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Kofi K. Dompere

# The Theory of Info-Statics: Conceptual Foundations of Information and Knowledge

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# Contents

# Preamble

"The purpose of what follows is to advocate a certain analysis of the simplest and most pervading aspect of experience, namely what I call 'acquaintance'. It will be maintained that acquaintance is a dual relation between a subject and an object which need not have any community of nature. The subject is 'mental', the object is not known to be mental except in introspection. The object may be in the present, in the past, or not in time at all; it may be a sensible particular, or a universe, or an abstract logical fact. All cognitive relations—attention, sensation, memory, imagination, believing, disbelieving, etc.—presuppose acquaintance" (Bertrand Russell, [R3.79, p. 127]).

"The obvious characteristics of experience seem to show that experience is a two-term relation; we call the relation *acquaintance*, and we give the name *subject* to anything which has acquaintance with objects. The subject itself appears to be not acquainted with itself; but this does not prevent our theory from explaining the meaning of the word '*I*' by the help of the meaning of the word 'this' which is the proper name of the object of attention. In this respect, especially, we found our theory superior to neutral monism, which seems unable to explain the selectiveness of experience" (B. Russell, [R3.79, pp. 173–174]).

"Scientific progress has been two-dimensional. First, the range of questions and problems to which science has been applied has been continuously extended. Second, science has continuously increased the efficiency with which inquiry can be conducted. The products of scientific inquiry then are (1) a body of information and knowledge which enables us better to control the environment in which we live, and (2) a body of procedures which enables us better to add to this body of information and knowledge.

Science both informs and instructs. The body of information generated by science and the knowledge of how to use it are two products of science" (Russell L. Ackoff, [R16.1, p. 3]).

"All economic decisions, whether private or business, as well as those involving economic policy, have the characteristic that quantitative and non-quantitative information must be combined into one act of decision. It would be desirable to understand how these two classes of information can best be combined. Obviously,

there must exist a point at which it is no longer meaningful to sharpen the numerically available information when the other, wholly qualitative, part is important, though a notion of the 'accuracy' or 'reliability' has not been developed" (O. Morgenstern, [R13.18, pp. 3–4]).

"The chief thing is to understand that there is a fundamental difference (in the field of economics) between mere *data* and *observation*. The latter are naturally also data, but they are more than that. They are selected. They are supposed to arise from planned observation, guided by theory, which however need not necessarily be tied to controlled experiments. *Observations* are deliberately *designed*; other *data* are merely *obtained*. Together they constitute economic information which is related to the entire body of information, partly deriving from it, partly illuminating that section of problems that is not yet understood. Theory itself is never based solely on ordinary data in the above sense, i.e., merely obtained information with largely unknown but probably exceedingly wide error margin. Theory, moreover, is constructed and invented; data are merely gathered and collected even though this involves always administrative planning…

It is desirable to set forth systematically the relationship of such terms as 'observation,' 'data,' 'statistics,' and 'evidence.' Our use may not find general acceptance, but, in order to achieve precision, clarity of the terminology is essential" (O. Morgenstern, [R13.18, pp. 88–89]).

The quotations that have been presented in this preamble point to certain difficulties in the traditional definitions of the concept and phenomenon of information. One cannot speak of the usefulness of information without a reasonably clear definition that helps the understanding of its linkage to knowledge and decision-choice systems that find meaning in varieties over the epistemological space. Information is neither transmission nor communication, both of which are actions which are made possible by the existence of information under the conditions of matter and energy. It is this linkage system of information, knowledge, decision, choice, and practice in the universal space of varieties that justifies the reflective notion that when ignorance ascends to the throne of human organization, lies become elevated to the deputy of governance and the first casualty is truth with a violently relentless prosecution of knowledge under the principles of disinformation and misinformation. Alternatively, when knowledge ascends to the throne of human organization, truth becomes elevated to the deputy of governance and the first casualty is lies with a violently relentless prosecution of ignorance under the principles information, freedom, and justice. The confused understanding of the defining nature of the concept and phenomenon of information increases the complexity of the relationship that connects ignorance, knowledge, truth, and lies in the collection of problem-solution dualities over the epistemological space, over which cognitive agents operate to understand the necessary conditions and create the sufficient conditions in order to connect freedom to necessity, where the toolbox to deal with disinformation and misinformation is the practice of the principle of doubt at the expense of credulity.

# Chapter 1
# The Theory of Information and Knowing: Ontology Epistemology Reality

## 1.1 General Epistemic Reflections on Information and Knowledge

In this monograph, we shall concern ourselves with the morphology of non-standard information structure and its effects on the controllability of socio-natural decision-choice systems. In doing so, a number of questions tend to arise. The primary questions center on the concept and the definition of information. Given the concept and the definition of information, the derived questions involve the concepts of standard and non-standard information structures, their transformations and communications. What are the similarities and differences between standard and non-standard information structures? To identify the differences and similarities between the two conceptual structures of standard and non-standard, we need to have a clear and conceptually workable definition and explication of information and information structure. The definitional structure of standard information has been provided in a number of places [R12.18, R12.19, R12.20, R12.22, R12.23, R12.45, R20.6, R20.11, R20.12]. The definition of standard information structure takes two and interrelated paths of communication theory of information [R20.7, R20.11, R20.12] and the semantic theory of information [R12.4]. The emphasis depends on how one views the uses of information. Both definitional paths use the concept of probability. In the case of the semantic framework, Bar-Hillel & Carnap state that *the fundamental concepts of the theory of semantic information can be defined in a straight forward way on the basis of the theory of inductive probability that has been recently developed by one of us* [R12.3]. The mathematical theory of communication has an approach where the theory of communication is used as an analytical vehicle to define the amount of information as a measure of the statistical reality through the concept of probability of occurrence. In the standard-information framework, what is the definition of the concept of probability? Is the concept of probability an information-derived or is the concept of information a probability-derived? What is the relationship between



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the concepts of probability and possibility and how do they interrelate within the quality-quantity duality with relational continuum and unity? Both the communication concept and the semantic concept of information of the standard information structure, seem to assume the definition and explication of the concept of information away. In other words, the phenomena of information, probability and possibility are assumed as known. In the mathematical theory of information that reflects the communication approach to establishing the definition of the concept of information, the meaning and the truth of messages are not of concern. As such, they are restricted to a limited domain of some present and future explanations of a general concept of information-knowledge production. As new problems emerge in the decision-choice system, such as *deception* and the development of the *science of deception* within the management of command and control structures, the utility of the standard approach becomes limited and sometimes analytically helpless. For example, on what basis does one claim something to be true, false, valid, real or fiction in the spectrum of socio-natural activities? The answer to this question involves comparative analysis and cannot be simply information. If one claims information as the answer, then another question follows as to what is information and how does one know that there is information? Here, it may be noted that both the mathematical theory of communication and the semantic theory of information are about communication among objects in terms of energy actions.

