PROLOGUE

The main motivation behind setting up and articulating the theoretical model of *"Natural Communication"* in a book of this form proceeds from the intention of the author to criticize, and transcend the current, "target-oriented" paradigm of complexity science, by proposing and elaborating an alternative one, envisioning and implementing a fundamental architectonics of communication. The proposed model of "Natural Communication" encapsulates modern theoretical concepts from mathematics and physics, in particular category theory and quantum theory respectively, not for the sake of a technical formalization, but in order to abstract accurately basic notions that lead to a conceptual appreciation of this theory. Additionally, this makes it possible to re-consider and re-evaluate novel ways of thinking about complexity deeply-rooted in the past, which have been unfortunately, either oversimplified and distorted, or forgotten and left to oblivion. The author believes that only by looking to the past, does it become possible to establish a continuity and coherence in our current way of thinking, in particular regarding complexity, which is the pre-condition for any serious future development on these matters.

　　　The fundamental realization underlying the generative reason of this treatise is that a certain architectonics of relations based on communication is ultimately necessitated in all cases, where direct accessibility to sharply distinguishable domains of objects and their behaviour is not feasible, due to obstacles or obstructions of any particular type. In these domains, objects are intrinsically shaped according to foamy or cloudy patterns, and they are characterized by topological plasticity, emergent properties and generically probabilistic attributes. The application of pre-specific, readily-tailored design ontologies to these domains, based on the reductive notion of some hypothetical sharply-distinguishable elementary constituency, not only distorts the architectonics of their non-trivial connectivity patterns, but limits and restricts, albeit inadvertently, the potential to unravel their rich computational capacities. In light of this, the notion of computation cannot be disentangled from the architectonics of relations based on communication. In the opposite case, complexity is reduced to a particular form of *complicatedness* due to mixing hypothetical elementary constituents, with the end result that information is treated exclusively in terms of statistical data attributes, effectively depriving these domains from the possibility of manifesting genuine novelty.

　　　The basic idea proposed in this book is the following; to address and utilize the architectonic modelling of not directly accessible, or more

generally, obstacle-laden domains. Instead of analysing them in terms of constituent set-based elements and their hypothetical absolute relations, the approach is to adjoin to them other adequately-understood or directly accessible domains, which can provide pointers and open up communication channels with the originals. The process of adjoining should not be ad-hoc and should not depend on artificial choices, meaning that it should be qualified as structurally-respecting, at least, locally or partially. This refers to the "naturality requirement" of the model, a term which is exemplified in the context of category theory. Technically, this adjunction process can be always abstracted properly in terms of a pair of adjoint functors between the categorical domains involved. The essence of adjoining in order to open up or potentiate communication channels is based on the idea of partial or local structural congruence, and implies a certain type of modularity in the treatment of obstacle-laden domains. It is deeply rooted in the old art of *"Gnomonics"*, i.e. in the masterful articulation of sundials, calendars, and atlases, to probe some domain inaccessible by direct means and obtain information in modular relation with respect to the *gnomon* adopted, by forcing or effecting a certain similarity or congruence relation.

In practice, the process of adjoining a controllable domain to another one, initially not directly accessible, or obstacle-laden categorical domain, amounts to viewing these domains as different categorical levels in a stratified universe of discourse, which are bi-directionally connected by means of oppositely-oriented bridges, to be thought of as communication channels. The architectonics of communication targets precisely the conception and explicit construction of these bridges, once suitable probing domains have been structurally delineated for adjunction to the directly inaccessible domain. The bridge directed to the controllable domain plays the role of an encoding bridge, whereas its inverse plays the role of a decoding bridge.

These connecting bridges effect the communication between the domains in question, in the sense that they naturally establish universal bidirectional communication channels through which a holonomic schema of *"metaphora"* is accomplished, based on the notion of an *"obstacle-encircling"* flow. In topological terms, the initially inaccessible categorical domain is resolved cyclically by a process of unfolding with respect to the probing domain that has been adjoined to it. In this manner, the invariants emerging by the process of unfolding depict the invariant characteristics of the reciprocal communication flow between these domains. Consequently, the complexity of the not directly accessible, or obstacle-laden, domain is not specified constitutively on the basis of a pre-assumed or axiomatic elementary ontology, but relationally, modularly, and, in the technical sense naturally, in terms of the invariants emerging in the bidirectional communication flow

established with some appropriate probing domain. From an algebraic viewpoint, these invariants can be qualified in terms of structural group-type ciphers for the symbolic encryption/decryption of the induced flow.

