Application Resilience and Antifragility from the Internet of Medical Devices to Healthcare Governance Systems

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Abstract

For Healthcare, the potential benefits of applying "Internet of Medical Devices" (IoMD) to solve both the cost problem and to improve patient safety and outcomes are tremendous. The medical industry is quickly adopting mobile technology (mHealth) as a means of connecting lay users with medical professionals. Unfortunately, current apps can be quite fragile to unespected event, and unpredictable changes can be very disorienting at enterprise level. These major changes, usually discontinuities referred to as fractures in the environment rather than trends, will largely determine the long-term future of organization. They need to be handled, as opportunities, as positively as possible. We need more robust, resilient and antifragile application to be ready for next generation systems. They are mandatory to develop antifragile self-organizing and self-regulating system further. Health Information community can take advantage of a new HICT Natural Framework proposal, to get a more reliable conceptualized synthetic and powerful systemic vision, to be used in advanced modeling for healthcare application and organization (HO) and high reliability organization (HRO) in general. Two application examples are presented. HICT Natural Framework can be used to develop competitive applications, from telemedicine apps, antifragile anticipatory learning system (ALS), health information management system, to health governances policies for advanced HO, new competitive HRO "environmental friendly" information management strategies conveniently, and beyond. The present paper can give a relevant contribute to that perspective and to let you achieve pactical, operative results quite quickly.

Keywords

Medical Apps, Health Information Systems, Health Care Quality, Antifragile Systems, Anticipatory Learning Systems, Health Governance

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1 Introduction

Digital medical devices, wellness and wellbeing apps are rapidly improving, but connected care via health services in the cloud will be the next really important milestone.[1] All network-connected devices that record health data from humans make up the "Internet of Medical Devices" (IoMD). The advent of mobile technology has redefined how modern consumers read the news, communicate with others and entertain themselves on the go. The medical industry is quickly adopting mobile technology (mHealth) as a means of connecting lay users with medical professionals. In 2013, the global mHealth marketplace already represented a staggering $1.3 billion annual economic impact, and analysts are confident that this trend will continue upwards. Consumers have increasingly shown a willingness to adopt mHealth applications as a part of managing their health. Whereas years ago patients needed to make a doctors appointment for a proper diagnosis, the Internet has placed a world of information at patients fingertips. Furthermore, many medical organizations have begun to recognize the value in providing high-quality care, even if it means serving a smaller group of people. Using mHealth platforms to deliver such services is a natural transition. In most ways the invasion of technology in Healthcare is no different than how mobile digital capability is changing that way we all live.[2] For Healthcare though, the potential benefits of applying these technologies to solve both the cost problem and to improve patient safety and outcomes are tremendous. Personal health devices will change how we deal with our health in just as significant of ways. We are just at the start of this health device movement. Over time more and more important information regarding our health issues will be instantly communicated as needed to the concerned consumers, to the health care professionals, and will automate important health care in many ways (early detection, medication, etc.). Most current applications are designed to function in an ideal network environment, but that's never the case in the real world. Quite often, applications have to face unexpected perturbation, from network behavior and configuration to user problematic interface, etc., and to address the errors that inevitably surface, if they are programmed for. Unfortunately, current human made application and system can be quite fragile to unexpected perturbation because statistics can fool you, unfortunately.[3] We need resilient and antifragile application to be ready for next generation system. Can we achieve application resilience and antifragility at system level conveniently? They are mandatory to develop antifragile self-organizing and self-regulating system further. While the amount of data doubles every 1.2 years, the processing power doubles every 1.8 years. Unfortunately, the complexity of networked systems is growing even faster. In other words, attempts to optimize systems with the usual top-down approach will be less and less effective, and cannot be done in real time. Paradoxically, as economic diversification and cultural evolution progress, a big government approach would increasingly fail to lead to good decisions.[4] The logical answer is to use distributed (self-)control, i.e. bottom-up self-regulating systems. Cybernetics (i.e. advanced control theory) and complexity theory tell us that it is actually feasible to create resilient social and economic order by means of self-organization, self-regulation, and self-governance.[5, 6] If we want to to achieve self-organization, self-regulation in a competitive arbitrary-scalable system reference framework, we need application resilience and antifragility at system level first. The present paper can give a relevant contribute to that perspective and to achieve practical operative results quite quickly.