It is, therefore, useful to present a new framework for the definition and explication of information for the development of self-containment in the current monograph. This new framework will lead to a definition and explication of *non-standard information* and *information structure* that will make the concept of information explicit. The objective is to develop pathways to relate the information structure to controllability of socio-natural decision-choice systems through knowledge productions which must be related to the value of communication, learning and knowing. There are needs in this new framework for obtaining analytically workable general definitions of decision, choice and decision-choice system. Given a satisfactory definition of information, a number of fundamental questions tend to arise in both ontological and epistemological spaces as we examine conditions of controllability and convertibility within any system's structure. (a) At the level of ontology, how does nature produce, store, process and use information? (b) At the level of epistemology, how do cognitive agents obtain, code, store and process information to create conditions of knowing to obtain knowledge about reality as seen from exact sciences, such as physics, and inexact science such as economics? (c) At the level of natural transformations, how does nature relate and manage the relational structure of convertibility and controllability of ontological elements? (d) What is reality and how is reality related to the process of knowing? (e) Does reality present itself the same way in both ontological and epistemological spaces? (f) At the levels of physical engineering and social engineering, how do cognitive agents relate the processes of natural transformations to social transformations under conditions of general information structure?

The search for answers to these fundamental questions will begin with critical examination of information-knowledge structures and how these information-knowledge structures relate to controllability and convertibility of decision-choice systems within the ontological-epistemological polarities. From the viewpoint of knowledge production, we need an analytical clarity between the concepts of ontology and epistemology. Under the viewpoint of decision-control process of systems, we need to examine the convertibility, knowledge and credulity of the source of information. The credibility of the source of information must be examined by relating it to the phenomena of *subjective-objective duality* in the knowledge-production process. Similarly, the subjective-objective duality must be mapped onto the dualistic structure of *qualitative-quantitative dispositions*. For reasons of controllability and convertibility of states, the conditions of subjective-objective duality and qualitative-quantitative duality under the information-knowledge structure must help in instrumentation of useful control elements that will constitute the general analytical tool box for the management of commands and controls of the decision-choice system at social levels. The dynamics of the decision-choice system under commands and controls for any given object must meet observability conditions that allow the assessment of the state of the system and the distance from the preferred destination. The conditions of the preferable state are the same as the conditions of optimality which is the temporary preferred state in the epistemological space and the temporary final state in the ontological space. The distance between any state and the destination state in the ontological space will be called *ontological-controlled deficiency* which must be internally corrected by natural decision-choice actions for any given ontological information structure. The distance between any state and the preferred state in the epistemological space will be called *epistemological-controlled deficiency* which must be internally corrected by social decision-choice actions for any given epistemological information structure. What are the similarities and differences between the ontological and epistemological information structures? Similarly, what are the similarities and differences between ontological-controlled deficiency and epistemological-controlled deficiency? How can the similarities and differences in all possible cases be known?

The correction of ontological-control deficiency is an objective process which depends on an objective information. This objective information structure exists whether the ontological objects are aware or not. The correction of epistemological-control deficiency is a subjective process which depends on subjective information. The subjective information structure exists as a result of existence and awareness of ontological objects. The corrections of ontological-control deficiency and epistemological-control deficiency are information-decision-choice processes that relate to self-correcting and self-organizing control systems. The complexities of these processes are such that the definition and structure of the standard information composed of semantic and communication approaches do not constitute solutions to the tasks of problems of the general class of self-correcting systems especially when categories are under epistemic and ontological work. The transfer of definitions of standard (semantic and communication) information and information structure to

the fields of non-standard information may be simply grafting on a process as well as possibly misleading the specification of the analytical structure. The problem of non-standard information structure will be formulated and discussed in reference to socio-natural decision-choice systems. For the validity of the analytical discussions and derived conclusions, it will be necessary to show that the social decision-choice systems are isomorphic to the physical decision-choice systems and that the social management of commands and controls are *ontological mimicry* at the level of biophysical decision-choice systems.

The epistemological deficiency is simply due to the nature of information and information structure as will be discussed. The concept of ontological mimicry must be defined and explicated. Additionally, the ontological mimicry process must be shown to relate to internal activities of command, controllability, observability and convertibility of states of the decision-choice system. The theory of the management of commands and controls is an information-decision-choice process and must be useful in dealing with quantity-time problems, quality-time problems and relational problems of quantity-quality duality with neutrality of time. Here, the management of commands and controls must deal with three types of equation of motions. They are the quantitative equation of motion for a constant quality, the qualitative equation of motion for a constant quantity and the simultaneity of equations of quantity-quality motion in relational unity. The unified elements of all managerial structures are the available information-knowledge structure that must be defined and explicated for each phenomenon under the decision-choice system. The concepts of command, controllability and observability are familiar. The concept of convertibility, however, may be unfamiliar, and hence requires an explanation of how it relates to other essential concepts in statics and dynamics of the decision-choice system. The importance of the concept of information-decision-choice processes that impose on any decision-choice system, the attributes of self-correction and self-organizing should not be underestimated. In fact, the behaviors of all elements in both ontological and epistemological space are governed by nothing else but decision-choice processes under information-energy actions.

The initialization of discussions on theories, conclusions and practices of information, decision and choice must be placed in the spaces of ontology and epistemology whether the phenomenon resides in a natural or social science. Controllability of decision-choice systems must be placed within the information-knowledge duality under the principle of relational continuum and unity as the guiding framework of actions for continual transformations that are true of all ontological and epistemological elements. What is the analytical relevance in introducing information-knowledge duality with relational continuum and unity in the decision-choice system? Is information not the same thing as knowledge? If the answer is no, then it will be useful to examine the defining differences and similarities that set them apart as well as unite them in the process of thought as well as their utilities in decision-choice actions. What is the relational structure of uncertainty and ignorance? Is the concept and the material meaning of ignorance derived from uncertainty, is the concept and material meaning of uncertainty derived from

ignorance, or, are the concepts of ignorance and uncertainty the same? Is it meaningful to speak of *ontological uncertainties* and *epistemological uncertainties* and how are they related to the information-knowledge duality? Similar questions come to the surface in dealing with static and dynamic decision-choice systems as they are seen in transformation and change. Is the definition and explication of ignorance derived from knowledge or from information? Similarly, is the definition and explication of uncertainty information-derived or knowledge-derived? The management of commands and controls of the decision-choice system is the production of outputs (outcomes) that must have inputs. Are these inputs information or knowledge, none of them or both?