The obstacle-embracing schema of "metaphora" giving rise to this cyclic flow, called the *"logical conjugation method"*, is always implemented on the basis of a legitimate logical manoeuvre through controllable or directly accessible domains, which are adjoined to an obstacle-laden domain as markers or pointers, providing eventually the means of specifying it indirectly through communication. The logical conjugation method should be thought of in terms of a *"motivic key"* that bears the capacity to unlock harmonically the complexity of the inaccessible domain depending on the nature and type of the obstacle encountered. The thing to be emphasized is that it always gives rise to a partition spectrum of the latter. Each cell of this spectrum is characterized completely by the pair of encoding/decoding bridges utilized for communicating an aspect of the directly inaccessible domain with respect to some probing domain.

The creative art consists in the innovation of genuine bidirectional encoding and decoding bridges between these two domains that make possible the instantiation of a cyclic communication flow capable of embracing the present obstacle. In this manner, the theoretical model of "Natural Communication" is deeply rooted conceptually to the old art of "Gnomonics", and it is meant as a continuation of this paradigm, articulating a schema of an "abstract gnomonics" in a modern theoretical scientific context.

For all practical purposes, the model of "Natural Communication" can be implemented briefly as follows: We consider a problem in the context of a domain whose objects and relations are inaccessible by direct means. It is instructive to think of this domain as a particular level in a broad universe of discourse, which can engulf other possible levels as well. First, we move out of the context of the problem, formulated at the level of the inaccessible domain, by adjoining to it another controllable domain, assuming existence within the same universe. In order to accomplish this, we have to set-up an encoding bridge from the level of the inaccessible domain to the level of the accessible domain, such that some certain form of congruence can be established between these domains. Once we have succeeded in setting up this bridge, we are able to mirror the initial problem at the level of the controllable domain, where we have the means to address it effectively. The process is completed by setting up an inverse decoding bridge from the level of the controllable domain to the level of the inaccessible one. In this way, the available means or knowledge pertaining to the controllable domain can be lifted at the initial context of the problem. Thus, the pertinent problem can be effectively resolved in the context of its initial

formulation by the embracing of the obstacle it engulfs via the communication channels established with the other domain. The reciprocal encoding and decoding bridges constitute the means of a novel architectonics of communication. It has to be stressed that this procedure can be iterated by the adoption of more than one controllable domain complementarily adjoined to the inaccessible domain. The skeleton of this spectral resolution process remains invariant under the adjunction of deeper levels, and most important, it always gives rise to a partition spectrum of the inaccessible domain, amenable to possible refinement, whose cells are indexed by the respective pairs of encoding/decoding communication bridges.

  The present treatise consists of eleven chapters. These chapters run in no linear order. Rather, the reader may discern a multiplicity of navigation paths through the exposed landscape depending on the type of questions, insights, topics, and depth, she or he wishes to be engaged with in this exploration. Faithful to its communicational roots this book does not intend to install any pre-assigned order for the mind of the reader. The hope is there will always be certain widths of spectral frequencies to resonate with readers coming from diverse backgrounds. Although the development is based on mathematical and physical ways of thinking and arguing, essential care has been taken for quite detailed conceptual articulations of the treated subjects, which may appeal to readers not wishing to delve into the more technical aspects of this work. The main novelty consists in the attempt to transcend the strict linear chronological order, imposed by a misconceived sense of historical coherence, and establish bonds among ideas, notions, and thinkers, which are seemingly unrelated if not viewed through a gnomonic perspective. In this manner, a new view of coherence emerges, which in the author's opinion characterizes the diachronic value and persistence of all these elements. Since the method of the book is mainly synthetic, traditional divisions among mathematical and physical concepts, as well as divisions within a discipline playing a mere organizational, less than organic role, are systematically avoided, or they are bridged together appropriately, focussing on the coherence in the functioning of a body of knowledge.

  Undoubtedly, the most suitable mathematical framework to express the model of "natural communication" is the framework of category theory. The major problem, beyond the technicality of this framework, is that it is usually introduced in an ad hoc axiomatic fashion, as unifying together all the most important parts of mathematical thinking and knowledge. This approach to the framework of category theory dangerously predisposes to a view of its formalism and concepts merely as the means of generalization and unification, and not as the means of innovation in relation to the whole body of mathematical thinking. Rather, it is the deep roots of category theory in

