding of these slippery others and their ungraspable totality. No longer signifying the impossibility of a seamless closure of a subjective reality, the totality is now reimagined as a fractal of networks, guaranteeing our unlimited speculations about inter-objective realities drawn by these objects’ constant withdrawals from us. The wireless sensor and actuator network (WSAN) of the IoT operationalizes this ontological turn and discovers the resources for its creative reality-making from the ubiquitous intervals between sensors and actuators. Within the intervals, some things persist in lurking and making their secret networks without yet being communicated by any registered sensor-actuator arcs. These things can be unknown correlations between environmental parameters, imperceptible environmental cues, various vital signals from organisms, neuronal firings, and people’s conscious or nonconscious behaviors. For human users, these things are only felt affectively as they always fail to pay proper attention to these existences beyond human understandability. Their repeated frustration in paying attention is in turn followed by their speculation about the problematic realities secretly proliferating in their surroundings and own bodies.

This concluding chapter of the dissertation discusses how the current media industry accumulates its speculative capital within these ubiquitous phenomena of intervals, in the forms of people’s ontological concerns about something unperceivable but proliferating behind their perceptions. In doing so, it examines found footage, a recent film genre characterized by its use of fragments of video footage created by the recent trend of miniaturization of camera technologies represented by the current designs of camcorders, smartphones, and surveillance cameras. In line with the dissertation’s focus on sensor and actuator networks, this new film genre is important as the example to show the breakdown of the institutional form of cinema,
camera obscura, or an architectural prototype of a single and universal viewpoint of the modern subject into the multitude of small cameras embedded in our everyday life. Each of these cameras is the simplest combination of a sensor and actuator. Often augmented with a motion-sensitive motor operation, this camera provides another instance of interval that cultivates within itself something withdrawing, persistently felt, but never fully graspable by the motor’s local follow-up. Found footage, in this respect, reflects the changed meaning of media technology from the machine to produce attention to the machine to culture some things escaping from attention. This concluding chapter takes these things, proliferating or cultured within the ubiquitous intervals of surveillance networks, as the source of the recent cultural paranoia about hidden networks.

**Horror of found footage**

*Paranormal Activity* (Peli, 2007) and *The Blair Witch Project* (Myrick & Sanchez, 1999) are often considered the two most essential contributions to *found footage*’s establishment as a film genre in the early twenty-first century. Alongside their unexpected box office success, both films’ employment of portable video technologies as a means of extracting something photogenic from every quarter of reality has been cited as foundational of the genre’s cinematic form (Heller-Nicholas, 2014; Och, 2015; Sayad, 2016). Something that has not been discussed, however, is how their conversion of material realities, now embedded with numerous video cameras, into ever-expandable filmic spaces suggests a cognitive condition for the genre’s typical supernatural contents to be witnessed everywhere: from a domestic setting in San Diego recorded by an immobile camcorder to a desolate forest near Burkittsville, Maryland recorded by student filmmakers on a shaky handheld camera. *Paranormal Activity*’s iconic long take
surveillance footage is noteworthy for the way it locates audiences in front of a monitor, making them hypersensitive to any minute anomalies occurring at the edges of the frame without letting them take proper action—panning, zooming-in, or moving to a better angle—to further identify what they perceive (Figure 5.1). On the other hand, *The Blair Witch Project*’s handheld movement results from the filmmakers’ panicky motor reflexes to the things they see but which are obscured for the audience, leaving too many vectors to reconnect its abrupt cuts into the intended narrative for a documentary (Figure 5.2). As the two aesthetic signatures of camera operations available in found footage, these moments of demonic emergence expose the genre’s self-reflexiveness. Contrary to other classical genres, found footage has established its generic dimension not by sharing a thematic prototype but by its conscious deployment of a camera’s sensorimotor relations to a space according to its redefinition of reality-effect, no longer based on the seamless interconnection of the actions the camera(s) take(s) in different angles. It is the alternative rule for reality-effect; all cameras need to be set-up, operated, and moved by a person, not an author or invisible narrator, but standing on the same material footing with cameras and other objects, so that a shot can be closed only by the actions contained in itself such as a person pushing the record button or an assault on the camera by unknown entities. As the result of this rule’s consistent application, a segment of footage displays a tension between the things gradually foregrounded as responding orderly to the actions taken by the cameraperson and the things remaining embedded without eliciting any distinguishable response.

Even in a shot closed by a camera operator’s intentional action, this tension persists as an ambiguous quality sensible but not identifiable; we can think of this unresolvable tension as now emerging everywhere in our life-world which the ubiquitous surveillance cameras reframe with each narrow focus. As the owner of their own points-of-view rather than constructed as a textual
subjects in the continuous editing, the characters in these films ironically discover the uncontrollable always embedded in the periphery of their POV. As a self-reference to the genre’s lack of proper means to exorcise the peripheral, the haunting of the spaces conversely reminds us of other genres’ institutional means to represent something paranormal through the choreography of multiple cameras and their seamless combination. To reframe what the endings of both films leave unsolved, their sequels, *Paranormal Activity 4* (Joost & Schulman, 2012) and *Book of Shadows: Blair Witch 2* (Berlinger, 2000), indeed re-employed this institutional technique; respectively through the seamless interoperations of various self-tracking technologies such as video cameras, MacBook webcams, iPhone cameras and Xbox Kinect, and by simply restoring the institutional solution of continuous editing.