The inputs of the decision-choice system to be transformed into outputs are dependent on the processes of knowing of the universal elements to produce actions. Conceptually, it may be useful to speak of an *ontological knowing process* and an *epistemological knowing process.* In general, however, should the process of knowing be placed in knowledge-ignorance duality with relational continuum and unity where knowledge and ignorance appear in degrees of knowing whose sum, for any particular phenomenon, may be expressed as one? Similarly, should the knowledge-ignorance duality be mapped onto the information-uncertainty duality? The answers to these implicit and explicit fundamental questions that have been raised require conceptual definitions of information and knowledge, and how they may be related to ontological and epistemological realities. The ontological and epistemological realities must be connected to the process of knowing and management of systems' controllability through decision-choice actions. The control actions are defined in the quality-quantity space with neutrality of time such that there are *quality-time phenomena, quantity-time phenomena* and *quality-quantity-time phenomena.* The analytical process of these conceptual definitions leading to the meanings and awareness of the varieties and their identities defines a structure of *info-statics* and the corresponding *theory of info-statics.*

At the level of epistemology, the relational structure of these concepts in knowing is generated by an *epistemic process* which must be connected to representations such as the vocabulary and grammar under methodological nominalism which in turn must be connected to the language of science and all areas of the knowledge system through the methodological constructionism and reductionism. The theory of knowing is spun by *epistemic categories of reality* and not *ontological categories of reality*. These epistemological categories are *derived categories* under an epistemic rationality and must be related to the ontological categories which are the *primary categories.* It is the organic process of moving from the epistemological space to the ontological space to claim a *known item* (called *IT*), that information, information representation and cognitive-input processing are defined in terms of paradigms of thought which become not only necessary but imperative. The paradigms of thought function as enabling instruments that are defined for epistemic activities within the information-knowledge duality as well as the uncertainty-ignorance duality. Every selected paradigm of thought must meet the conditions of methodological nominalism, constructionism and reductionism within the *epistemological-ontological polarity* (These conditions

will not be stated and explained in this monograph, but interested readers may consult [R4.7, R4.13, R17.15, R17.16]). All these questions and abstracted answers must be linked to *inputs* and *outputs* in the decision-choice processes involving the management of commands and controls to induce transformations of varieties in socio-natural systems under the principle of relational complexity. At the level of ontology, there is the organic concept of an *ontological decision-choice process* which is a set of individual ontological decision-choice processes involving ontological elements and ontological input-output structures within relevant environments. At the level of epistemology, there is also the organic concept of an *epistemological decision-choice process* which is a set of individual epistemological decision-choice processes involving cognitive agents using appropriate inputs. The time-point conditions of the decision-choice process specify the info-static state that may be used to specify the initial conditions of *info-dynamics* and the construction of the *theory of info-dynamics*.

The process of knowing is the linkage between the ontological categories of reality ("the *IT*") which are created by natural processes, and epistemological categories of reality ("the *BIT*") which are created by cognitive agents in the epistemological space. The epistemic process is guided by a conceptual framework of paradigms that serves as an *information processing machine* for knowing within the source-destination duality. The understanding of the morphology of any paradigm of thought requires a clear understanding of its input of thought creation. The knowing is composed of the discovery and understanding of the nature and behaviors of ontological elements and their corresponding categories. In this respect, the act of knowing of ontological categories is the work of a *paradigm of thought* operating on *information structure* whose elements must be specified, coded and symbolically represented for an epistemic operation. The symbolic representation of information (the bit") is part of the acquaintance and language which reflect some *sense data*. The concept of data must be clearly defined, explicated and linked to the concept of information. Here, a question arises as to whether data is information or information is data. Is the concept of data information-derived, or is the concept of information data-derived? The understanding of the information-data relational structure is important in the continual advancement of information technology and frontiers of sciences under exact and inexact nature.

The elements in the ontological space constitute the *identities* of varieties which are completely described by the *ontological information* and hence contain complete knowledge in their states of existence. The elements in the epistemological space constitutes *derived epistemological elements* which are described by *defective information structure,* composed of vagueness and incompleteness, which is abstracted by cognitive agents through the methodological nominalism [R3.18, R3.19, R3.34, R3.49, R3.50, R3.53, R3.54, R3.80]. The ontological categories as identities constitute a *family of primary categories,* while any category in the epistemological space constitutes a *derived category*. The theory of knowing is to

establish *necessary and sufficient conditions* for an isomorphic relation between an epistemological category and an ontological category where the theory of knowing is guided by a *methodological trinity* of nominalism, constructionism and reductionism to produce a claimed known item. The methodological trinity of nominalism, constructionism and reductionism constitutes a knowing mechanism which provides justified necessary and sufficient conditions of a belief system on the basis of the known, for the management of the commands and controls in the decision-choice system of any kind. As discussed, the objective of knowing is to produce inputs into the socio-natural decision-choice systems. Over the epistemological space, the methodological constructionism and reductionism are at the mercy of methodological nominalism that must carry their inputs where such inputs must be shown to relate to information under a general definition. The social decision-choice system is composed of humanistic decision-choice systems and physical decision-choice systems, both of which are under the management of cognitive agents.

The importance of these discussions is to specify the necessary and sufficient conditions for the definition and explication of the concept of information and information structure that will be useful as inputs into the statics and dynamics of the socio-natural decision-choice systems. The relational nature of the methodological trinity of nominalism, constructionism and reductionism is presented as an epistemic geometry in Fig. 1.1. In dealing with the complexity of definitions of information and information structure at the level of epistemology, nominalism