2 Objectives

This paper offers theoretical and operative answers to previous question. We revised scientific literature extensively, to look for already available effective solutions. Unfortunately there was none able to fulfill our system requirements, so we have to propose a new reliable approach (see section 4 Results, and section 5 HICT Natural Framework proposal). First of all, we need to have a good understanding about the root of the problem: ontological uncertainty. Second, we need to learn why contemporary applications can be quite fragile to unexpected perturbation, if managed by classic probability risk management technique and tool only.

3 Methods

First, we document how, even across so many different scientific disciplines, "Scientists 1.0" have not yet worked out a definitive solution to the fundamental problem of the logical relationship between human experience and knowledge extraction. Then, we analyze uncertainty sources according to two main reference knowledge areas: a) natural uncertainty and b) epistemic uncertainty, to arrive to a systemic solution: ontological uncertainty management at system level. Third, based on previous knowledge, we formulate a simple four-level reliability hierarchy scale for system properties (from most to less vulnerable) to grade system ability to face uncertainty and unexpected perturbation. Fourth, recently discovered (Computational Information Conservation Theory) CICT rational number system **Q** numeric properties are applied to previous system property hierarchy scale to build resilience and antifragility at system level, to arrive to a convenient arbitrary-scale HICT Natural Framework proposal. Two examples are presented.

3.1 The Root of the Problem

At system level, the classical instrumentation noise discrimination problem is still faced by the single domain channel transfer function concept (Shannons noisy channel, 1941), starting from classic Shannons information theory concept,[8] and then applying traditional perturbation computational model under either additive or multiplicative perturbation hypothesis.[9] In general, H(x), called "Shannon entropy," is the average unpredictability in a random variable, which is equivalent to its information content. The interested reader in digging deeper details into mathematical theory of entropy and information theory, inference, and learning algorithms, is referred to [10] and [11] respectively. As a matter of fact, biologists measure information in different ways. Neurobiologists and researchers in bioinformatics often measure information using information-theoretic measures such as Shannons entropy or algorithmic compression on mutual information. Behavioral biologists and evolutionary ecologists more commonly use decision-theoretic measures, such the value of information, which assess the worth of information to a decision maker. It can be shown that these two kinds of measures are intimately related in the context of biological evolution research areas.[12] In communication theory, the transmission of information is the reduction of uncertainty about what signals will come through a channel. In thermodynamics, a decrease in entropy refers to the fold reduction in the number of states that a system can be in. In evolutionary biology, the fitness value of a cue about an uncertain environment refers to the fold increase in the number of surviving lineages made possible by responding to the cue.[13] In 2004, University of Michigan physicist Mark Newman, along with biologist Michael Lachmann and computer scientist Cristopher Moore, has extended the pioneering 1940s research of Claude Shannon to electromagnetic transmission. Specifically, they show that if electromagnetic radiation is used as a transmission medium, the most information-efficient format for a given message is indistinguishable from blackbody radiation.[14] In other words, since many natural processes maximize the Gibbs-Boltzmann entropy, they should give rise to spectra indistinguishable from optimally efficient transmission. Furthermore, in 2008, Calude and Svozil proved that "Quantum Randomness" (QR) is not Turing computable.[15] In 2013, at Politecnico di Milano, academic scientist Fiorini confirmed Newman, Lachmann and Moore's result, creating analogous example in pattern recognition and image analysis, by CICT [17], putting even more into evidence the fundamental information double-bind (IDB) problem at the core of contemporary classic information theory and current instrumentation systems. Unfortunately, even across so many different disciplines, scientists have not yet worked out a definitive solution to the fundamental problem of the logical relationship between human experience and knowledge extraction.

3.2 Ontological Uncertainty Modeling and Management

In the past five decades, trend in Systems Theory has slowly shifted from "General System Theory," introduced by Ludwig von Bertalanffy and classic single domain information Shannon's channel transfer function approach to the more structured ODR Functional Subdomain Transfer Function Approach (by Observation, Description and Representation Functional Block; see Figure 1).[18] Shortly, the ODR approach allows for fitting theoretical system modeling and design consideration to practical implementation needs much better (according to information "Input, Processing, Output" paradigm, respectively), than classic single block domain channel approach. Nevertheless, if careful information conservation countermeasure is not provided at each step, from source to destination, ODR transmission channel could suffer from the same problem, discussed earlier.

