From Predictability to the Theories of Change

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Abstract The study of processes and change in systems is a requirement for Theoretical Physics after the development of complexity and emergence theories. This matter is far beyond the ideal models—centered on predictability—that Mathematical Physics usually deals with. The strongly interdisciplinary and systemic issue of a Theories of Change implies a careful reconsidering of the essential features of the relationships between the observer/model-builder and the system under consideration. We delineate here such relationship as the meta-theoretical step wherein it is possible to give the first and partial collocation to the wide class of not ideal models, and to evaluate the effective forecasting possibilities of Big Data.

Keywords Complexity · Emergence · Ideal and not-ideal models · Predictability · Change · Big Data

1 Introduction: The Climbing of Mount Epomeo

Mount Epomeo (789 m, as Wikipedia says) is the highest mount of the isle of Ischia. The legend tells it is one of the four entrances to Agharta. As for me, it surely was the occasion for an extraordinary encounter. It was a very hot end of May in 1991, Giuseppe Arcidiacono—the great mathematician and cosmologist of Projective Relativity I first met through an intense epistolary exchange and, later, during my military service in L'Aquila—invited me to a Conference organized by University of Perugia and the Istituto Filosofico of Naples. I had the chance to discuss with

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many interesting people there, such as J. Barbour and L. Kostro. Anyway, getting acquainted with Eliano Pessa has modified and broadened enormously my Physics and has endowed me with a vision for Systemics. I had recently published some papers (I find them quite naive now) about lattice space-time on Plank scale. The lattice worked as a constraint for a set of oscillators which produced the observable particles . Just to give an idea to the contemporary reader, it was an idea similar to what ‘t Hooft has been recently developing, far more elegantly than me, indeed (Licata, 1991, 2003; ‘t Hooft, 2016). What he first said was: “I read your work. That’s one of the best thing I have seen this year”. We had an intense conversation and we keep on talking in the afternoon, in a quite unusual way for me. Eliano was an expert alpinist who had already climbed the most challenging mountains on the Planet, such as the Nanga Parabat, and yet he couldn’t resist to the temptation of ascending, as short as it may be. So, he proposed me to climb Monte Epomeo, while climbing each of us told about his life. Reaching to the top was not an event worthy to be recorded in the Alpinism annals, but it was the celebration of our friendship birth as well as an enduring collaboration made of meetings and periods at high epistolary intensity. Eliano Pessa had his Ph.D. in Physics with Bruno Touschek, had collaborated with the mathematician Bruno Rizzi for a long time, had found a new interest in Cosmology with Giuseppe Arcidiacono, and, thanks to a formidable series of works on neural nets, was going to became the first theoretical physicist Full Professor in Psychology at The University of Pavia.

These few notes clearly give the idea of a vision far beyond the slightly narrow horizons of a traditional physicist, usually connected to the rhetoric of infinitely small or big.

In that period, Eliano was working on some problems related to the synergetic approach (Haken, 2012). The Haken Theory, on the strength of the work on collective behaviors in laser and on phase transitions, suggested that in many different contexts—Biology, Sociology. Etc.—it was possible to find situations where few parameters “took command” of all the other variables into play, which thing provided a more elegant description and, if not (asymptotic) predictability, a kind of understanding of the “possible destinies” of the system. It has to be said that the Haken conjecture gets a strong and immediate meaning: if there weren’t exist the variables that “mediate” between the components or the agents (microscopic level) and the possible global outcomes (macroscopic), it would be nearly impossible distinguish between information and entropy because the non-cooperative aspects of the system would prevail. Actually, there wouldn’t be any authentic emergence. That is just a well-founded conjecture. The real problem lies in questioning if it is possible to classify systems depending on how they produce information. According to Systemics general terms, there exists the Theorem of R. Shaw (1981), one of the members of the legendary chaos collective, which establishes a relationship between the phase space of a system—whose coordinates are the variables fixing its behavior—and some features of the equations describing them (non-linearity degree, constraints and so on). Accordingly, we can distinguish between: (a) Information-conserving Systems where the principle of energy conservation is valid; (b) Information-amplifying polynomial Systems, where information increases along time until a certain state of equilibrium. All the self-organizing models belong to this category, such as the dissipative structure by I. Prigogine. It has long be debated whether such models—and catastrophes, their geometrical counterpart—could be the universal key of morphogenesis, but some fundamental theorems, among which those by R. Landauer and R. Fox, and then the N. Koppell and D. Ruelle, have shown that there are very precise limits to complexity for the configurations that these systems can reach. Finally: (c) Information-exponential amplifying Systems, which chaotic systems belong to. The Theorem of Shaw is a very cornerstone because it introduces a way to look at systems no more centered on non-linear complications, but as classes of complexity of systems. It is patent that the "interesting" systems can be found in a narrow range between the moderately ordered of systems (b) and the savage proceeding towards chaos of systems (c). That poses extremely fascinating questions about the relationships—for example—between Physics, Biology and Cognitive Sciences (Licata, 2018; Pessa, 2008; Vitiello, 2001; Freeman & Vitiello, 2008), and tips the epistemic scales from the model as a mirror of an "objective" world to the specific conditions in which it is actually possible to apply it to something we individuate as a system. The awareness of a conditional and never banal correspondence between models and systems is the basis of the recent intense interdisciplinary crossing—models can "migrate"!—, but it is also a Copernican Revolution in the way we look at the constructive activity of science.