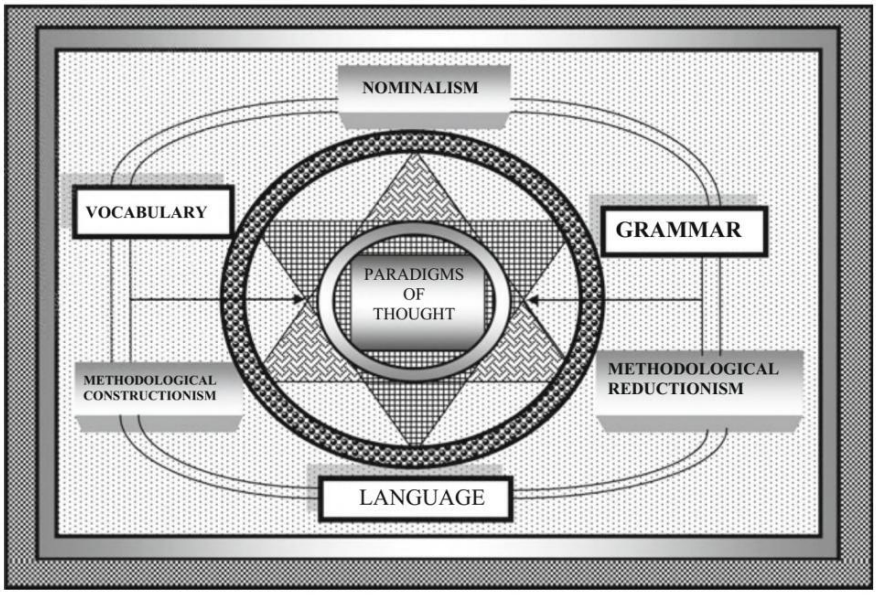


**Fig. 1.1** Cognitive geometry of methodology and language in thought production

relates to language, vocabulary and grammar which allow information to be encoded and decoded, while constructionism and reductionism relate to paradigms of thought given the information and information structure to assist the decoding process. The concept of information is still not defined. The reason for a lack of a definition of the concept is simply a searching for a continual framework that will allow the understanding of the phenomenon of information and a construct of a general definition of information that is applicable in all cases over both the ontological and epistemological spaces. The search is therefore on a general framework for a general information definition that is applicable over all epistemic areas without exception.

## 1.2 A General Framework for Examining the Definitions of the Concepts of Information and Information Structure

So far, the concepts of Information and information structure are very broad with multiple meanings in such a way that the many definitions are restricted to needs and uses. In defining information, the general framework takes as its point of entry the idea that all these socio-natural needs and uses belong to the general class of decision-choice activities. For the general purpose of socio-natural decision-choice activities, it is useful to have a definition that will encompass all the different number of specific definitions that may be developed. As has been discusses in [R4.7], the general definition of information must be developed from interdependent components of a set of *properties of objects* and a set of *relations of objects* which together provide the dual character of information in a relational continuum and unity. The set of properties of objects resides in the ontological space and projects ann*objective phenomenon* as will be argued. At the level of ontology, information is objective phenomena that present properties of objects. The set of relations of objects resides in the epistemological space and projects a *subjective phenomenon* in its interpretation as will be argued. It is this dual character of objects that allows both the semantic theory of information and the mathematical theory of communication to define the source of information and destination of information at the level of relationality. The source and destination find their existence in the ontological space in terms of material existence. The linkage and the activities in the linkage between the source and the destination are made possible by *something.* This something is what is called *energy.* The objects are what is called matter.

In this respect, the conceptual definitions of information in both the mathematical theory of communication and the semantic theory of information with other standard theories of information are restricted to relations of objects in the source-destination duality over the epistemological space where the properties of objects as information are neglected. In other words, the standard approach to the

definition of the concept of information is restricted to the component of subjective phenomenon to the neglect of the component of an objective phenomenon. A general definition of information must start with the properties of objects that constitute the differential distribution of identities of varieties of matter. The properties of objects can then be transferred as subjective concepts of information and information structure. It is through the process of defining the concept of information structure, that information becomes defined in relation to specific needs in the epistemological space.

In this respect, information structure cannot constitute a vehicle to define the concept of information. Without the existence of these ontological objects, relations of objects are undefinable. The relations of information are established as subjective phenomena that give meaning to information transmission defined in terms of quantity and quality of the transmitted as seen from the source object and by the destination object. It is through the transmission process that the concepts of possibility, probability and reality arise in the epistemological space. These concepts do not arise in the ontological space [R4.7, R4.10, R4.13]. The relational structure of matter, energy and information is presented as a cognitive geometry in Fig. 1.2. It is not by accident that the dominant scope and emphasis were given to energy and not to information in the previous era of scientific advance due to the complex nature of

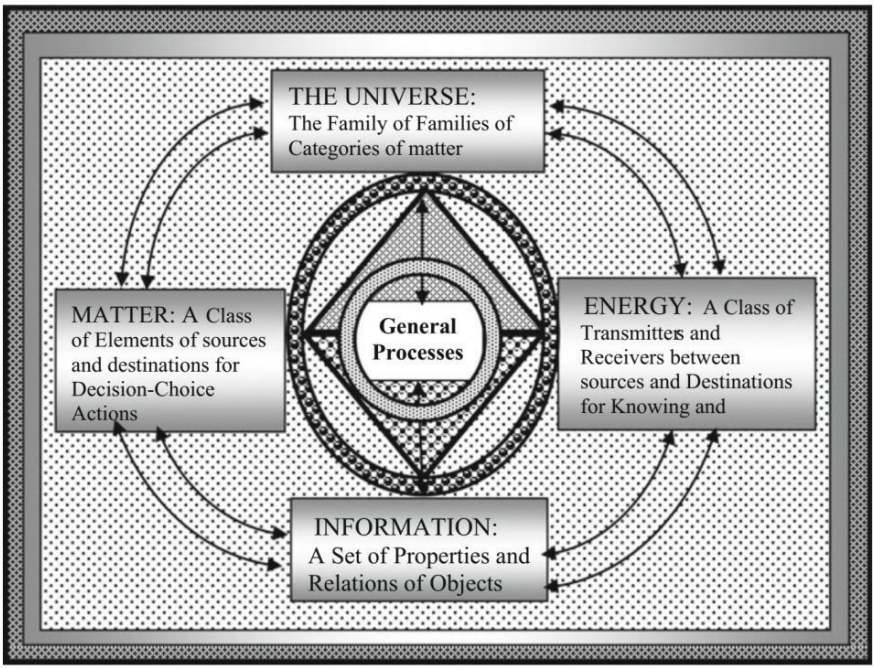


**Fig. 1.2** Epistemic geometry of a relational structure of matter, energy and information for a definition of information

information and its relationship to energy in the ontological space. All that cognitive agents can do are progressive actions that are undertaken in the epistemological space to understand the information-energy relation given matter. Without the understanding of energy, it would be an increasing difficult to understand information, varieties of information structures and the identities of the ontological varieties. Here, the universe is conceived to be composed of matter and energy that are welded together by information in the sense that both matter and energy are composed of a distribution of varieties with identities that are established by information without which these identities are unknowable. The existence of matter and energy implies the existence of information the definition of which must be clearly established in generality.