canonics and gnomonics, going back to the generative forces shaping mathematical thinking itself that underlies the value of this framework. Unfortunately these roots, which emerged only after the fundamental theory of adjoint functors shone through the whole endeavor, remained nevertheless suppressed creating the artificial distorted unifying generalization of an "abstract nonsense", a humoristic expression used more or less seriously by the insiders in the field. This bias can be remedied only by tracing back the roots of category theory in canonics and gnomonics, i.e. by viewing this framework as a continuation of the old schools on gnomonics that historically re-emerged as an emergency exit out of the set-theoretic paradise that threatened to absorb everything mathematical and physical, although never acknowledged as such. For this reason, category theory is introduced officially only after Chapter 8, and after the reader has acquired a quite thorough acquaintance with the notions of "abstract gnomonics", and "natural communication". Moreover, the presentation of the powerhouse of this framework follows an inverted order, in comparison to the usual account. The reason for this is that category theory shines through the crystallization of the notion of adjunctions, and in this sense, it is a higher level, structural continuation of the old art of gnomonics, based on the same conditions of metaphora and communicability between different structural species.

Besides the role of category theory in formalizing "natural communication" in modern structural algebraic and topological terms, the conceptual compass of the book is especially sensitive to the currents of thinking of our ancient predecessors who initiated the whole endeavor of *"Natural Philosophy"*, not as an internalized closed mental systematics of encompassing the workings of the whole world, but mainly as a means to qualify their dialogue with Physis, i.e. primarily as an open-ended means of experimentation and communication with what is directly inaccessible in order to unveil and remember it. The same stance is also necessary to re-examine and re-evaluate major modern advances in mathematics and the physical sciences in order to unravel the invisible threads of continuity and coherence through historical time.

Essentially all the mathematical and physical notions introduced in this work are associated with the names of the thinkers who first conceived of them, or played a major role in their establishment. Notwithstanding this, all these notions are scrutinized in light of their emergence from the gnomonic perspective permeating the whole volume, i.e. all these notions are recast in relation to their role in a corresponding process of communication. One of the artifacts of this association is that citation becomes particularly simple. Direct numerical citations in the text are avoided, and the reader may find bibliographical references in endnotes, directly after the name of the

person involved appearing in the main text. In this manner, the credit goes to the innovators themselves, and not to textbooks, as is usually the case. As a general rule, the original works, although more difficult to read, and in many cases more fuzzy in comparison to latter formulations, expositions, simplifications, and appropriations, contain the real gems shaping a new field. It goes without saying that self-citations are intentionally completely suppressed in this work.

An aspect of this book that may disturb some readers is that it contains a significant amount of seeming neologisms in English. This is only apparent, since all the non-standard English terms used are actually rooted in the ancient Greek language. The difficult choice was to settle for a standard term, or to introduce a neologism at some point, as a viable way to emphasize some basic concept. The dilemma essentially originates through the linguistic loan of a term into English, and the subsequent appropriation of this term in the context of a specific discipline that, in many cases, delimits and even distorts the original meaning and functional applicability of this term. This is the case, especially, regarding the basic notions of "analogia", and "metaphora", employed in the text, since in English, the corresponding terms of "analogy", and "metaphor" have either a general meaning, or are used in specific linguistic or logical contexts unrelated to the etymological underpinnings of the original Greek terms. Additionally, in mathematical phraseology, the prefixes "homo" in algebra, and "homeo" in topology, have been adopted to characterize certain types of mappings associated with particular types of equivalence. Since the notion of an equivalence relation is formulated in set-theoretic terms, the abstract gnomonic type of these mappings is captured here by the term *"homeotics"*. As another example, the mathematical term "monodromy", is widely used in a sense opposite to the meaning of this term, i.e. "monodromy" is used instead of "polydromy", which would be the correct usage. Finally, in category theory the term "topos" is used, the plural of which is even conjugated in the absurd form "toposes", without the realization that this is a term originating from rhetoric. In other words, a topos is meaningful only through the lines of argument or communication permeating it, the so called "geometric morphisms" in the technical context. The same applies for the notion of an "object of truth values" characterizing a topos, which is absurd if not qualified through the term *"aletheia"*, encapsulating the energetic act of unveiling in Time and remembering.

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form of this book owes much to all these. It should also be mentioned that the term "gnomonics" itself has been suggested in the context of our conversations by Vera Bühlmann. A special thanks also goes to all my students, who patiently followed my long series of lectures on these subjects during the last four years in the context of the postgraduate teaching and research modules on "Gnomonics" and "Mathematical Thinking", and attempted to obtain a deep conceptual and applicable comprehension of all the relevant subjects. Last, but not least, I would like to thank my family, and especially my wife Anna, who created the conditions for undisturbed work on this book, and who managed to reconcile with my peculiar sense of time.

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