ONTOLOGY, SEMANTIC TECHNOLOGY, AND KNOWLEDGE SOCIETY: World Wide Intelligent Web

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Nowadays, computers grounded to electronic measuring devices, transducers, and telemetric systems are increasingly transforming into worldwide integrated information processing networks. Increasingly, ontology science and engineering dealing directly with reality and its content is getting a long-waited and fully deserved recognition of a critical factor in the 21st century information and communications technology (ICT); especially, in building the knowledge-driven intellectual technologies, meaningful machines and reasoning systems, the engine and driving force of the Global Knowledge Information Society (Novik and Abdoullaev, 1991).

Providing the unifying modeling schemes and languages for advanced information technology, the fundament of knowledge societies, ontology is bridging the real world and the information universe, giving the dynamic world modeling fundamentals, principles, constructs, representations, and schemes for building a radically new class of intelligent technologies and knowledge systems, Ontological Semantic Technology. The world science of ontology thus becomes the central cause of a never-seen-before global social transformation, an Intellectual Knowledge Society: **a state of technological civilization where societal evolution and environmental development are sustained by knowledge infrastructures, intellectual technology, and knowledgeable government.**

What is Ontology and Computing Ontology

As far as ontology reveals general structures and patterns of relationships in the world and computing is concerned with computable structures and processes, the former permeates the key branches of computer science: knowledge engineering in AI, conceptual modeling in information systems and databases, and type systems and domain modeling in programming languages design. It can be claimed that the most important and breakthrough technological works are now in ontology research, design, engineering and large-scale intelligent applications constructing thereof (Abdoullaev, 1989).

Today particular domain theories and models (as specific ontologies) are actively used in all basic fields of computer science and technology: artificial intelligence, computing networks, informatics, software engineering, programming languages, and computational linguistics. It is increasingly realized that computing knowledge systems ought to be founded on the real world models with the ontology-controlled syntax (the Web content structure, axioms, and rules), semantics (the Web content meanings) and pragmatics (agents, attitudes, intentions, values, actions, communication, measurement) instead of the formal representational languages implying the logic-restrained syntax and formal semantics. It is all-important to differentiate two classes of representational languages and technologies: general and specific. On the one hand, there is Reality (or World) Representation and Reasoning [(RRR) or (WRR)] system describing the universe of things which involves foundation ontology as a content and problem-solving theory providing a strategic knowledge and reasoning mechanisms about the world. So the RRR system can be qualified also as Reality Modeling Framework or World Description Semantic Frame or the Universe of Discourse of Anything, all in the sense of unified framework ontology (UFO). On the other hand, there are knowledge representation and reasoning (KRR) systems which all involve formal logical languages, models, and schemes. While the former tends to a unitary representation of reality, the latter diversified as various formal languages and technologies like as formal logic operating with individual entities and their relationships; rule-based systems using attribute-object-value triples and plausible inferences; frames operating in terms of prototypical objects, defaults and taxonomies; or object-oriented languages using classes and objects.

If the KRR languages belong to foundational mechanisms of AI technologies, then the RRR language is everything for constructing a unifying knowledge structure compounding the particular models and theories about diverse portions and parts of reality within a single standard account. In other words, there is a global world schema covering the whole reality, material and mental and cultural, with its things, beings, and relationships, and there is a plurality of domain ontologies dealing with the specific regions, parts, domains, or realms of reality. That means that there is Ontology in the primary sense, intensional or foundational, and there are ontologies in the secondary senses, extensional and applied. The basic meaning (intension) consists in a fundamental account of reality and realities and their associative orderings; hence, at the first place, the global model of UFO concerns with the key features of reality and its entity-relationship species. Only at the second, it studies how the realities [world things and relationships] may map (or project) to the concepts and associations in the mind, to the coded representations and structures in machines, and to the words and sentences in natural languages. So, computing ontology is also about the representation of the world, its entity states, changes, and relationships, but in machine-processed codes and forms. The foundational ontology, looking at things from an objective and universal viewpoint, provides a consistent set of axioms and rules of inference about reality implemented as general purpose reasoning engines for intelligent application programs, web services and processes. Thus intensional ontology provides a basic set of ontological commitments about the largest environment, the world, its parts and relationships, specifying the very content of formal logical systems and representational languages. For, "ontologies can of course be written down in a wide variety of languages and notations (e.g., logic, LISP, etc.); the essential information is not the form of that language but the content, i.e., the set of concepts offered as a way of thinking about the world" (Davis, Shrobe, and Szolovits, 1993). Regardless the wise admonition, most current research projects creating ontology models and languages for knowledge technologies are still guided by the logicist and formalist programs employing first-order logic or higher-order logics and intensional logics long struggling with the meta-logical issues of completeness, consistency, and decidability.