2 The Scientific Explanation and the Causality-Determinism-Predictability Triad

Predictability is still considered as a crucial ingredient in scientific explanations. Likely, this close association depends on the historical fortunes of Determinism, a peculiar trait for a lot of physical theories from Classical Mechanics to Relativity up to Quantum Mechanics, anyway the predictability into play changed its features and range at each step. As it is known, a physical system is described by deterministic laws when, given the dynamic laws and the initial conditions, the "mathematical crank" (differential equations) univocally fixes a state of the system in a future or past instant. The successes of Rational Mechanics confirms the philosophical triumph of the Laplace's demon (Licata, 2015) and for a long time the huge complications linked—for example—to the three-body general problem were considered as computational problems or just a matter of inexact data. It will be a 1887 work by Poincaré to clarify that the problem actually pertains to a new typology, so prefiguring the modern theory of dynamical systems based on chaos and non-linearity. In this case, the sensible depending on the initial conditions limits very quickly the predictability in a range strictly connected to the system's non-linearity (Lyapunov time). In addition, it can be demonstrated that a non-linear system is an information amplifier—it can, for example, "inglobate" a fluctuation—

thus the connection between determinism and predictability completely falls down (Cencini et al., 2009; Licata, 2008a). The qualitative theory of dynamical systems has developed since the 30s in order to solve these situations by proposing a concept of predictability no more based on the detail of the specific trajectories, but on the global behavior of the system, i.e. stability and asymptotic states (Kutznetsov, 2004). We find this situation also in General Relativity, the difference—and some subtler problems more, see the specialized bibliography—lies in the fact that there is no background, but the space-time itself is generated by the initial data and the evolutionary equations (Barrow, 1982).

The case of Quantum Mechanics is a completely different one. Actually, if the evolutionary dynamics U (for example, the Schrödinger's equation) are strictly deterministic, any predictability on a single event (R, reduction of the state vector) is impossible for principle reasons linked to the very nature of quantum systems. The whole debate on foundations can be seen as the different attempts to find a synthesis between U and R, or, at least, the "ontological" elimination of one of the two sides.

Despite its "erosion" within the hard fabric of theoretical physics, predictability seems to maintain a special position. Actually, it is considered that determinism distills the scientific features of causality, a long debated notion in philosophy. Clearly such idea does not stand to a careful examination. The possibility to connect two events in a temporal framework (for example in the light cone structure in relativity) does not guarantee by itself a causal relation (Mumford & Anjum, 2014; Illari & Russo, 2014). Moreover, the local features of Quantum Mechanics would make the question much more problematic (Näger, 2016; Ringbauer et al., 2016; Pegg, 2006; Popescu & Rohrlich, 1998).

Thus, it is more natural to connect the notion of "cause" with the global structure of a scientific explanation, considered as the configuration of theories and models providing a picture of how things work! Predictability is rather a feature of some classes of models. We can easily realize they are different things by a simple example. Just consider the classical double slit experiment for electrons by C. J. Davisson and L.H. Germer in 1927, which R. Feynman correctly considered as the archetypal QM experiment (Feynman, 1985). Let's imagine we could collect all the data of the electron impacts on the screen and process them statistically. In the end, we can get a very good probabilistic evaluation of the areas where we can find an electron, no more, no less than we use wave-function. Anyway, such prediction does not explain the phenomenon. In order to have an exhaustive picture of the situation we have to turn to Schrödinger equation; moreover, our statistics cannot be exported to other phenomena, the Schrödinger equation, instead, is an explanation connecting scales, objects and dynamics for non-relativistic quantum systems.