In short, these found footages extract new horror values from the peripheries of a camera operator’s restricted attention, and their timely appearance in the early twenty-first century and coincidence with the wide distribution of portable camera technologies reflect the media system’s recent interest in capitalizing upon something hidden in these peripheries. The demonic is supposedly lurking at each edge of ubiquitous sensors but fully identifiable only through the institutional control of the sensors’ sophisticated interoperation. From found footage not only as a film genre but as the raw output of democratized sensor technologies, represented by lots of “smart” spaces today such as Smart Body, Home, Office, and City, this conclusive chapter infers a new mode of attention economy that I term *speculative economy of attention*, and argues how it transforms something paranormal, or elusive of our efforts to pay attention, into a novel form of commodity in the new media industry.
Post-cinematic affect in-between sensors and actuators

In the frame of narrative cinema, or its Deleuzian definition as *movement-image*, we can describe the cinematic form through which the *poltergeists* possessing the spaces in both films reappear as such: something *perceived* at the edges of the sensor but never re-locatable to the center by a proper *action*, thus dischargeable only through the disordered motor responses. Deleuze categorizes cinematic images according to their states in circulation in a nervous system, or a machinic assemblage that consists of mechanical sensors, motors, and human brains. For
him, the classical narrative cinema is most of all a technological restoration of a brain’s sensorimotor representation, in which something perceived gets involved with subjective meanings as it changes in response to the actions taken by an actor (a camera or character). On the other hand, what he terms affection-image is an intermediary form of delay between perception and action, or that which “surges in the centre of indetermination, that is to say in the subject, between a perception which is troubling in certain respects and a hesitant action” (1986, p.65). As a quality remaining unresolved due to the absence of any following actions, the demonic in Paranormal Activity in this sense provides an example of affection-image recently emergent from between the machine’s fatigueless perception and the human’s delayed or “failed” actions to follow it (Hart, 2019, p.76). In Blair Witch, the demonic on the other hand appears to be more active in arousing numerous unorganized actions from the camera operator, and in this respect the affective is also agential in the Spinozian sense as the quality of a shot in a “critical point” at which it “embodies multiple and normally mutually exclusive potentials, only one of which is ‘selected’” by an abrupt cut (Massumi, 2002, pp.32-3). Brian Massumi characterizes “our information-and image-based late capitalistic culture, in which so-called master narratives are perceived to have foundered” as the “surfeit” of affect. According to him, affect is distinguished from emotion as “a subjective content” since it is pre-individual and pre-signification, emergent from the suspension of the sense-making of images at “the semantic or semiotic level” defined “linguistically, logically, narratologically, ideologically, or all of these in combination, as a Symbolic” (pp.26-7). The wane of “symbolic efficiency” of the narrative structure in fictional and nonfictional forms of media has revealed the “post-referentialitity” of our material reality, which rarely turns clear responses back to the actions for its technical and discursive measurements (Andrejevic, 2013, p.85). As a result, affect has been generalized as our
common responsive state. The timeliness of found footage as a new film genre of the early twenty-first century can be in this sense examined from its redeployment of the geographical distribution of digital cameras as the means to display the affective through its cinematic re-emergence between sensor and actuator. Found footage exploits affect as the new resource for filmmaking accidentally re-discovered from the failure in the seamless relay between multitude perceptions and actions of these ubiquitous sensors and actuators, and in this respect it also reflects the media industry’s recent strategy to monetize even audiences’ failure to pay attention.

In the film theories of the second half of the last century, the cinematic meant the quality effected from the alignment or misalignment of the images montaged together along the concealed actions of machines, such as a shutter’s flickering, the camera’s movement within a single shot, or its geographical displacement between two shots. Jonathan Beller says that “the cinematic mode of production,” which operationalized the attention economy of the last century, was based on the “separation and expropriation of vision from the spectator” by substituting this machinic circulation of images for our voluntary motor responses to the field of perception (2006, p.8). For him, the cinematic means the neurophysiological extension of the logic of industrial capitalism. He says; “Instead of striking a blow to sheet metal wrapped around a mold or tightening a bolt, we sutured one image to the next (and, like workers who disappeared in the commodities they produced, we sutured ourselves into the image)” (p.9). In other words, what the expropriation of the kinetic means of perception production in a theater leaves for the audiences to do is invest their “freedom reflex” (or neural plasticity liberated from the physical and geographic constraints of human bodies) into the production of surplus meanings between montaged images according to the imagined motor responses of the coherent/schizophrenic narrative subject (p.27). The cinema in the discourse of attention economy during the first decade
of this century\textsuperscript{20} has been in this sense defined by its two-fold kinetic operations to create “suspensions of perception” (Crary, 2001); first by its mechanical operation to translate the field of perception into the images framed in each fragment of celluloid; second by its embedding imaginary motor responses of normative/schizophrenic subjects within the filmic texts as the software to reprogram attention. As the surplus value in cognition, attention reifies images into something bigger than real not because audiences add physical labor of motor response to the images but because they believe that someone behind the camera (such as a protagonist or hidden narrator) is moving his/her body to pay attention to the objects. Attention separated from the intentional motor responses of audiences in front of a screen is instead re-inflected through the mechanical or algorithmic relay of images, and turned back to the audiences as the attention already given to those images by the actions of imaginary others textually or statistically constructed (especially statistically in Google’s PageRank algorithm). The cinematic as the mode of attention production in this sense operationalizes a theory of (re-)action which audiences need to internalize.

On the other hand, the surplus of cameras in every corner of our lives and following every move we make, which found footage mobilizes to extract hidden narrative values from the peripheries of attentions, defines another productive mode of attention. “The profound sense of

\textsuperscript{20} Attention economy was suggested in the late 1990s as the concept to explain the source of “scarcity” which governs the new economy of the cyberspace, whose oft-misconceived resource, information, is always “abundant” and “overflowing,” and thus impossible to be a “basis of an economy” (Goldhaber, 1997). On the other hand, the amount of attentions audiences pay to the information is always limited. In the subsequent works of the researchers such as Jonathan Crary (2001) and Jonathan Beller (2006) to expand the concept’s coverage even to the media culture of the early twentieth century characterized by the abundance of images and spectacles, cinema has been discussed as a technique to convert the attention into the form measurable and exchangeable in an economy. For the overview of the theoretical discourses on attention economy, see Crogan & Kinsley, 2012.
helplessness and paranoia” (Och, 2015, p.209) characterizing the affects aroused in Blair Witch and Paranormal Activity is mainly attributable to the person behind the camera not taking proper actions such as panning and zooming-in to follow and re-center the anomalies at the edge.