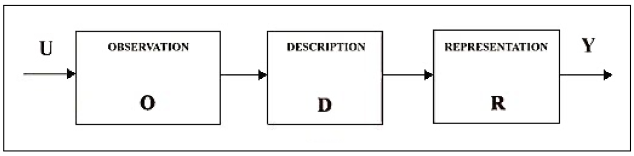

Figure 1: Decomposition of classic Single Domain Channel Transfer Function into more structured ODR Functional Subdomain Transfer Function Approach (Observation, Description and Representation Functional Blocks)[18].

Two basic areas of uncertainty that are fundamentally different from each other were recognized as traditional reference knowledge: natural and epistemic uncertainty. Intrinsic randomness of a phenomenon (e.g. throwing a dice) or natural uncertainty cannot be reduced by the collection of additional data and it stems from variability of the underlying stochastic process. On the other hand, epistemic uncertainty results from incomplete knowledge (or lack of information) about the process under study. Unlike natural uncertainty, epistemic uncertainty can be reduced by the collection of additional data. Statistical and applied probabilistic theory is the core of traditional scientific knowledge; it is the logic of "Science 1.0"; it is the traditional instrument of risk-taking.

APPLICATION / DOMAIN	Simple payoffs	Complex payoffs
Distribution 1 ("thin tailed")	Extremely robust to Black Swans	Quite robust to Black Swans
Distribution 2 ("heavy" and/or unknown tails, no or unknown characteristic scale)	Quite robust to Black Swans	LIMITS of Statistics – extreme fragility to Black Swans

Figure 2: The fourth quadrant. The South-East area (in orange) is where Statistics and models fail us [19].

In turn, epistemic uncertainty sources can be reconducted to three main core conceptual areas: a) Entropy Generation (Clausius-Boltzmann), b) Heisenberg Uncertainty Principle and c) Gdel Incompleteness Theorems. A further detailed description of epistemic uncertainty core conceptual areas far exceeds the size of present paper and the interested reader is referred to the extensive bibliography available elsewhere. Usually, epistemic uncertainty sources are treated with the traditional approach of risk analysis, but deep epistemic limitations reside in some parts of the areas covered in decision making. These limitations are twofold: philosophical (mathematical) and empirical (human known epistemic biases). We can talk about system knowledge uncertainty by referring to "Application" and to "Domain", according to the four-quadrant scheme of Figure 2.[19] Decision theory, based on a "fixed universe" or a model of possible outcomes, ignores and minimizes the effect of events that are "outside model" or unexpected perturbations. A fixed model considers the "known unknowns" (North-East-quadrant), but ignores the "unknown unknowns" (South-East-quadrant).[20, 21, 22] The idea of known and unknown unknowns recognizes that the information those in positions of responsibility in government, as well as in other human endeavors, have at their disposal is almost always incomplete. The best strategists try to imagine and consider the possible, even if it seems unlikely. They are then more likely to be prepared and agile enough to adjust course if and when new and surprising information requires it, when things that were previously unknown become known.[22] So, we have even to think about uncertainty in the characterisation of uncertainty by counterfactual thinking.[23]

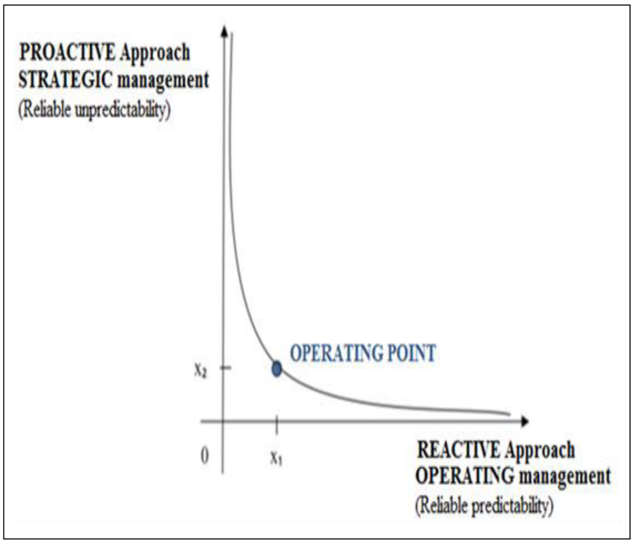

Figure 3: Operating Point can emerge as a new Transdisciplinary Reality Level, based on Two Complementary Irreducible Management Subsystems [26].