The separation between explanation and predictability becomes far more evident in the study of complex and emergent systems. Without going into technical details, we know that – in an emergent process – redefining the system's internal structure and modifying the relationship with the environment leads to the emerging of new properties which, generally, cannot be ascribable to the level of its constituents, in a way that remind us the universal aspects of phase transitions (Licata, 2008b, c). It can imply different levels of description, and the manifestation of some forms of coherence on some levels and not in other ones. In general, intrinsic emergence is connected to the appearing of properties or phenomena compatible with the models which describe those phenomena, but—in principle—they are unpredictable considering that the models, being conditions the same, admit more different behaviors and the new properties or phenomena can modify irreversibly the nature itself of the system (Licata 2010; Ryan 2007; Anderson & Stein, 1985; Ronald et al., 1999; Goldstein, 1999; Pessa, 2006, 2008; Bedau & Humphreys, 2008). So, the problem is to understand the physical and mathematical reasons why some classes of models admit a strong predictive apparatus as a consequence of their descriptions and some other not, and—in this case—what evaluations and interventions are possible.

3 Ideal Models, Phase Space and Boundary Conditions

Predictability is a mathematical feature of a model and corresponds, all in all, to a series of physical conditions satisfied by the system under consideration. We will focus here on these ones by taking into consideration some essential points that constraint the building of the so-called ideal models, susceptible either of closed analytical solutions or, anyway, of approximations that assure a broad predictability, if not a local one, at least on its asymptotic states. Such wide class of models cover a quite big theoretical range encompassing from Newton Mechanics to Quantum Field Theory (QFT).

Differently from what is often stated, reductionism—i.e. the exclusive attention for constituents and explicative downward arrows—is not an essential prerequisite to have predictability. This idea derives from classical trajectories, but it is easy to realize that it is not so just by thinking to a perfect gas in a jar. If we open the jar, the gas will diffuse in the environment; this will fixes a time arrow based on entropy. In spite of it, the level of gas particles is always ruled by a reversible dynamics unchanging if we “rewind the film”: in fact, it is ruled by the Boltzmann Stosszahlansatz. Anyway, the evolution of the system is possible by using a diffusion equation applied to the whole statistic ensemble. This exemplary case demonstrates that it is not so much the request of reductionism the key for predictability as the particular connection interplay between different micro, meso and macro levels. In this case, the physics and mathematics of the phenomenon is fully fixed by the mirable bridging by statistical physics between Newton Mechanics and Thermodynamics (Cercignani, 2006).

The case of molecular chaos is interesting because we can introduce some important elements more. The “identity” of particles and forces into play is always well defined and fixed, moreover, temporal reversibility at microscopic level is conserved, and the environment is just a very elementary and “passive” scenario. “The first” and “the after” of the phenomenon takes place by modifying the boundary conditions of the gas when the jar is opened. One of the reasons which contributed in creating a reductionist-deterministic mythology has been the fact of neglecting the decisive importance of the boundary conditions. If we forget them—and the environment influence as well—, physical laws turn into good for all season mere algorithms and, above all, indifferent to the level under consideration. That is not so! Our example reminds us that a level of analysis does not guarantee its portability to other levels. For molecular chaos, we can, at least, connect macro and micro thanks to the statistical interpretation of thermodynamic quantities, it is impossible for most of the real interesting complex systems. On the contrary, emergence processes suggest that the creation of new models and the "convergence" of different approaches into a "super-model" is not for sure. The complementary between laws and conditions is well described by D. Bohm (1957) when he states that a physical law is a frame of possibilities, it will be the chance (in etymological sense) to decide which phenomenon will take place. It could sound obvious for quantum systems and inappropriate for an aseptic world of Newtonian balls, but it is not so for systems where noise, fluctuations, non-linearity and the strong variations ruling the system-environment relations make that frame greatly sensible to chance with modifications of boundary conditions. Complex systems can be defined as systems where the variation of boundary conditions is more important than laws, because they modify the role of the laws involved—by a drastic complexifying of the phase space—and the nature itself of the "objects" into play (Licata, 2012, 2015; Licata & Minati, 2016).