Something is haunting where our attention reaches but does not return anything to reconstruct a normative subject who would translate the sliding-by images into the rational movements of attention. What becomes productive for unfolding a narrative is instead the audiences’ *withstanding the images without taking actions* in order to charge the circuit between a sensor and actuator with affective qualities until they are discharged through the multiple disordered vectors with arbitrary cuts, whose hidden connectivity should be *re-found* only at a meta-level.

The new normative subject to rationalize the economy of attention in found footage is not the owner of the gaze behind the camera but the archivist whose job is to excavate the fragments of footage and reassemble them for display; such as the hidden commentator at the beginning of Blair Witch, who says “In October of 1994, three student filmmakers disappeared in the woods ... A year later their footage was found.”

Let me call this new mode of attention production *post cinematic*, following Steven Shaviro, in that cameras are now the “*machines for generating affect*, and for capitalizing upon, or extracting value from, this affect” (2009, p.3). The poltergeists as the sources of the paranoiac affects, whose exhibition values are rediscovered by the archivists at the meta-level, can be then understood as the metaphors for something hidden in the peripheries of our attention, which the attention economy recently attempts to monetize. In this respect, it is not a coincidence that, in a conversation on Paranormal Activity, Shaviro relates what the house is possessed by, namely “the demon in the PA movies,” to “an immense collection of data” performed by the self-tracking technologies in today’s smart buildings (Grisham et al., 2016). Even though we have
ownership of all these machines, “It isn’t always clear who ‘owns’ all the data.” Like the woman possessed by the demonic being omnipresent in the house of *Paranormal Activity*, our quantified-selves generated in real-time as our digital double from ubiquitous sensors are, he says, owned mostly by “Google and Amazon” (Grisham et al., 2016). As Cheney-Lippold says, “In most instances of algorithmic identification, we are seen, assessed, and labeled through algorithmic eyes, but our reaction is often available only to be obliquely felt”; “we may very well feel we are being watched but never see what sees” (2017, p.24). However, in this re-appropriation of the rhetoric of horror film criticism, *the return of the repressed* in cognition, Shaviro overlooks the fact that, in the film, the use of self-tracking technologies for the obsessive data collection is not the demon’s means to possess the woman’s body, but a part of her husband’s attempt to persuade her that there is nothing paranormal. To rationalize the phenomena occurring *beside* the center of attention, he is willing to share what his camera recorded with a psychic, professional analyst for paranormal activities. However, what he rediscovers even after he “lightened up the footage” artificially with video editing software is the fact that the ambiguous quality of the video typical for surveillance footage becomes even more ambiguous as he pays more attention to the periphery through a technological aid. As Sayad acutely points out, the husband’s belief “that by turning on the camera when an eerie presence haunts [his wife]’s sleep he can tame and control it establishes an ironic pattern that underscores both the film and its sequels: the act of filming invariably backfires, granting the ‘monster’ access into the characters’ lives” (2016, p.52). The horror of found footage in this sense shows the irony of the recent democratization of sensor technologies and simple data processing tools. By retrieving these means of attention production, which support the recent *streaming culture* in which an audience seems to retrieve the power to direct even the attention of others to the action
s/he locally takes and broadcasts through a webcam, we also rediscover something *para* with which we have always shared our spaces; something embedded *beside* as the stain in the peripheries of attention and withdrawing further *beside* under our limited tools for data processing such as the digital zoom to enlarge the images already recorded. It should be *re-found* and *re-archived* at the meta-level to be reintegrated into the economy of attention. Put differently, something affective or post-cinematic in its mode of being appears from the grassroots and needs to be re-circulated in the higher level.

**The new low and high**

As Gillespie (2000) once pointed out, reality television programing in the late twentieth century already provided the platform for these affection-images emergent from ubiquitous sensors to be re-deployed in an institutional context, and we can examine this TV genre as having mobilized our affective concern over the peripheral for the emerging new attention economy even before found footage emerged as a film genre.

Neither constructed around the semicircular movements of the camera in a studio nor chasing the actions of journalists, surveillance TV series such as *World’s Wildest Police Videos* (1998-2001) and *Real TV* (1996-2001) in Gillespie’s analysis have a generic form as the collection of “found footage,” as “images produced outside of the entertainment television apparatus: workplace surveillance footage, police dashboard camera surveillance, hidden camera footage, amateur home video, and raw television news footage” (p.37). Whereas this *seamful* collage of low-tech videos inevitably contains inherent ambiguities, the stacked layers of audio—from “on-camera soundbites from police officers, witnesses, victims” to an expert’s comment weaving all of these reports from below together (p.37)—function in these series to
extract multiple vectors from the videos to then interconnect into a narrative describing images stuck within a city’s sensor network as pathological and criminological such as hidden dangers of crime, vandalism, and terrorism. According to Gillespie, the legitimate and illegitimate uses of video cameras for the participatory bottom-up process of surveillance, often called “synopticonism” (Andrejevic, 2004) or “sousveillance” (Cascio, 2005), have been defined. In Video Justice: Crime Caught on Tape (1997), a special on FOX, the voice of the narrator authorizes footage as a viable use of home video, “a white man being harassed by neighbors about his homosexuality sets up a camera and records himself being brutally attacked”; another is conversely categorized as the deviant use of video technology, “a video made by several black youths as they gleefully drive around Los Angeles shooting paintballs at transients and pedestrians” (Gillespie, 2000, p.39). These two cases of camera movements, which I term withstanding without action and discharging through unorganized action, represent two poles in a continuum of possible actions a local sensor device could take, from a complete inaction to a completely disordered reaction, which also expose the affects stuck in-between perception and action of the city’s “artificial nervous system” (Hayles, 2016; Hill, 2008) in the forms of paralysis and haphazard responses. If the footage in these cases were intentionally selected to display something affective, unresolvable by a sensor’s modular action, the editorial processes of reality television on the other hand emphasizes the necessity of the discursive control of the expert’s voiceover to redeploy something para sensed from below in a sense-making narrative (which the amateur documentary producers in Blair Witch failed to do).