In the fourth quadrant of Figure 2, knowledge is both uncertain and consequences are large, requiring more system robustness and resilience.[19] In fact, can we understand health without considering wild diseases and epidemics? Indeed the normal is often irrelevant. Almost everything in social life is produced by rare but consequential shocks and jumps. The traditional bell curve ignores large deviations, cannot handle them, yet makes us confident that we have tamed uncertainty. Uncertainties are characterized as epistemic, if the model developer sees a possibility to reduce them by gathering more data or by refining models. Uncertainties are categorized as aleatory if the modeler does not foresee the possibility of reducing them. From a pragmatic standpoint, it is useful to categorize the uncertainties within a model, since it then becomes clear as to which uncertainties have the potential of being reduced. But, more generally, decision theory, based on a "fixed universe" or a model of possible outcomes, ignores and minimizes the effect of events that are "outside model". While the advantage of differentiating between natural (aleatoric) and epistemic uncertainty in analysis is clear, the necessity of distinguishing between them is not, by an operative point of view. As a matter of fact, epistemic and aleatory uncertainties are fixed neither in space nor in time. What is aleatory uncertainty in one model can be epistemic uncertainty in another model, at least in part. And what appears to be aleatory uncertainty at the present time may be cast, at least in part, into epistemic uncertainty at a later date.[24] It is much better to consider ontological uncertainty [25] as an emergent phenomenon out of a complex system.[26] Then, our ontological perspective can be thought only as an emergent, natural operating point out of, at least, a dichotomy of two coupled irreducible complementary ideal asymptotic concepts: a) reliable predictability and b) reliable unpredictability (Figure 3).

4 Results

Based on previous knowledge, we formulate a simple four-level reliability hierarchy scale for system properties (from most to less vulnerable) to grade system ability to face uncertainty and unexpected perturbation (4.1 A Four-Level Reliability Hierarchy Scale). Then, recently discovered CICT rational number system **Q** numeric properties are applied to previous system property hierarchy scale to provide examples of resilient and antifragile system at different systemic operative levels (4.2 Two Application Examples, and section 5 HICT Natural Framework proposal).

4.1 A Four-Level Reliability Hierarchy Scale

In agreement to Taleb [7], our main idea is not to attempt to predict black swan events, but to build robustness against negative ones that occur and be able to exploit positive ones. We can conceive a simple four-level reliability hierarchy scale for system properties (from most to less vulnerable), to describe system capability to face uncertainty and unexpected perturbation: a) Robustness, b) Resilience, c) Antifragility and d) Hippocraticity.

a) Robusteness: statistical and applied probabilistic theory is the core of traditional scientific knowledge; it is the logic of "Science 1.0"; it is the traditional instrument of risk-taking. It provides an acceptable cost/benefit ratio to manufacturer, but in some cases it may not represent an optimal solution to end user/customer/consumer.

b) Resilience: For living matter, in 1888, hormesis was first described (though still not given a name) by a German toxicologist, Hugo Paul Friedrich Schulz (1853-1932), who observed that small doses of poison stimulate the growth of yeast while larger doses cause harm.[27] A human body can benefit from stressors (to get stronger), but only to a point (Wolff's Law, 1892).[28] Newly engineered composite material of carbon nanotubes arranged in a certain manner can produces a self-strengthening response previously unseen in synthetic materials, "similar to the localized self-strengthening that occurs in biological structures."[29]

c) Antifragility: even better. The notion of antifragility, an attribute of systems that makes them thrive under variable conditions, has been proposed by Nassim Taleb in a business context first.[7] Antifragility is a decelerating sensitivity to a harmful stressor, producing a convex system response that leads to more benefit than arm. We do not need to know the history and statistics of the system to measure its antifragility, or to be able to predict black swan events.[7]