Let us now consider with a little more attention the powerful theorem on the non-linear systems' behavior from the informational viewpoint by Shaw (1981). Suffice it to remind that the system's volume in the phase space (i.e. the space of the behaviors in relation to a set of observables) modify its information content at a rate connected to the peculiar type of non-linearity of the system. Such theorem can be thus considered as a non-linear filiation of the Liouville Theorem. A critical notion to focus our attention on is the system's volume. Even without any mathematical lingo, it easy to see that it is closely connected to boundary conditions. In other words, it is supposed that the system/environment relationships can be clearly described by a handful of fixed parameters, it makes possible monitoring the information exchange. In spite of its being a limiting condition (just think to Maturana and Varela's system/environment coupling for living systems, Maturana & Varela, 1980), many interesting systems are included in this classification. Information amplifying systems are particularly interesting for the topic of predictability. A first category are the polynomial amplifiers, which include the well-known dissipative structures (Nicolis & Prigogine, 1989); these systems evolve towards self-organization states by means of a balancing feedback between outgoing entropy and ingoing energy. Such approaches has been welcomed with great enthusiasm, at first they were considered able to provide a general framework for the order out of chaos program, soon, many limiting theorems (Kopell & Ruelle, 1986) have showed that the complexity of these structures is rather poor. The expectations for H. Haken Synergetics (Haken, 2012) met the same destiny. Synergetics treats the emergence of some order parameters on mesoscopic regime that lead the system toward more organized states, by taking control of the microscopic variables. In spite of the interesting analogies that such scenarios have stimulated for systems very far from physics or chemistry, their importance in biology is limited and purely metaphoric in socioeconomic fields.

What is worthy noticing is that in all the above-mentioned cases, the hypotheses on the system's openness are such that there can be applied some mathematical techniques corresponding to a careful mapping of information in the phase space. With dissipative and synergetic systems, non-linearity allows a simplified situation when passing from the microscopic to the mesoscopic, by merging many down level disordered dynamics into an ordered scenario. All that guarantees high predictability. Also in the case of exponential amplifier systems—the chaotic system in strict sense—, there are many different techniques to monitor the transition to chaos and the asymptotic states (at least for low dimensional systems). We are there at the extreme borders of predictability, whose essential condition seems to be the possibility to get models able to follow the system's phase space. Such condition is equivalent to apply a series of hypotheses related to symmetries, balancing laws and constraints about the system-environment relationship to the system; these hypotheses turn into the possibility to develop an analytical treatment with strong predictive features (Vakulenko, 2013).

It has also been suggested to use the Quantum Field Theory (QFT) formalism as a general framework to study formally the dynamics of phase transition with intrinsic emergence. In these systems, emergence is introduced as symmetry breaking and there new types of long-range correlations are created. Despite some interest-worthy cases, such as the Quantum Brain by G. Vitiello, everyone agrees that these approaches are quite far from the actual complexity of a biological system. (Pessa, 2002; Vitiello, 2002).

After having thoroughly explored the possible links between QFT as a framework of complexity, in recent years Eliano Pessa strongly expressed the idea that QFT was too "narrow" for the study of complex systems:

> *Unfortunately, the intense research activity on emergence has not yet produced a universally agreed definition of what is meant by 'emergence'. There is however a widespread consensus regarding the general aspects that should characterize any form of emergence (the Goldstein's work,* 1999 *is very useful in this regard). A synthetic list of these aspects includes:*
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> *a) dependence on an observer; this means that emergence is not an objective property or event in Nature, but it is linked to the surprise an observer (equipped with tools concepts, theories, beliefs, intentions, purposes and so on) feels when - placed in front of a system - there sudden appear properties not attributable to any observable efficient cause in the system itself;*
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> *b) the existence of different levels of description; this is equivalent to say that emergence can reveal itself only by adopting an appropriate level of description.*
>
> *c) the appearance (or disappearance) of some form of coherence; without going now into the very difficult question of what exactly is meant by 'coherence', here we limit ourselves to point out that in all emergence processes so far considered as such (not only in the physical sphere, but also in biological and social one) we always managed to identify some kind of consistency that was acquired (or lost).*
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> *(...)*
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> *a grounded- both philosophically and scientifically - theory of emergence processes - is yet to come. The TTPT(Traditional Theory of Phase Transitions) certainly represented a starting point to build such a theory. However, despite the mathematical sophistication of*

> *the tools employed, the TTTF remains too low a theory, inadequate not only to account for the processes of emergence in the biological, psychological, social and economic fields, but also to explain many processes in Physics. Among the possible remedies for this inadequacy, we have tried to emphasize the introduction of adequate theories of system-environment interactions.*
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> *These arguments have shown us how this path, still in the initial stages, is fraught with both technical and conceptual difficulties. Moreover, it does not sound strange: for centuries science and philosophy have just taken into consideration very simple systems where it was not necessary, by hypothesis, to worry much about the environment they were immersed in. Therefore, they never bothered to define what environment was, what it was like and how to distinguish it from the systems immersed in it and how to model it* (Pessa, 2012).