The search for the general concept of information must begin with an entry point that constitutes an axiomatic foundation in defining the concept of information and an information phenomenon. This axiomatic foundation is the existence of matter and energy in relational continuum and unity in the ontological space. The matter and energy are ontologically linked by *information* that gives matter and energy the never-ending static and dynamic activities. In this respect, there is matter, energy and information which are being conceptualized as ontological trinity, where matter and energy constitute an organic ontological polarity. One finds matter in the primary existence while one finds energy and information in the derived existence. In other words energy and information are derivatives of matter. This ontological relational structure becomes the occupation of the activities of ontological objects whose objective is continual shaping and reshaping of the elements in terms of variety in the ontological space. It also becomes the occupation of cognitive agents in the epistemological space whose objective is to understand the ontological existence composed of objects, states and processes. The ontological activities in the ontological space are the works of ontological information-decision-interactive processes on behalf of ontological objects for internal management of command and controls of ontological decision-choice systems for continual transformations of varieties. The epistemic activities in the epistemological space are simply the works of epistemological information-decision-interactive processes on behalf of cognitive agents for the management of commands and controls of epistemological decision-choice systems to understand the activities and events in the ontological space. The defining attributes of ontological information are illusive and not controversial unlike those that present the epistemological information.

The processing of the ontological information in the ontological decision-choice system is a natural process in terms of the connectors between the source and the destination. These connectors are *natural paradigms* of transformation that present natural laws of relational continuum and universal unity with neutrality of time. The activities of the connectors are made possible by energy that resides within matter. The results of the natural paradigms from the ontological space present ontological information which is encoded and mapped by a subjective process onto the epistemological space as epistemological information that must be processed through

decoding. The coding and the decoding are done by ontological objects in the epistemological space. Here, the ontological information is objective and not only that but it also constitutes knowledge in such a way where there is an equality between ontological information and ontological knowledge. The processing of the epistemological information also requires a paradigm of thought in transforming the epistemological information into an output which is called knowledge. The epistemological information like the ontological information is not knowledge. Necessary and sufficient conditions would have to be established for equality between epistemological information and knowledge. As is being discussed here, there is the *ontological paradigm* of natural creation that provides rules for acting on the ontological information to provide an input into the management of the commands and controls of the ontological decision-choice system. Similarly, there are epistemological *paradigms* of cognitive creation that provide rules of thought for acting on the epistemological information to provide an input into the management of the commands and controls of the epistemological decision-choice system.

The ontological paradigms are natural creations and follow the rules of nature. The epistemological paradigms are epistemic constructs that must be related to the type of information that is held as an input in the epistemological space. The paradigms of thought in the epistemological space may, thus, vary in accord with the concept and nature of information and information structure. Much of the controversies and paradoxes regarding the concepts of information and information structure are due to subjective information that presents itself in the epistemological space. Are inputs into the management of commands and controls of decision choice systems information or knowledge? Is subjective information the same as knowledge? Are both epistemological information and knowledge exact or inexact? Are uncertainties and risks the attributes of both ontological and epistemological spaces or are they only attributes in the epistemological space? Are the concepts of possibility, probability and actual phenomena of epistemological information combined with human ignorance? What does risk mean and connote as it is linked to the ontological space and epistemological space? It will become clear that if ignorance is lack of knowledge and risk is the presence of ignorance then risk is a phenomenon defined in the epistemological space and is undefinable in the ontological space.

The answers to these questions require a comparative analysis of the attributes of information in ontological space and epistemological space no matter of the definition provided. The definitions of the concepts of information and information structure that combine objective and subjective phenomena have not been given yet. However, it has been stated that information is composed of properties of ontological objects and relations of ontological objects, where the ontological objects constitute the sources and destinations of information transmission through activities in the encoding-decoding duality with relational continuum and unity where energy is an enabler. The comparative analytical structure of ontological and

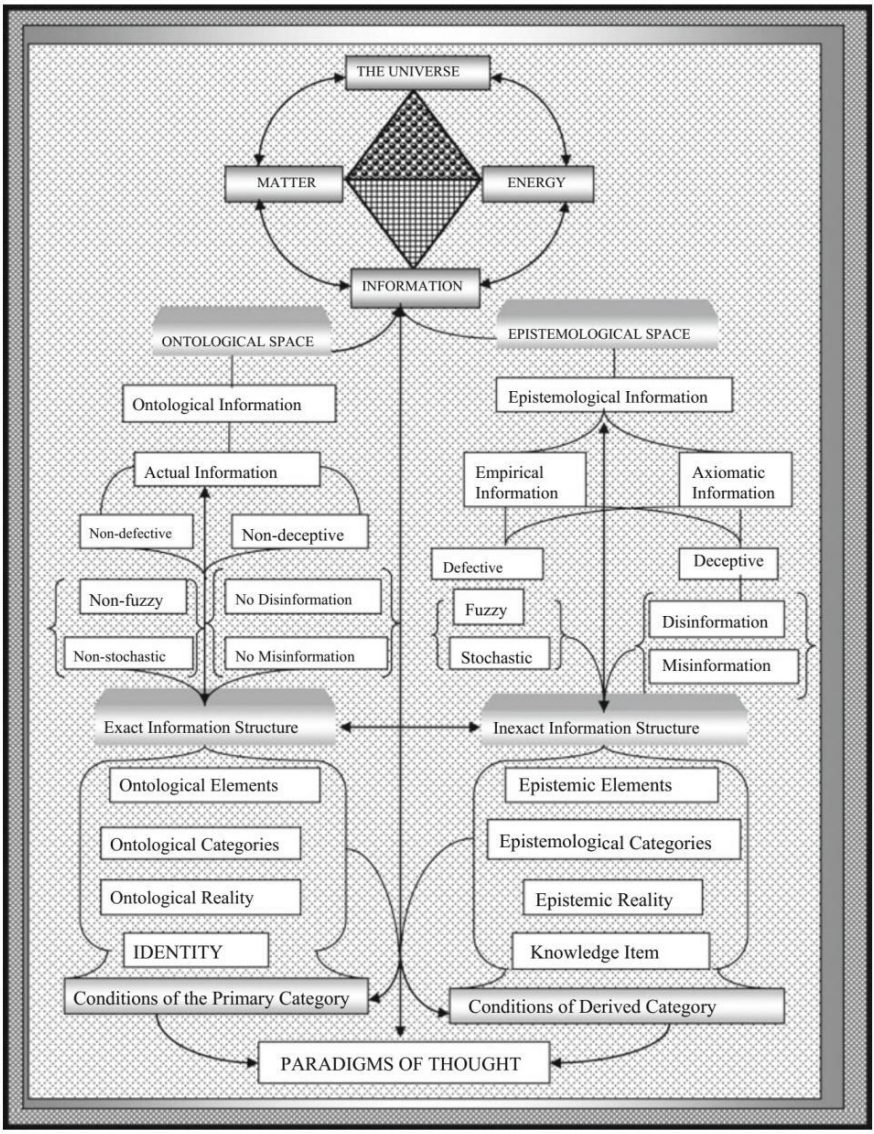


**Fig. 1.3** The relational structure of ontology, epistemology, information and paradigm

epistemological information types is provided in Fig. 1.3 which presents the relational structure of ontological information and epistemological information. One important way to view this comparative structure is that the information in the ontological space represents the conditions of the *IT* while the information in the epistemological space represents the conditions of the *BIT*.