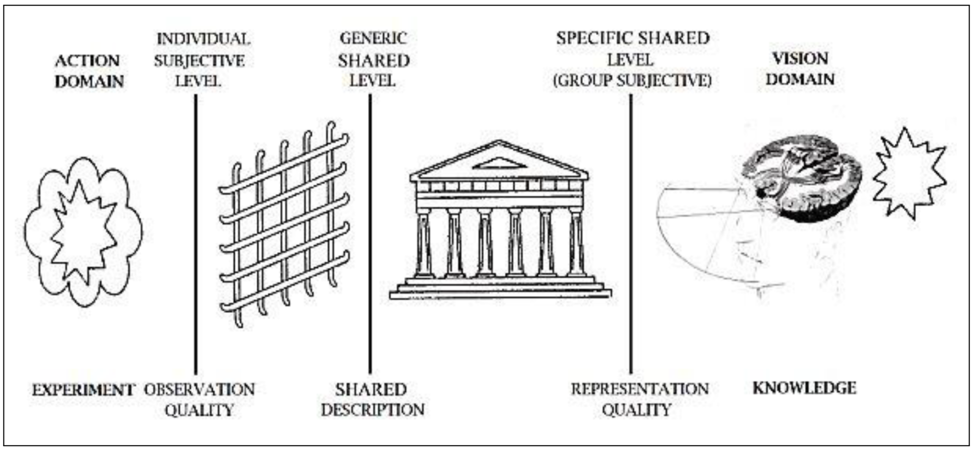

Figure 4: ODR Co-domain Diagram for HO and HRO [17].

d) Hippocraticity: it is even a stronger concept for a natural resilient and antifragile system, which can emerge from a self-balancing complex system to its environment, when human being health conservation is mandatory (intrinsic safety and security system). Canadian ecologist Crawford Stanley (Buzz) Holling (1930-) focused on natural living organism antifragility, including resilience, adaptive management, the adaptive cycle, and panarchy. Panarchy is a conceptual term first coined by Paul Emile de Puydt (18101891) in 1860.[30] Here, "Panarchy" refers to the framework for conceptualizing the type of coupled human-environment systems described in Gunderson & Holling [31] and more briefly, with some changes, in Walker et al.,[32] and Gotts.[33]

4.2 Two Application Examples

Classical experimental observation process, even in highly ideal operative controlled condition, like the one achieved in contemporary most sophisticated and advanced experimental laboratories like CERN,[34] can capture just a small fraction only of overall ideally available information, from unique experiment. The remaining part is lost and inevitably dispersed through environment into something we call "background noise" or "random noise" usually. That is even more true at clinical level, specifically. Our first example, to get more resilient system, can use CICT rational number system $\mathbf{Q}$ numerical properties, to get closer to real computational information conservation by a top-down point-of-view. So, ODR Functional Sub-domain Transfer Function block diagram (Figure 1) must be coupled to a corresponding irreducible complementary "ODR Information Channel Co-domain Diagram" to get reliable strategic overall information functional closure (Figure 4).[17]

We use an arbitrary-scalable system top-down approach, i.e. from overall system to system components, an so on, arriving to single block, single digit computational information conservation. In this case, we start with Natural numbers as generators, and their geometric powers, to compute their coherent functional closures, by using decimal system operative representation ($r = 10$), with no loss of generality. To get a coherent functional closure our rule is simple. One digit word number to the second power gives two digit number word, to the third power gives a three digit number word, to the fourth power gives four digit number word, and so on. Leading zeroes do count, so you have to fill in all word digits. We start with Natural number $D = 3$ as a generator, and $W = 1$, where W is the word representation precision length of number D and k its power exponent. We have:

$$\begin{array}{ll}
3^1 = 3 & 10^1 - 3^1 = \bar{D}.(1)_1 = 7 \\
3^2 = 09 & 10^2 - 3^2 = \bar{D}.(13)_2 = 91 \\
3^3 = 027 & 10^3 - 3^3 = \bar{D}.(139)_3 = 973 \\
\cdots & \cdots \\
3^k & 10^k - 3^k = \bar{D}.(3^0.10^{k-1} + 3^1.10^{k-2} + \\
 & \cdots + 3^{k-2}.10^1 + 3^{k-1}.10^0)_k \equiv PC
\end{array}$$

where $\bar{D}$ is the additive 10^W complement of D, i.e. $\bar{D} = (10^W - D)$. On the left column we have the powers of 3 and on the right side their corresponding coherent functional closures. It is simple to see that for k going to infinity even the asymptotic expression in round bracket $(\cdots)_k \equiv PC$ from eqs.(1) becomes an infinite polynomial and therefore an incomputable expression. Nevertheless it has quite a definite and unique evolutive polynomial structure, easily to be computed exactly to any arbitrary precision by CICT.[17] As a matter of fact, CICT rational number system $\mathbf{Q}$ numeric properties allow to generate an irreducible co-domain for every computational operative domain used. Then, all computational information usually lost by using classic information approach, based on the traditional noise-affected data stochastic model only, can be captured and fully recovered to arbitrary precision by a corresponding complementary co-domain, step-by-step, to obtain a Resilient ODR system (RODR, for short), according to CICT Infocentric Worldview.[17] Applying this line of thought, you can develop more reliable, resilient med apps. A further detailed description of the diagram of Figure 4 far exceeds the size of present paper and the interested reader is referred elsewhere.[17, 18]