The bottom-up process of surveillance is textually reconstructed by the stacked layers of audio and video in this TV genre, but it is not simply participatory or successful in democratizing the visual pleasure of the Panoptic observer. The bottom-up is rather re-interpreted as the
institutionalized route for the citizen sensors’ concerns for the invisible dangers sneaking around their limited attention to be redirected to the authority accessible to a citywide sensor network, preventing them from jumping to the paranoiac delusion of a demonic network behind. (For instance, the husband’s stepwise attempt to bring his footage to a psychic in a town, and then to a famous demonologist Dr. Johann Averies in *Paranormal Activity* is, despite his failure to do so, the only possible cure for his wife’s paranoiac jump-to-conclusion regarding the poltergeist.) In this sense, the two modes of video technology, which Fiske calls *videolow* and *videohigh*, are in a new complicity in surveillance TV shows. And along the vertical pipeline through which the producer in the high extracts hidden narrative values from the videos in the low (or along the pipeline which distinguishes found footage as a film genre from surveillance TV shows in that the former’s armature producer always fails to control these videos in the low whereas TV producer is always exploitive to these grassroots), affects are now not simply discovered but cultivated as the resources for the network’s sustainable expansion. Regarding this affective quality of videolow, Fiske says;

> [L]ike the Rodney King video, their lower-quality images, poor but closely involved vantage points, moments of loss of technical control (blurred focus, too-rapid pans, tilted or dropped cameras), and their reduced editing all serve to reveal the discursive control that official news exerts over the events it reports. Videolow shows that events can always be put into discourse differently from videohigh, and this enhance its sense of authenticity (2002, p.389).

Jump-to-conclusion is descriptive of the common pattern of conscious process observed in the delusional subjects suffering from paranoia, namely to draw a very improvable conclusion immediately after they see very ambiguous and insufficient hints (McKay et al., 2007). This pattern seems to be relevant to the patients’ intolerability to seeing anything open to unknown relations, indescribable by known narrative closures (Mills, 2003).
For Fiske, the authenticity of low-tech video is due mainly to “its user’s lack of resources to intervene in its technology.” The user, or citizen sensor with “a camera, but not a computer enhancer” could “produce and replay an electronic image, but could not slow it, reverse it, freeze it, or write upon it,” and thus the images the user creates appear “so authentic to so many precisely because he could not” (p.388). His definition of authenticity of mechanically produced images is distinguishable from that of Bazinian realism based on the images perceived and relayed purely by the mechanical action due to a human operator’s intentional non-intervention (Bazin, 2005). Authenticity of videolow for him is rather a sort of affective value added to the footage due to the operator’s inability or frustrated attempts to intervene in its hidden meanings. Redefined as these mechanical images charged with either meanings or affects according to whether they are successfully redeployed in a citywide surveillance network or still stuck in-between a local sensor and actuator, found footages as videolow proliferating in the recent urban landscape turn out to interface two very different networks beyond our accessibility; first, there is the network of cameras whose simple and modular actions can be reassembled by an institutional agent in an editing room for reality TV programming, or control room for citywide security cameras (Sadowski & Bendor, 2019); and the imaginary network of demonic beings or terrorists the citizen sensors obsessively infer beyond their perceptibility. These two networks are symmetrical as the former’s intervention in the low becomes more justifiable as people become more paranoid and jump to conclusions at the presence of these invisible evils behind the surface. The participatory and democratic form of bottom-up surveillance, which reality TV programming idealizes as well as monetizes, is in this sense driven by audiences’ generalized paranoia, or their self-reflexive and gut feeling that there is always something non-representable left beside their technologically mediated attentions. In other words, for the bottom-up to be
agreed upon by the participants as the solution for their local issues, it needs to be speculated by them: everywhere is haunted by nowhere in which something demonic is embedded. It is always unclear who really occupies this nowhere since it constantly moves beside our actions to grasp it. However, for that precise reason, videohigh claims its right to videolow; or mediahigh in the upper layer of cloud servers, such as “Google and Amazon” accessible to not only optical sensors including webcams but all kinds of digital sensors, claims ownership of data collected from a user’s material lower layer insofar as the problems lurking in the space are too dispersed to be identified by our local action of zooming-in. The proper actions to exorcise them are still supposed to be programmed by the high capital, high technology, and high power with enough means to intervene everywhere in a simultaneous and timely manner just as the expert’s voiceover in FOX’s special redisposes all the lower layers of video and audio for a sense-making narrative. However, this authorized narrative or its “Mass surveillance may be doing less to deter destructive acts [from the demonic] than it is slowly narrowing of the range of tolerable thought and behavior” without being reported to the authority (Pasquale, 2015, p.52).

In this respect, the found footage both as a film genre and raw material for surveillance TV series reflects media systems’ recent division into the new low and high, whose vertical complicity is strengthened by the problems whose symptoms are distributed too horizontally. For this complicity to be sustainable—in other words, for more symptoms to appear to be identifiable only through their redisposition in the high—the sensor technologies owned by individuals need to be post-cinematic in the sense of the term by which Shaviro means machines for generating affect. The most urgent problem for these sensors to put under their local surveillance is something perceived beside their restricted focuses and moving further beside as they take actions to catch up. For capitalizing upon, or extracting value from its constant sidling
movements at the bottom, the software in the top should be accessible to these local technologies to trace its escaping vectors (just as a human operator in a control room improvises a multitude of local actions with security cameras to reassemble the ambiguous hints distributed at the edges of each screen into something criminal happening in the city). Media’s *systems of visibility and statement* are restructured along these autonomous *sensors* with simple modular *actions*, and their bottom-up process to make statements about what is going on in the space is no longer dependent on the normative actions of anthropomorphic paying attention, through which the mechanical, or algorithmic, relay of images used to be interpreted into something perceived by a hidden subject behind a screen. Instead, the only normativity of the actions in the editing room and control room is the flexibility in reassembling multitude small actions in a timely manner. There is nothing behind the cameras for us to internalize as the normative observer of what happens at the peripheries, only the modular actions of the sensors and their algorithmic interoperations, never anthropomorphized by the continuous editing because they are “operatorless” (Sayad, 2016, p.48).