## 1.3 Some Reflections on the Standard Information Definition (SID)

It is now useful to turn an attention to the definition of information and the structure of information after which attentions will be devoted to the paradigms of thought in the epistemological space. Epistemic reflections on the main ideas of the conceptual definition of information in the *standard information theory* which involves the definition and structure of information will be useful in providing a point of entry for definition of the concept of information in the non-standard theory of information which is composed of interdependent sub-theories of the theory of info-statics and the theory of info-dynamics. The concepts of information and knowledge were introduced in the previous sections without their explicit definitions. It seems that in most theoretical and empirical works in exact and inexact sciences over the epistemological space, information and knowledge acquire interchangeability without specifying the conditions of their substitutability and transformation. In this way, knowledge is information and information is knowledge generating the concept of information-knowledge equality. The information-knowledge equality has become important conditions of the standard definition of information. As has been pointed out in the previous sections, the information-knowledge equality holds only in the ontological space in which case there is no uncertainty, ignorance, surprise or risk as is represented in Fig. 1.3. The knowledge production where information-knowledge equality does not hold takes place in the epistemological space. The similarity and differences will be discussed under the sub-theory of info-statics of the *theory of non-standard information*.

It is useful to state what the concept of information is not, by keeping in mind the process-path to knowledge discovery. The first thing is the identification of a phenomenon that may lead to naming and creation of a concept in terms of vocabulary within a particular language through the principle of acquaintance to generate *experiential information structure*. The next step is to clean the concept from what it is not and set the framework for its definition and possible explication. Given the definition and explication, it becomes useful to examine the content of the concept (semantic containment, quality). This process may be placed in methodological nominalism. The content of the concept may be subjected to conditions of measurement and unit of measurement (quantity). In general, one cannot meaningfully discuss the content of an unknown concept as well as measure a content of an unknown concept. This is the *quality-quantity problem* of all concepts when they are given definitions and explications. The use of the concept in any language may project deception or non-deception whose analysis as the definitional structure of non-standard information will be discussed.

The steps for the standard information definition may be presented in a cognitive geometry as in Fig. 1.4. It is useful to observe that the phenomenon of information is missing in the establishment of the process of the standard information and its theoretical development. In this respect, the standard theory of information deals

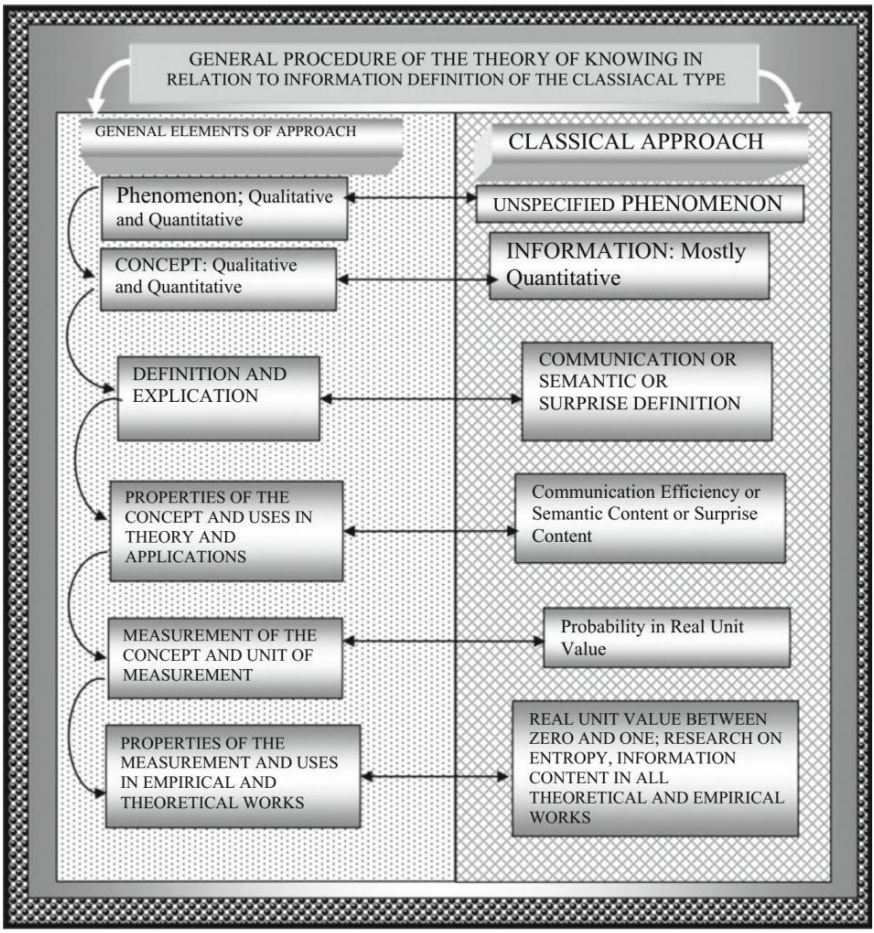


**Fig. 1.4** A cognitive geometry the process of knowing and information structure

substantially with the quantity side of information. Even the semantic approach to information is also guilty of this emphasis on quantitative disposition. The question that may be asked is: in what process can the concept of information incorporate elements of quality and quantity of the phenomenon of information in the standard approach and utilize the epistemic machine of the classical paradigm of thought? The definition of the concept of information in information theory no matter how the theory is constructed cannot claim independence from the theory of knowing which may affect the form and the structure of the concept of information as conceived in the epistemological space. Analytically, it will become clear that both the classical paradigm of thought and the corresponding theory of knowing have substantial influence on the standard definition of information.