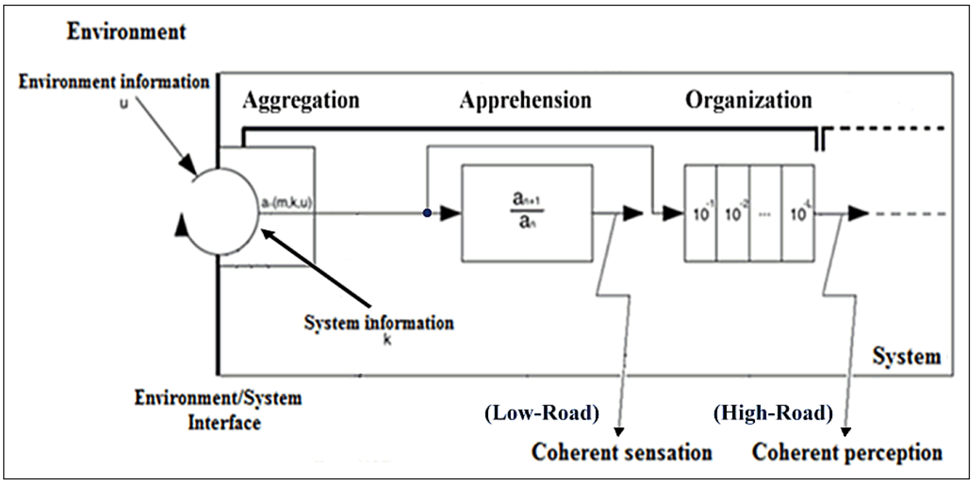

Figure 5: System internal control status(k) and system external input (u) are aggregated coherently by recursive sequence of order (m) to generate self-organizing attractor point information (Apprehension, coherent sensation) and self-structuring polynomial weighted information (Organization, coherent perception) [26].

This computational approach can be quite mandatory and convenient specifically for advanced Health Organization (HO) applications and High Reliability Organization (HRO) in general. Our second example is an antifragile, self-organizing and self-regulating anticipatory learning system (ALS) model from neuroscience, developed from a bottom-up point-of-view. Recent Neuroscience and neuropsychology achievements support both Emotional Intelligence (EI) and Emotional Creativity (EC) as multi-scalable properties of living organism, from proteins to cell, from cell to organ, from organ to organism.[35] In human Eulogic Thought (ET), EI and EC coexist at the same time with Rational Thinking (RT), sharing the same input environment information. At brain level, it is possible to refer to "LeDoux circuit" (Logical Aperture) for emotional behavior (i.e. fight-fly) and to "Papez circuit" (Logical Closure) for structured behavior (i.e knowledge extraction and organization).[36] ET uses both Logical Aperture (to get EI and EC, to survive and grow) and Logical Closure (to get RT, to learn and prosper), both fed by environmental "noise" at the same time. We get an intelligently articulated operative asymptotic dichotomy, which we can use to model human learning behavior at systemic level efficiently and realistically. EI and EC have to coexist at the same time with RT, and at the same time, to share the same environmental input, even if they show an apparently uncorrelated behaviour.[37] We can use this operative asymptotic dichotomy to model efficiently and realistically system behavior, to get different consistent reality levels and worldviews (operating point in Figure 3).[38] Our main idea is binding unknown information to the known one recursively. Then, unknown "environmental noise" or/and "external signal input" information (u) can be aggregated to known "system internal control status" information (k), by the recurrence relation of order m, to provide structured synthetic attractor points. In this way system can search automatically for a minimum environmental perturbation level (system internal status) useful to insure sequence asymptotically convergence to get vital information from system environment (self-regulation and learning as quest for the difference that makes the difference, probing by probing...). Irrational numeric limit attractor points, identified by converging recursive numeric sequences allow the self-organizing and self-structuring of a mathematical Baires Space as attractor point families landscape, to manage numeric information usefully, to synthetise quick and raw system primary response "to survive and grow" (Apprehension, Open Logic Section, see Figure 5).[26] Homeostatic operating equilibria can emerge out of a self-organizing landscape of self-structuring attractor points with their own "World Cloud." Recursive sequence represents a mathematical method that holds anticipatory properties because it is possible to implement the anticipatory computation of any recursive sequences term.