What then are these worldly problems always outside our attentions and thus represented as something demonic by the high? Regarding this question, the rhetoric of *the return of the repressed* is still helpful to describe the productive mode of repression in the recent attention economy. Attention as the surplus in cognitive production is not simply added to the images as “we sutured one image to the next” (Beller, 2006, p.9) according to the actions and choices performed by an imaginary normative subject such as the average user algorithmically reconstructs. What should be monetized further in the time where everyone is an editor of one’s own attention in the customized software interface is the fear of the marginalized in their limited focus; the generalized concern for the fact that our too human attention leaves too many blind
spots. “The sense of lurking danger is enhanced as much by our fear about seeing things as by our anxiety about what we do not see, and the generation of this uncertainty about whether or not we will see anything involves choices in framing” (Sayad, 2016, p.55 ). By speculative economy of attention, I mean this new structure of attention economy in which audiences’ overvalued concerns over their inattention are speculatively reinvested into their overvalued hope for algorithmic attention. The following interpretations have been nominated for the demons occupying these blind spots overvalued by our inattention, or attention always-not-enough-paid: the danger of terrorism (Massumi, 2015), nonlinearity of environmental changes (Lanzeni, 2016), non-self-recognizable inefficient resource use (Strengers, 2016), and products you are likely to like but unlikely to pay enough attention (Thalere & Tucker, 2013). As the horror genre of found footage allegorizes, the urgency of this nowhere is overvalued as a person’s local actions to detect it are frustrated repeatedly. On the other hand, the advanced software of surveillance, what the expert narrator in the surveillance TV show allegorizes, is supposed to exorcise this nowhere through its sophisticated redeployment of multitude sensors and actuators, which eventually illuminates the hidden dimension, hitherto felt only affectively, as measurable in terms of statistical patterns. The demons are discovered by the ubiquitous sensors and then re-invented as the problems to be solved by the ubiquitous actuators, just as the unresolved ending of Paranormal Activity leaves a problem resolvable by the interoperations of self-tracking technologies in Paranormal Activity 4. This is also the reason why, in the era of smart phones embedded with multiple sensors, we need to agree that the applications empowered by cloud servers also have the right to activate a phone for collecting data about what happen to the phone and its user.
John Durham Peters says: “The cloud evokes ancient ideas of a heavenly record containing everything ever said and done, a record both worldly and infallible. If ever there were a target for old-fashioned Marxist demystification, this would be it” (2015, p.332). On the other hand, regarding the power of *data clouds* the supposedly omnipotent AI applications are based upon today, our resurrected faith in the cloud is rather our rational response to the re-discovered boundary of our restricted subjectivity; beyond which we encounter not only the demonic but lots of algorithmic beings communicating each other about the demons on behalf of their human users.

**Speculative economy of attention**

The recent achievement of miniaturizing sensor, processor, and actuator technologies to the point where they can be embedded in a variety of objects in various environments has popularized the adjective “smart” as applicable to various social spaces of different scales (Crandall, 2010). Now our smart life stems from the awareness of our very standing at the interlocked boundaries of these spaces each re-divided into low and high; such as our physiological, domestic, and urban spaces tracked by different sets of sensors embedded in the lower layers of a Smart Cloth, Smart Home, and Smart City under the control of each different software application in the cloud servers. We can consider the middle between this new infrastructural low and software-running high as the space for the new market of speculative attention economy to be cultivated, in that the domains of our life, from a body to city, resituated in this grey area are now fully charged with the demonic; this is comparable to the various vital signals under wearable sensors and people’s collective behaviors under citywide environmental sensors, elusive from our local monitoring but detectable through a network of distributed smart
The more we feel affective to these flows beside our attention in our generalized concerns for dormant health problems, invisible dangers of violence, or distracting surpluses of information, the more attentions we might delegate to the software application which redirects our attention. “Smart disclosure,” a policy to encourage “the release of government information, corporate disclosures, and customer usage data in machine-readable form,” can in this sense be understood as a recent government-driven effort to re-direct this distracting tendency of digital flows into the algorithmic reorganization of attention through various “choice engines” (Thaler & Tucker, 2013, p.49). But for these engines in the cloud to be smart enough to draw our attention back to the best choice out of many available consumerist solutions for our worldly well-being (such as better diet, healthcare, housing option, retirement plan), we first need to agree, willingly or reluctantly, with the disclosure of our own social network profiles, online/offline behavior patterns, and the scores of psychometric tests we take consciously or unconsciously online (Stark, 2018) both to the government and corporate agents and even to the third-party intermediaries as the prerequisite for all other smart disclosures. And it is through this delegation of attention investment to the attention engines that the problems, which the husband in Paranormal Activity attempted to catch in a single camera take, turn out to be in fact stretched along many different domains; just as your heartbeat under the 24/7 monitoring of your smart watch can also be an efficiency problem in the task to find the most optimal behaviors in your house/office/city as much as detecting terrorists becomes a problem to find irregular shopping behaviors online. In other words, the algorithms’ redirection of our attention back to the urgent problems is potentially never-ending insofar as even a tiny pulsation such as your heartbeat could reappear in many different embodiments along the network such as your physical states not yet optimal to work out, sleep, have sex, and so forth. For these attention engines as well as
demonologists, a pulsation detected in one’s body, cookies about user behaviors, or in a haunted house appears to be a topological object that they can stretch to any other problems virtually connected to this tiny symptom. Redeployed in the high, these worldly problems are put in the forms not only easy but also necessary to attend to because they are displayed as “push” notifications on your smart phone and watch, or spoken directly by a smart speaker in your living room.