## 1.4 The Theory of Knowing and Information Definition in the Classical Approach

Since the definition of the concept of information cannot be devoiced from paradigms of thought and the corresponding theories of knowing over the epistemological space, it is useful to examine some questions of importance in the *theory of knowing* that may help the general definitional structure of the concept of information. The theory of knowing is directed to answer the following class of fundamental questions in cognition. (1) What does the knower know (content)? (2) What is the motivation to know (curiosity and survival)? (3) What is the method and procedures for knowing (methodological constructionism composed of laws of thought, thinking and reasoning)? (4) How does the knower know he or she knows what is claimed to be known as well as convince others that something is known (methodological reductionism composed of verification, truthfulness and communication)? (5) What is the usefulness of what is known (the utility of the known)? This class of fundamental questions of the theory of knowing is different but intimately connected to the theory of learning which must answer the class of the following fundamental questions: (1) What does the learner learn (the content)? (2) What is the motivation to learn (curiosity and survival)? (3) What are the methods, techniques and processes of learning (methods and techniques)? (4) How does the learner know that he or she has learned the content of what is to be learned (content verification and assurance)? (5) How useful is that which has been learned (the utility of the learned). The theory of knowing is the foundation of all knowledge-production processes to establish contents of information. The theory of learning is to ensure the continuity of the known through the communication of the messaging systems of the contents of information. Both theories of knowing and learning are mutually connected. They both relate to information and knowledge. Information and knowledge are phenomena, while knowing and learning are processes. The theory of knowing is directly connected to the definition and content of information. On the other hand, the theory of learning is connected to communication and messaging systems and hence a process derivative of knowing. It should be noted that both knowing and learning processes take place over the epistemological space as a derivative of the ontological space.

Every phenomenon is defined in quality-quantity space. However, it is always the case that a concept of a phenomenon may be introduced into the knowing and learning processes to capture its *qualitative existence* without a known process of measuring the qualitative content. It is within the quality-quantity duality with relational continuum and unity for every phenomenon, that the concepts of qualitative and quantitative dispositions arise in such a way that behind every qualitative disposition there is a quantitative disposition and vice versa establishing a duality with a relational continuum and unity. Information as a phenomenon resides in the quality-quantity duality with relational continuum and unity. The attributes required to define it must contain the elements of qualitative disposition and quantitative disposition. Here, the semantic containment is of a qualitative nature and is defined

which is a small part of universal complexity. These paradigms of thought have similarities and differences. The fuzzy paradigm can be used on the standard information structure as well as the non-standard information structure since it incorporate conditions of objective and subjective phenomena as well as qualitative and quantitative dispositions. The classical paradigm cannot deal with non-standard information structure that contains subjective and qualitative dispositions. The comparative structure of the classical and fuzzy paradigms of thought is provided as a continuity of Fig. 1.5. Here, it is assumed that the information structures become inputs into the epistemic processing machines which are generated by paradigms of thought with corresponding information-representation, laws of thought and mathematics. So far, the definition of the concept of information and its phenomenon have not been provided. It is useful to first start with the standard definition of information and analyze its strengths and weaknesses. This understanding will provide an entry point into the development of the theory of non-standard and general information.

## 1.5 The Essentials of the Standard Definition of Information (SDI)

The standard definition of the concept of information proceeds from a signal or message that is declarative (D), objective (O) and semantic (S) where the DOS is a message which is enhanced by *data* and *meaning* to define the concept of information. The attribute of information phenomenon as seen by the proponents are three interconnected relational structure.

1. The DOS Information contains one or more *data* (multi-data attribute of $n \geq 1$).
2. The data in the message are *well-formed.*
3. The well-formed-ness of datum is *meaningful.*

The initial standard definition of the concept of information as contained in the semantic theory of information, is that information is a message that contains well-formed and meaningful data. The declarative objectivity means that the information exists independently of the encoding-decoding process. Information, however, cannot be independent of the source and the destination which will be related to the problem of the *IT-BIT* phenomenon. The *IT* refers to existence and the *BIT* refers to representations in the processes of knowing, learning and teaching. The attributes of data, well-formed-ness and meaningfulness present some theoretical difficulties as they are referred to the existence of subjective-objective duality and quality-quantity duality. The difficulties concern the concepts of data, well-formed-ness and meaningfulness. They also relate to the problem of "*IT from BIT or BIT from IT*." This *IT-BIT* problem is fundamentally related to categorial existence in the *primary-derived duality* and in the general reference to *actual-potential polarity,* as seen in terms of activities of production and transmission


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revised standard definition of information (RSDI) allow for the analysis and claim of *reality* and deal with the *potential* where the concept of reality and potential are information-defined?

The DOS-RSDI basically deals with communication from one cognitive *IT* to another cognitive *IT*, where the transformation vehicle is the *BIT* which is powered by *energy* from the epistemological space to the ontological space. The introduction of the *cognitive IT* is through the concepts contained in the DOS-RSDI. The definition of the concept of information contained in DOS-RSDI does not allow relational structures to be analytically established between non-cognitive *IT* and cognitive *IT* or between non-cognitive *IT* and non-cognitive *IT*. It restricts the theory of knowing around cognitive agents through information-decision-interactive processes. The general definition of the concept of information must be such that the relational structure must allow knowing and learning among all *ITs* in the ontological space. An important conceptual difficulty in DOS is the concept of "objective" which is hard to maintain without qualification in the epistemological space. Both SDI and RSDI have concepts such as well-formed and truthfulness that present some difficulties. Given the DOS-SDI, the measure of the amount of information is developed on the basis of the theory of inductive probability [R12.3, R12.4]. The inductive probability cannot be separated from the claim of epistemic truth established by the classical paradigm under the principle of excluded middle where simultaneous existence of opposites in an element such as a message is denied. The implication here is the classical logical position where simultaneous existence of true and false is denied.

## 1.6 Mathematical Theory of Information and Communication

It is useful at this point to turn an attention to the mathematical theory of communication as another dimension of the classical information theory which also includes the semantic theory of information. The *mathematical theory of communication* which has become the *information theory,* on the other hand, takes as given some notion of the concept of information. The concept of information is not defined by but associated with the amount of information contained in outcomes or a signal under conditions of uncertainty which are measured in the probability space. The appeal to probabilistic and probabilistic measure of uncertainty allows a measure of a unit of information and a logical computability of the *expected value* of the information contained in a message or the outcome. In this frame, the value of information must be interpreted as the content of information contained in the message which must be made explicit. The fundamental problem of the mathematical theory of communication as seen by Shannon is not on the definitional concept of information, but about the amount of information contained in a transmitted message given the *concept of information* and its *content*. As pointed out by Shannon:

framework of the prescriptive process for the construction and understanding of the *general theory of unified engineering sciences* in the destruction-construction processes of varieties. It is useful to understand that the general theory of unified sciences with its practices is unbreakably linked to the general theory of engineering sciences and practices over the epistemological space by methodological nominalism in the field of languages that codify and de-codify the signal dispositions from the characteristic dispositions.