To synthetise more organized and articulated, but slower, system response "to learn and prosper", it is necessary to structure recursive information into an "ordered polynomial reference framework", by "polynomial weighing" mapping, to obtain a "coherent perception" (Organization, Closed Logic Section, see Figure 5).[26] So, we get a sequence of different structuring operations to get external information more and more coherent to system internal status to arrive to a system "coherent perception" representation of external information. In this way, a natural balanced "Operating Point" can emerge, as a new Transdisciplinary Reality Level, from an irreducible complementary ideal asymptotic dichotomy: Two Coupled Complementary Irreducible Information Management Subsystems. Due to its intrinsic self-scaling properties, this system approach can be applied at any system scale: from single medical application development to full healthcare system governance strategic simulation and assessment application.[26] This approach allows you to develop more antifragile anticipatory learning system (ALS), for more reliable, safe and secure med app and system.

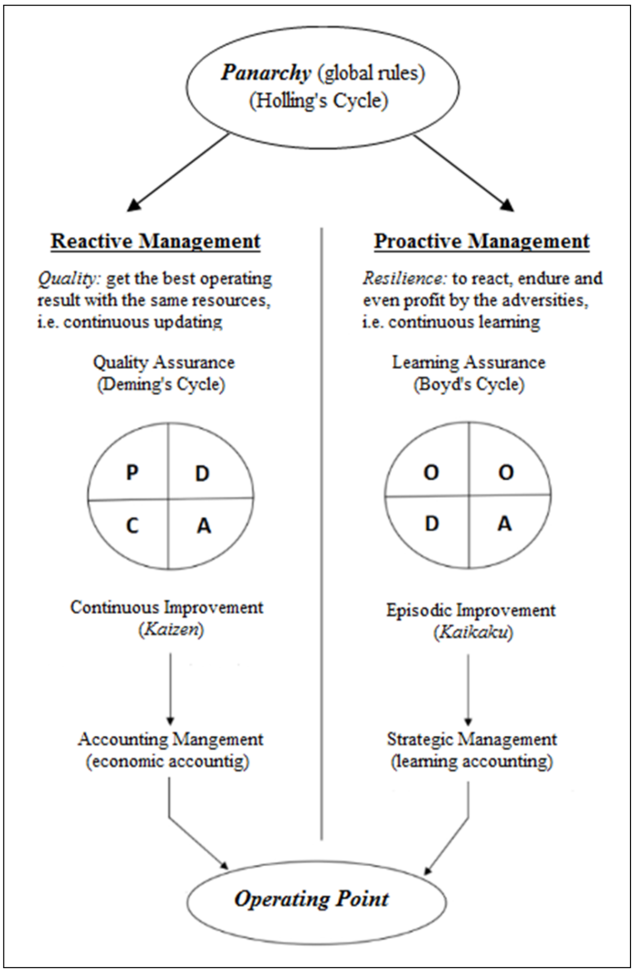

Figure 6: Our Final Architecture for HICT Natural Framework for Safety and Effectiveness Health Systemic Governance.

5 HICT Natural Framework proposal

Following this line of thought, at a higher level of abstraction, it is possible to conceive a general Health Information Conservation Theory (HICT) Natural Framework to develop advanced antifragile and hippocratic systems (see Figure 6). Again, environmental noise and input information are aggregated to system internal status information to provide a structured homeostatic synthetic operating point. Then, System Interaction by internal and external information aggregation can allow both quick and raw response (Proactive Management, to grow and survive) and slow and accurate information for future response strategic organization (Reactive Management, to learn and prosper) by coherently formatted operating point information. So, we can envisage again two coupled irreducible management subsystems, based on the ideal coupled asymptotic dichotomy presented in Figure 3: Reliable Predictability and Reliable Unpredictability Management Sub-System. In this way, to behave realistically, overall system must guarantee both Logical Closure (Reactive Management, to learn and prosper) and Logical Aperture (Proactive Management, to grow and survive), both fed by environmental "noise" (better from what human beings call "noise"), according to Holling's framework.[31]