4 Recalcitrant Systems and Configurational Variables

There is thus a problem in fixing some common features to recalcitrant systems. These ones resist to mathematical formalization and, anyway, do not offer a firm anchorage for the traditional notion of predictability.

The concept itself of equilibrium state does not make sense for these phenomena. Such systems are continuously evolving, often very fast, and cannot be “zipped” within a model because their nature is essentially that of a process. In these cases, neither the system’s nature nor the environment can be regarded as fixed and characterized by few parameters; the attention, instead, has to be focused to the kind of coupling in order to put into evidence what aspects can influence the evolutionary characteristics which continuously undergo a multi-level plurality of meta-stable situations of adaptation. Strictly speaking, we should not to speak about a system-environment distinction, but about classes of events. In particular, lately, there has been an intense activity on networks—a strategic architecture in nature and artificial system too—that clearly shows another important difference: the one between dynamics and history. In networks, the dynamic behaviors can lead to the disappearing/creating or reinforcing of some hubs so modifying completely how the system manages information (Barabasi, 2018; Boccaletti et al., 2006; Costa et al., 2007). In this situation, some frozen components can come out; they mark the system’s history in the form of stratified constraints which act on temporal scales much longer than the ones of other nodes. In a much more radical way than the case of the gas in the jar, the system’s global history develops on a different level from the individual dynamics. Moreover, such transitions do not take place near a critical point, as it happens in the traditional phase transition theory, and this makes investigating these situations even farther from the ideal models. The changes linked to complex structures of internal constraints tend to make the system autonomous and its relation with environment is highly selective, so introducing a semantic dimension in the informational flux; this is, maybe, the current strongest limit for the mathematical modeling, which allow some sort of predictability. It is clear that in these situations, such as the conservation of energy (as well as the microscopic syntactic information) is naturally compatible, but it does not say anything about the global semantic choices. Actually, it is merely true also in “simple” systems:

a physical description of the energy dissipated by a computer hardware does not indicate us anything about the characteristics and the complexity of its software. A strong evidence of the global importance of semantics has came from the study of biological neurons, it has been found out that the electrical activity of the same neuron crucially depends on the global functions performed by the neuron network it is immersed in (Sahasranamam et al., 2016).

We can realize, even from these few lines, that the majority of interesting complex systems—for example, the socio-economic ones—are recalcitrant to ideal modeling. This is the big challenge of the theories of change, which is not referred to a formal structure such as the T theory and M model—axiomatic or semi-axiomatic—of theoretical physics, but to a set of multi-model strategies focused on the observative and computational inquiring of the events under consideration. It is not as much predictability into play, but rather the understanding of the change factors and—above all—the intervention on an actual process.

The good news is that the extremely recalcitrant systems—i.e. living within pure disorder and perfect casualty—, are very rare and, anyway, are not so interesting to study. An authentic casual sequence, according to Kolmogorov, is an infinite sequence that cannot be zipped in a string shorter than the sequence itself, we can only observe its evolution step by step. Actually, stating that for any finite sequence it is always possible to find a rule or interpolation connecting them does not solve any empiric problem. What is really interesting in a network of event is to individuate information, at least, as meaningful configurations for an observer. The 300-years-old implicit assumption of theoretical physics is that our descriptions correspond to something in the World out there, it is surely true, but we have not to forget we are the ones who build such descriptions. We can do it because the systems ruled by ideal systems are simple. The challenge comes out for the systems suspended between order and disorder, where "at the edge of chaos, the boundaries of change fluctuate endlessly between a sluggish status quo and the anarchy of perpetual destruction" (Cohen, 1997). In these systems, to bridge the microscopic and the macroscopic levels in a simple way is almost always impossible, but there emerge configurations always remodeling the system and make possible to identify some mesoscopic variables which mediate between the two levels and characterize the metastable state of the change. These are not "observables" in a traditional sense, but a choice between the patterns an observer individuates as the expressions of the change. Here, we will focus neither on the available analytical tools nor on the formidable problems of quasi-ergodicity (Bertuglia & Vaio, 2005; Moore, 2015), in the end, we will try instead to fix some conceptual aspects the study of these systems offers.