The demonic, once the source for the rupture in our habitual identification with a camera’s restricted POV in found footage, no longer ruptures the new attention economy since our paranoiac concerns for the invisible problems are now reinvested in the software in the high. Our new technological field of perception appears under algorithmic optics to be full of urgent problems, but what unfolds this problematic space out of databases collected from ubiquitous sensors is neither the simple action we take with our body and camera, nor the imaginary action of the normative subject. It is rather unfolded by the sidling movements of the demonic, now redirected to the network of smart sensors and actuators which translates these affection-images from the low into the images corresponding to the executions of software in the high. For example, the chaotic traffic congestions perceived in each intersection in the low could be recognized from the high as the images corresponding to the collective responses of drivers to the smart traffic lights distributed in a city (Xie & Wang, 2018); your irregular heartbeat perceived by the smart watch on your skin is translated into the image corresponding to your running pace guided by the fitness app in the cloud. In this sense, Deleuze’s typology of perception-images, affection-images, and action-images along the images’ circulation in a machinic nervous system has now another field of post-cinematic application in the wireless sensor and actuator networks (WSAN) in the IoT-based smart buildings and cities. Something
affective still emerges sporadically within the bottlenecks between sensors and actuators (or perceptions and actions) in the form of the temporal paralysis of software or abrupt discharging through the shutdown of software, reminiscent of *Paranormal Activity* and *Blair Witch*. But these horrible moments are also when the users are asked to invest their affective concerns into the bottom-up process of reporting errors in order to help the developers to update the software’s capability to further capitalize on the elusive signals.

Rather than being the surplus labor of cognition to add imaginary values to the images attended, our attention in this speculative economy is now capitalized indirectly as its investment delegated to the software ironically overvalues the urgency of problems hidden in the periphery of our attention. The software in the high on the other hand exploits the overvalued hope for its algorithmic preemption of the problems at the bottom as what justifies its permanent data collection practice. The motive power for the perpetuation of the attention economy of the past century was audiences’ *neurophysiological* investment of desire to the images they consumed (Terranova, 2012). The speculative economy of attention is on the other hand perpetuated by the overvalued dangers to which nobody could pay enough attention; or the overvalued hope for the network of manifold sensors and actuators, which is supposed to redirect our attention back to these urgent problems. As Andrejevic acutely points out, “Data mining is, in this regard, speculative as well as comprehensive” insofar as “data is captured not solely for current use, but also to take into account the possibility of any and all future scenarios and technologies” (2013, p.78). The problems expected to lurk in our lives will be never resolved immediately after we purchase a smart watch and move into a smart home in a smart city. But our investment in these technologies is still justifiable insofar as their constant data collection promises a near future
where all these problems are data minable; and thus until this future comes we need to delegate our investment of attentions to these sensors everywhere.

Chronicle

Asymmetry can now be understood as the key term which describes the sensorimotor relation through which we are engaged with our surroundings. In mathematics, symmetry means the feature of an object or its properties invariant under certain transformation such as rotation, projection, and displacement. Take our field of perception as this sort of object under constant transformations. The world appearing symmetrical to our perception would be then restricted to the world of objects which return invariant or orderly-variant responses to the actions we take with our body and technological sensors under our control. However, the increased number of sensors we are accessible to would not guarantee our more symmetrical engagement in the world, because it would rather redraw the boundary between two worlds we are engaged symmetrically and asymmetrically. Even if we could control all the zooming and panning of the webcams and surveillance cameras, we cannot trace all the problems embedded in a space, not just because we cannot monitor all of them simultaneously but because some of them are traceable only by a sophisticated montage of the cameras’ interoperations. (This advanced montage is comparable to the job of a criminal investigator who reconstructs the course of a disastrous event from the ambiguous hints distributed in the surveillance footages, but only after the event already happened.) These problems are asymmetrical to our simple actions but present to the advanced software in the high capable of reassembling the sensors’ worldly operations. Their asymmetries are nevertheless felt as something affective in the low. Until these unknown problems are re-symmetrified in the high, we thus need to withstand our staring nowhere without taking any
significant action. In this sense, it is the lesson of *Paranormal Activity*: do not attempt to communicate with the poltergeist, and do not play with an Ouija board before you contact a demonologist. What appears then as our common response to this restraining order is a “paranoid worldview in which everything is hopelessly complex but, with the right (data) tools, can be made deceptively simple and explainable” (Hu, 2015, p.124). This obsession with hidden orders “buried beneath the surface” of ambiguous symptoms (122) is nevertheless rational insofar as it promises a future where all these esoteric meanings would be explained even though it is infinitely postponed until one discovers the proper algorithms, data analysts, or demonologists.

For the audiences of the speculative economy, paranoia is even understood as “a strong theory” since it appears to be “capable of accounting for a wide spectrum of phenomena which appear to be very remote, one from the other” as resulted from “a common source” of danger (Sedgwick, 2003, pp.133-4). As Ulrich Beck already noted in 1980s, their paranoiac speculations about the latent dangers are “oddly immune to the critique of science.” It is because these fatalistic speculations also earn “their ‘truth’ and their supporters not before science, but in interaction with [science],” such as environmental science, behavioral science, or data science; whose algorithmic procedures to identify the problems are now re-incarnated in the form of smart applications (1992, p.169).