The concepts of variety, categorial variety, intra-categorial movement, inter-categorial movement, qualitative characteristic disposition, quantitative characteristic disposition, actual-potential polarity, qualitative disposition, quantitative disposition and others provide foundations for the development of the philosophy and mathematics of information that is not restrictive and closed but open and dynamic, connecting variety-existence to information, to knowledge-development, to decision-choice action, and to creation-destruction action of variety under certain principles of ethics and dynamics of organic and individual quantitative-qualitative dispositions. In this respect, philosophy of information is just as old as philosophy of knowledge whether constructed or not. Every theory of knowledge, irrespective of the area of knowing, has an underlying theory of information or an implicit concept of information on which some epistemic operation is applied to obtain knowledge.

The true-false duality either with excluded middle and disunity or with relational continuum and unity has no existence without information. The philosophy and mathematics of information as is seen in contemporary times must not be restricted to the domain of computational systems and quantitative processing in specific areas such as biomedical information, or informatics and related areas. As has been discussed, data is a derivative from the signal disposition and acquires meaning in the specificity of categorial varieties in the area of investigation as a sub-set of the set of universal varieties. In this respect, the area of informatics is concerned with the science of signal disposition where all types of information systems are sub-derivatives from the signal disposition as the primary element. The differences among the subject areas of knowing reveal themselves as the differences in the defining characteristic dispositions that are subjectively imposed to create varieties of knowing and knowledge areas. In this way different disciplines of research, teaching and knowing are cognitively established for efficiency and specialization.

Critical examination of decision-choice processes, information, knowledge and input-output processes over the epistemological space leads to a number of important questions the answers of which will provide us with the meanings of informing, knowing, learning, teaching, deciding and choosing in the space of human thought and practice under the guidance of a constructed rationality. It has been argued that knowledge is a derivative from information as a primary category of knowing. Informing over the epistemological space is a derivative from the signal disposition. The activities of learning, teaching, deciding and choosing are all at the mercy of the organic and specific information-knowledge processes. Every paradigm of thought is an epistemic information processer under a cognitive action in the search of a variety or categorial varieties to add to the stock of knowledge,


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# Multidisciplinary References

## R1. Category Theory in Mathematics, Logic and Sciences


**[R1.1]** Awodey, S., "Structure in Mathematics and Logic: A Categorical Perspective," *Philosophia Mathematica,* Vol. 3. 1996, pp. 209–237.

**[R1.2]** Bell, J. L., "Category Theory and the Foundations of Mathematics," British *Journal of Science,* Vol. 32, 1981, pp. 349–358.

**[R1.3]** Bell, J. L., "Categories, Toposes and Sets," *Syntheses,* Vol. 51, 1982, pp. 393–337.

**[R1.4]** Black, M., *The Nature of Mathematics,* Totowa, N.J., Littlefield, Adams and Co., 1965.

**[R1.5]** Blass, A., "The Interaction between Category and Set Theory," *Mathematical Applications of Category Theor*y, Vol. 30, 1984, pp. 5–29.

**[R1.6]** Brown, B. and J Woods (eds.), *Logical Consequence; Rival Approaches and New Studies in exact Philosophy: Logic, Mathematics and Science*, Vol. II Oxford, Hermes, 2000.

**[R1.7]** Domany, J. L., et al., *Models of Neural Networks III,* New York, Springer, 1996.

**[R1.8]** Feferman, S., "Categorical Foundations and Foundations of Category Theory," in R. Butts (ed.), *Logic, Foundations of Mathematics and Computability*, Boston, Mass., Reidel, 1977, pp. 149–169.

**[R1.9]** Glimcher, P. W., *Decisions, Uncertainty, and the Brain: The Science of Neoroeconomics,* Cambridge, Mass., MIT Press, 2004.

**[R1.10]** Gray, J.W. (ed.) *Mathematical Applications of Category Theory* (American Mathematical Society Meeting 89th Denver Colo. 1983)., Providence, R.I., American Mathematical Society, 1984.

**[R.1.11]** Johansson, Ingvar, *Ontological Investigations: An Inquiry into the Categories of Nature, Man, and Society,* New York, Routledge, 1989.

**[R1.12]** Kamps, K. H., D. Pumplun, and W. Tholen (eds.) *Category Theory: Proceedings of the International Conference*, Gummersbach, July 6–10, New York, Springer, 1982.

**[R1.13]** Landry, E., Category Theory: the Language of Mathematics," *Philosophy of Science,* Vol. 66, (Supplement), S14-S27.

**[R1.14]** Landry E. and J.P Marquis, "Categories in Context: Historical, Foundational and Philosophical," *Philosophia Mathematica*, Vol. 13, 2005, pp. 1–43.

**[R1.15]** Marquis, J. –P., "Three Kinds of Universals in Mathematics," in B. Brown, and J. Woods (eds.), *Logical Consequence; Rival Approaches and New Studies in exact Philosophy: Logic, Mathematics and Science*, Vol. II Oxford, Hermes, 2000, pp. 191–212.

**[R1.16]** McLarty, C., "Category Theory in Real Time," *Philosophia Mathematica,* Vol. 2, 1994, pp. 36–44.

**[R1.17]** McLarty, C., "Learning from Questions on Categorical Foundations," *Philosophia Mathematica,* Vol. 13, 2005, pp. 44–60.

**[R1.18]** Ross, Don, *Economic theory and Cognitive Science; Microexplanation*, Cambridge, Mass., MIT Press, 2005.




K.K. Dompere, *The Theory of Info-Statics: Conceptual Foundations of Information and Knowledge*, Studies in Systems, Decision and Control 112,
DOI 10.1007/978-3-319-61639-1

**[R21.40]** Nichols, Johanna "Functional Theories of Grammar". *Annual Review of Anthropology,* Vol. **13**, 1984, pp. 97–117.

**[R21.38]** Senft, Gunter, *Systems of Nominal Classification.* Cambridge University Press. ( ed.), 2008.

**[R21.39]** Swadesh, Morris, "The phonemic principle", *Language,* Vol. **10** (2): (1934), 117–129.

**[R21.40]** Tomasello, Michael "The Cultural Roots of Language". In B. Velichkovsky and D. Rumbaugh (Eds.), *Communicating Meaning: The Evolution and Development of Language.* Psychology Press, 1996, pp. 275–308.

**[R21.41]** Tomasello, Michael, *Origin of Human Communication.* MIT Press, 2008.

**[R21.42]** Ulbaek, Ib, "The Origin of Language and Cognition", In J. R. Hurford & C. Knight (eds.). *Approaches to the evolution of language.* Cambridge University Press. 1998, pp. 30–43.