5 Metastructures and Big Data Forecasting

Metastructures are a general framework for studying change. The question they come from equally belongs to cognitive sciences (observer) and Physics (observed):

how can a change in a process be detected? Since the very beginning an observer is called to choice what to observe and how to do it, by trying to spot the interesting characteristics which occur quite regularly. We are speaking about the intuitive emergence according to the famous classification by Crutchfield (1994), anyway, considering we are dealing with process that are quite far from ideal models, it is the only emergence we can detect, because there are not any available mathematical structures to study the dissipative forms or intrinsic emergence. So, investigating meta-structures is a research not only focused on the emergence features and the change in a system in "objective" sense, but also on the dynamic relationship between an observer and an observed system. For the technical aspects, see references (Licata & Minati, 2013; Minati & Licata, 2013).

The procedure is based on building one or more mesoscopic vectors whose values are chosen by an observer. In the "pedagogic" flock example the typical values can be: velocity, directions, habits, distance—maximum and minimum—between two "constituents", the instantaneous value in a time interval of the flock surface of volume, and so on. In this way, it is possible to get information from the system to individuate and detect change, its phases, sequences and modalities; for example, what elements play the same role at different instants or different roles at the same instant. In other words, the mesoscopic vector is an active "grid" that probes the system by means of computational procedures in search of meaningful signals for the observer/model builder. Such scenario offers some reflections about Big Data.

It is true that data did not become big overnight, in Jeff Jonas words (Jonas, 2012), and we can add that science has always strongly needed data not only to build theories, but to correct them, delimit them and, finally, to make them operative. The Navier Stokes equations would just be a conceptual scenario for meteorologists, if it weren't for a thick network of sensors, and it surely does not depend on their mathematical status of Millennium Clay Problem! Anyway, the debate about Big Data has become hot about epistemological and ethical problems just lately (Cardon, 2015; Mayer-Schönberger & Cukier, 2013). The Chris Anderson provocative paper for Wired (Anderson, 2008) has triggered many relevant answers among which we cannot avoid reminding the Calude and Longo one (Calude & Longo, 2017): in general, and for very good mathematical reasons, data don't speak for themselves, most of the correlation are spurious. It happens only if we look at correlations as "objective", and—above all—if we limit our research to correlations! If we accept that this is new brand field, and that data have to be investigated to speak then we will be in a world of possibilities similar to what Ermanno Bencivenga described: So there you have it. Big Data enthusiasts are (unwittingly) advocating a new definition of what it is to know. Their agenda is (unwittingly) semantical. Except that it is not worked out, and any attempt at developing it in the semantical terms that have been current (and antagonistic) for the past two millennia is hopeless (Bencivenga, 2017).

If we try to look beyond the simple correlations and consider Big Data as something more than a passive object of multivariate statistics, we can see an extraordinary number of patterns with formidable theoretical implications, such as the power law, non-Gaussian behaviors, scenery of criticality, fat fractals, and so on (for a general textbook on these techniques: Sethna, 2006; for a class of exemplary problems: Buldyrev et al., 2010). It does not mean that the processes under consideration cannot be included within the old theoretical boundaries; we have, instead, to do theory in progress, to use the historical baggage within a new style of work consisting in testing heuristic hypotheses following the process, according to an abductive line.

The current classification of Big Data in the so-called 6Vs model (volume, velocity, variety, veridicity, variability and value) is still too tied to the quantitative data flux and an objectivist conception. It's advisable, and greatly plausible, that the structures analytics (descriptive/predicative) more and more point towards the search of the secret life of Big Data, in order to do it we have to realize that analytics directly express what meaning the process has for the agent observing it. It is not a matter of building up a robot-scientist, dear to the old AI, but to get open to the idea that in the same way as high speed and extremely small have changed theoretical physics, the extreme complexity will modify our concept of Physics in an even more radical way.

6 Conclusions

In the history of theoretical physics, predictability has established itself within deterministic explanations, then it has extended, in its different forms, to the class of ideal model, which allow an univocal description of a system. In complex systems at high emergence, univocity breaks down and the descriptions become plural, that is an extreme limit for predictability in strict sense. Many strategies and tools for forecasting a process have been grown, they are connected to the meaning that a class of events have for the observer or agent. In many complex systems it is not just an abstract forecasting to solve the problem, but the actual awareness about the possibilities to guess on. All that strengthens the Bruno de Finetti (1906–1985) intuitions: *Knowing how things will go, as if they were occurring on their own (...)It is a problem of decision, not prevision (. . .)...- Shouldn't the exceptional dimension of our empiric world lead to a completely new awareness? How can we expect that logic chains end with certainties, just like a good ole syllogism?* (de Finetti, 1968, 1972).

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