A person in found footage, standing behind his/her own camera without paying enough attention or taking proper action to the anomaly occurring at the edge of the frame, is therefore a perfect exemplum of the audiences for the new attention economy, whose persistent investment of attention to somewhere means their investment of undissmissable fears to somewhere else. For this person, the demonic is in nowhere to attend, or everywhere s/he fails to attend; so that its emergence from the peripheries is never rationalized through the anthropomorphized continuous
editing and thus needs to be put under the algorithmic perception through ubiquitous sensors. If our asymmetrical engagement to the surroundings is what justifies our decision to delegate our attention to the software to re-symmetrify them, the possibility to subvert this new hierarchy can be on the other hand thought of from the possibility that the local media users could hijack the software in the high as the means to redefine their affective surrounding not as demonic any longer but fully charged with potentiality as the Spinozian affect originally means.

Josh Trank’s Chronicle (2012), another found footage in the early twenty-first century can be examined with regard to this subversive possibility. Like many other entries in the genre, Chronicle takes the form of a personal record of supernatural phenomena which three teenagers experience after their encounter with an alien technology. The same aesthetic restriction of the genre, namely all cameras set-up, operated, and moved by a person standing on the same material footing, is consistently applied; but the styles of footages recorded before and after their encounter are significantly different due to the telekinetic superpower they earned from the encounter. This power enables a boy, Andrew, to control the movement and operation of his camera without physically touching it. In the early footages he records manually, the camera is thus always fixed or held in Andrew’s hand (Figure 5.3), but this restriction is not simply due to his lack of a technological aid for the more sophisticated camera operations but his need to behave as if nothing is recording whenever someone unexpected gets into the frame such as his father, street gang, bullies, and the boyfriend of the girl he peeped at a party. He must withstand their harassments rather than warn them about the camera; otherwise they will take away his camera and break it. Both his inactions and failed actions leave something unresolved within the frame, felt only affectively. On the other hand, after earning the superpower, he does not need to be afraid of taking action not only because nobody can beat him up any longer but because the
cameras floating up in the air are still fully under the control of his telekinesis. The more skillful he becomes at using his power, the more cinematic his life appears to be in the footage. In the latter half of the film where his cameras’ free floating becomes more sophisticated than any crane shot, the screen, once flattened as a two-dimensional plane typical of other found footage films such as *Paranormal Activity*, eventually appears to be crowded with lots of hidden objects, which are not “lurking dangers” any longer, but aligned along the camera’s unfolding a deep space reminiscent of institutional cinema.

![Image](image_url)

**Figure 5.3:** An inactive shot in the earlier part of *Chronicle*

One afternoon after he first used his power to retaliate against bullying, Andrew alone in a junkyard talks to the camera; “A lion does not feel guilty when it kills a gazelle. Right, you do not feel guilty when you squash a fly, and I think that means something. I just think that really means.” This “something,” once felt only affectively due to the lack of proper action to dramatize it, gets to be concretized into his theory of “apex predator” as his actions now reach everywhere; the camera starting from the close-up of his elated face slowly moves to a wide-angle shot and, at the end of his monologue, it reveals the hidden telekinetic cause and effect
between the action of his hand to squeeze the air and the deformation of a junk car in the background. His mobilization of the telekinetic resonance between his surroundings and cameras is culminated in its climax for self-narrative when he confronts his buddy Matt in the night air of downtown Seattle. Ignoring Matt’s warning against violence, Andrew hijacks tens of video cameras from the people in a building and surrounds his body with these cameras to record his rebirth as a super human from as many angles as possible (Figure 5.4), against the city’s surveillance network which translates something affective in the air into the familiar narrative of breaking news (Figure 5.5). Like a reality television producer, Andrew mobilizes a random set of cameras speculatively wherever he goes with an expectation that there remain hidden dramatic values still embedded in his home, school, and city: the expectation that would be fulfilled afterwards by the anonymous editor who found his footages and re-edit them into a chronicle of the emergence of a superhuman/terrorist out of the affective.

Figure 5.4: A shot cinematized along multiple cameras
Through the physical relocation of cameras from the low to high, *Chronicle* provides a magical scenario in which an individual’s investment of attention to his own life through multiple self-surveillance devices guarantees a high return. The wager Andrew is betting on with the cameras overinvested with his superpower is not like Pascal’s wager. According to Pascal, betting on an extremely improbable future event is justifiable insofar as the stake to lose is too high after it occurs by any chance; such as the existence of afterlife, or the possibilities that your house is really haunted, your neighbor is really a terrorist, the item Amazon recommends is really important to improve your life. Betting on these sorts of wagers is rational because to win the race is not for earning the reward but for losing nothing; if you win, you lose nothing, if you lose, you lose everything. Annie McClanahan (2009) points out that the popular narratives of catastrophic futures after 9/11 have assumed these hidden dangers as the kinds for which nobody can be properly prepared with purely “statistical models of forecast” given their too low probability (p.44). Instead, they can be preempted by proactive seeking for the possible links through which these yet-to-come events could really come. In the public understanding, these problems thus appear to be persuasive not because they look probable but because they sound
“plausible” in “scenario thinking.” Speculation is the discursive means of individuals to imagine myriad possible scenarios of these hidden links. And people’s paranoiac responses to their ambiguous surroundings with these overloaded speculations are, no matter how less probable they seem to occur in reality, sometimes enough to justify their speculative spending in algorithmic scenarios generated by smart applications if these scenarios are about catastrophic futures and they are at least plausible. As McClanahan says, “when plausibilist predictions (output) are made to serve as actual evidence (input) [for the urgency of the problems], they produce a closed circuit of speculation whose external truth can never be confirmed” (pp.58-59). Nick Bostrom (2019), in his recent suggestion of national and global policy of risk governance, suggests that this sort of speculative investment to preempt an extremely less probable future scenario could be still rational if it is plausible that at least one of balls that we pick up from “the urn of possible inventions” would be black. In other words, just one catastrophic case is enough to dismiss trillions of other non-harmful cases if it could result in a “destructive event that is at least as bad as the death of 15% of the world population or a reduction of global GDP by >50% lasting for more than a decade.” And then, he says,

even those who are highly suspicious of government surveillance would presumably favour a large increase in such surveillance if it were truly necessary to prevent occasional region-wide destruction. Similarly, individuals who value living in a sovereign state may reasonably prefer to live under a world government given the assumption that the alternative would entail something as terrible as a nuclear holocaust (p.4).