Again, an operating point can emerge as a new Transdisciplinary Reality Level, based on Two Complementary Irreducible Management Subsystems (Figure 3). As an operative example, for Reactive Management system, we can choose from different documented operational alternatives offered by literature, like Deming's PDCA Cycle,[39] Discovery-Driven Planning,[40] etc., while for Proactive Management system, we can choose from Boyd OODA Cycle (1987),[41] Theory-Focused Planning,[42] etc. For present paper, as simple example, PDCAs cycle (Reactive Management) and OODAs cycle (Proactive Management) can be selected to represent two corresponding complementary irreducible sub-systems for advanced integrated strategic management. Then, our final operative reference architecture, for HICT Natural Framework for Safety and Effectiveness Health Systemic Governance, is given as from Figure 6. Cybernetics (i.e. advanced control theory) and complexity theory tell us that it is actually feasible to create resilient and antifragile social and economic order by means of self-organization, self-regulation, and self-governance. The work of Nobel prize winner Elinor Ostrom and others has demonstrated this.[5, 6] By "guided self-organization" we can let things happen in a way that produces desirable outcomes in a flexible and efficient way. One should imagine this approach embedded in the framework of today's institutions and stakeholders which, however, will learn to interfere in minimally invasive ways.

6 Conclusions

First, we documented how, even across so many different scientific disciplines, "Scientists 1.0" have not yet worked out a definitive solution to the fundamental problem of the logical relationship between human experience and knowledge extraction. Then, we analyzed uncertainty sources according to two main reference knowledge areas to arrive to a convenient problem solution: ontological uncertainty management at system level. Based on previous knowledge, we formulated a simple four-level reliability hierarchy scale for system properties (from most to less vulnerable) to grade system ability to face uncertainty and unexpected perturbation. Recently discovered (Computational Information Conservation Theory) CICT rational number system **Q** numeric properties were applied to previous system property hierarchy scale to to arrive to our new HICT Natural Framework proposal. The major added value of our approach is provided by our new idea of low-level system interaction, defined as internal and external information aggregation by system recursive sequencing. It can allow both quick and raw system response (Proactive Management, to grow and survive) and slow and accurate information unfolding for future response strategic organization (Reactive Management, to learn and prosper) by coherently formatted operating point.[26] Now, it is possible, at systemic level, even to envisage a post-Bertalanffy Systemics Framework able to deal with problems of different complexity, in a generalised way when inter-disciplinarity consists, for instance, of a disciplinary reformulation of problems, like from biological to chemical, from clinical research to healthcare, etc., and trans-disciplinarity is related to the study of such reformulations and their properties. For the first time, Biomedical Engineering ideal system categorization levels can be matched exactly to practical system modeling interaction styles, with no paradigmatic operational ambiguity and information loss, as shown in Figure 7 (specifically, our innovative system interaction modality, called "Recursive Interactor", corresponds to the fourth order of biomedical cybernetics). Now, new health information application can successfully and reliably manage a higher system complexity than current ones, with a minimum of design constraints specification and of system final operative environment knowledge at design level, at any system scale. Health Information community can take advantage of a new HICT Natural Framework proposal, to get a more reliable conceptualized synthetic and powerful systemic vision, to be used in advanced modeling for healthcare application and organization (HO) and high reliability organization (HRO) in general. The present paper gives a relevant contribute to that perspective and to let you achieve pactical, operative results quite quickly. So far, according to our HICT Natural Framework, no country in the world seems to be well prepared for the "digital health" era yet. Therefore, we urgently need an U.S. Apollo-like program, and the equivalent of a Space Agency for HICT: an Health Innovation Alliance with the mission to develop the institution and information infrastructures for the emerging digital health society. This is crucial to master the challenges of the 21st century in a smart way and to unleash the full potential of health information for our euro-society.

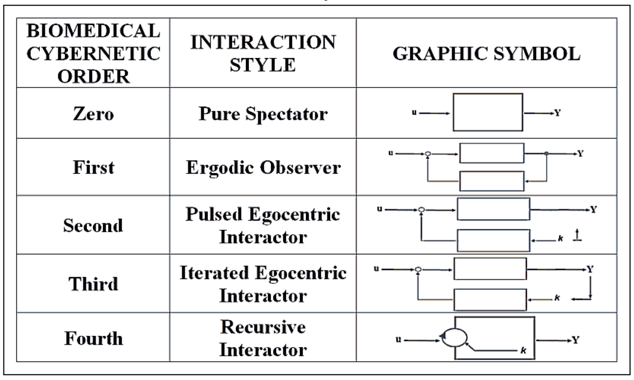

Figure 7: Our final post-Bertalanffy Systemics Healthcare Framework Proposal.

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