On the other hand, Andrew’s betting on the cameras is to earn everything, to claim his ownership over the data his cameras generate without gauging how many dramatic values are really embedded there. We can take his speculative investment of attention in Chronicle as an
allegory for the early *quantified-self* movement led by the technology gurus in *Wired* magazine such as Gary Wolf (2009, June), who delegated his attention investment to as many self-tracking devices as available to monitor “every facet of life, from sleep to mood to pain, 24/7/365” from different angles. Their expectation of the reward from this experimental practice was also very high, namely to discover the hidden parameters of everyday life for its unprecedented level of optimization and efficiency. However, it did not take long for the air, once opened to their decision to deploy which sensors in which positions, to be black-boxed by the ready-made smart objects and the IoT applications, smart enough to redeploy themselves in the rightest positions not only to exorcize but also monetize the inoptimality and inefficiency in their users’ life. In consequence, affect becomes once again the most immediate response of humans to the world under new media’s 24/7/365 surveillance as well as to their own body revealed to be possessed by lots of unknown problems out of their conscious control. As reported by many self-tracking users today, “a lack of ability to self-regulate,” or our asymmetrical engagement even to ourselves is what people find first from their selves quantified by self-tracking devices (Lupton, 2016, p.62). This generalized asymmetry as the rediscovered human relation to one’s own surroundings—whose hidden levels reappear symmetrical only to the advanced data mining applications—is the reason of “an obsession, compulsion or ‘addiction’ with one’s data to the exclusion of other aspects of one’s life” (p.64).

What does the telekinesis in *Chronicle* mean as to the ubiquitous asymmetries? As a magical solution for these asymmetries, through which our subjective reality is shrunken and stuck within the manifold of inter-objective realities, the telekinesis seems to emphasize the necessity to give humans back the control over the wireless and simultaneous operations of
ubiquitous sensors and actuators. What could then be more real-life examples of this magical solution to put the commercialized air, or the data cloud asymmetrical to data donors, back under the control of an individual for his self-narrative? The open-source movement and increased computational literacy may provide the keys to re-open these black-boxed realities of smart objects. But, as Burrell says about the limit of the human “code audit” for the ANN-based machine learning algorithms, the best even for the most computer-literate audiences to discover from the open-sources would be, in most cases, just the opacity inherent in “the way algorithms operate at the scale of application” (2016, p.4). The attempt to re-symmetrify the data cloud, which our voluntary and nonconscious interactions with digital objects generate, and to make it transparent to our own uses for optimizing our lives seems to inevitably reach a compromise. The subjective reality re-demarcated by this most enlightened human literacy of datum also turns out to be the most dwarfed since its Kantian enclosure as it is now stuck in a niche of manifold smarter objects.

Our insatiable dream of enlightening everything exhaustively is, however, still satiable ever after we reluctantly accept that there are hidden realities embedded in datum and we will never be fully accessible to them. This irony, which makes it easy to give up our fruitless pursuit for the self-enlightenment, is derived from a sort of ontologically reprogrammed ideology of today, the ideology no longer intervening in the condition of perception but pushing us to speculate about the beyond our restricted condition. The so-called Big Data is symbolic in this sense as a newly given big Other or a meta-object in the age of the Internet of Things. As an image of the non-representable totality, Big Data is not to cause the rupture of a coherent subject any longer. Instead, in its being a substratum of various smart spaces, Big Data encourages individual audiences to re-demarcate their restricted subjectivities along their obsolete human
literacy and reproduce their dwarfed boundaries by constantly projecting their paranoiac and ontological concerns about the existences beyond their boundaries. The world transformed into Big Data is supposed to hide an infinite number of correlations, inexhaustible by any human audits, but likely to be pattern-recognized some time or other if we let the smart objects continue to reassemble their inter-objective realities under different software applications. In other words, the IoT promises to further the project of the enlightenment through our rational wager on the agency of objects as nonhuman authors of ontologies. Under the new Enlightenment discourses of being smart in the current smart spaces, our paranoiac speculation about the problems in peripheries justifies our speculative investment in the futures, which the smart objects would bring after they infiltrate the finer-grained peripheries of our surroundings and fully enlighten all hidden orders embedded there.

As the first two chapters of this dissertation examined through the cases of a smart vehicle and smart home, the ambiances of the current smart spaces are characterized by the imperceptible operations of the ontological objects in the IoT and their secret exchanges of inaudible signals. Our affective responses to these ambiances sometimes make them charged with hidden horrors. On the other hand, the other two chapters on the open-world videogames and brain-machine interfaces suggested how the same ambiances could also be charged with our expectations and hopes for the smart objects that would unfold hidden solutions for currently unknown tasks and quests. With these ambivalent feelings, humans—the IoT subscribers or service providers—should bet on their future. The stakes they pay would be their concerns either on the overvalued horrors of hidden problems or overvalued hopes for these problems’ commodifiability; either hopelessly paying for their IoT solutions, or cultivating more horrors to convert them into the new IoT services. Our smart future and its promise of efficiency and
sustainability would be ever delayed to come to reality. This infinite delay is what we need to endure in the new phase of cognitive capitalism, which perpetuates itself through the trade-off between our speculations about unknown problems and their future solutions. While the totality of our hidden realities is constantly sliding under our discursive practices oscillating between paranoia and blind optimism, the smart objects embedded in the underlying continuum would unfold the actual futures. The smart futures, always remaining transitional, we would never feel fully secured by nor fully hopeless for.
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