The evidence that the KRR languages of the classical AI paradigm are inefficient for real live computing applications is very compelling. As a fresh object lesson may well serve the Vulcan project Halo failing to meet the expectations and promises of the initiators and has being quietly passing away (Project Halo, 2004). By initial design, the project was targeted to build a Digital Aristotle, a large knowledge representation and reasoning system, projected as 'a computer system containing extensive knowledge about the world, expressed as computer-processable rules, and an inference engine for reasoning with those rules' (Friedland, Allen, and Witbrock, et al. 2004). A venture to create a question-answering knowledge application driven by upper level descriptive taxonomies and logic-based knowledge representation and reasoning technologies (Friedland and Allen, 2004, Friedland et al., 2004) was doomed to failure. First of all, it is because of the critical deficiency of the unified representation of the world consistently and uniformly organizing the classes of things with their lawful associations, both in human understandable and machine readable forms. For just the RRR language can enable an educational dialogue system with broad scientific knowledge and deep causal reasoning, as the Digital Aristotle is designed to be.

Other illustrative examples may be the ongoing research projects initiated within the AI and Web communities and aimed to construct domain-independent ontologies and ontology languages for developing knowledge and reasoning applications. Under the auspices of the Institute of Electrical and Electronic Engineers (IEEE), there has been started the large goal of a standard upper ontology (SUO) of top-level concepts, definitions and relationships processed by computers (IEEE SUO, 2000; 2004). As the starting candidates the IEEE SUO initially included the IFF (Information Flow Framework) foundation meta-ontology based on a mathematical category theory and the SUMO (suggested upper merged ontology) targeted to sort out more than 20k common notions of objects and processes. These both were joined with the CYC ontology which commonsense knowledge base has more than 100k terms, 10k predicates, and 1M assertions, using the first-order predicate logic as its representational language. Later, the number of candidates was increased with the Shell's data model of things as a sample of 4D ontology, named Lifecycle Integration Schema, and the multi-source ontology (MSO) aimed to unite some of these taxonomies. The project's objective was to construct an ontology library of distinct modules by mapping, merging, and integration of broad vocabularies and nomenclatures and domain terminological sources. The nonachievement of a single domain-independent description of general entities may be explained by some fundamental reasons. The main reason is that "an ontology is not a catalogue of the world, a taxonomy, a terminology or a list of objects, things or whatever else. If anything, an ontology is the general framework (=structure) within which catalogues, taxonomies, and terminologies may be given suitable organization" (Poli, 1996). Still the SUO project carries a high utility and great potential for knowledge systems and intelligent applications. But to accomplish the project, its general taxonomies should be integrated into a universal standard entity classification system as USECS, an entity reference frame in which all things are orderly placed like the space-time continuum for physical events (USECS, 2005).

The same observation applies to another outstanding undertaking initiated under the World Wide Web Consortium (W3C) Semantic Web Activity, where the all-important role in the cause of transforming the current web into the semantic web is assigned to ontology (W3C, 2004). The new generation of the web is planned to develop radically novel features with respect to the traditional web. The web/semantic web distinction is seen in using the ontology languages as furnishing the necessary facilities for meaningful processing of the web content by machines. So the current web is *a worldwide information space of resources and services and web agents interrelated by hypertext links, and which architecture is based on three principles: identification of resources by global identifiers; representation of resources states, or data formats; and interaction protocols* (Architecture of the World Wide Web, 2004). Whereas, the upcoming semantic web is *a worldwide knowledge space of intelligent contents and resources (programs, databases, Web pages, models, and sensors) and services communicating by reasoning agents via the standard ontology language encompassing the Internet markup languages, schemas, and logics*.

The key technologies of the semantic web are usually structured as a seven-tier cake of specifications: the URI naming scheme; the Extensible Markup Language (XML) syntax (XML, 2004); the RDF (Resource Description Framework, 2004) vocabulary language for coding the web data; the Web Ontology Language (OWL) vocabulary; Description logic; Proof; Trust (W3C Web Ontology Language, 2004). This architecture guides more specific goals, topics, and projects: web ontology formalisms and languages; web-based intelligent software agents with semantic markup languages and tools; Ontology-based semantic portals; reasoning and knowledge representation on the Web; intelligent web services and products; Semantic integration of information resources on the web. And the essential component of the whole undertaking is an ontology language (built atop of URIs, XML namespaces, and the RDF vocabulary) viewed as an engine of interoperable technologies, web search and retrieval, knowledge management, software intelligent agents, and reasoning applications through providing machine-understandable processing of the web content. Unlike the SUO projects more focused on the nature of things and the content of information, the OWL formal language had a better fate of being recommended as a standard semantic markup language for web ontologies (OWL, WC3 Recommendation, 2004).

It is however symptomatic that any advanced computing projects purposed to build either a foundation ontology standard, or construct an ontology-based Web, or create the Digital Aristotle, tend to postulate some sort of extensive world models expressed in formalized ontology languages. So, implicitly or explicitly, the general classification schemes and conceptual models are involved in the tasks performing the most ambitious and challenging computing projects. And the search for a computing representation capable to cover all the possible entities and their relationships, either as a common upper ontology, a common ontology language, or in the form of global knowledge application, is currently established as an activity of great engineering import with many candidates aspiring after the Holy Grail and Soul of intelligent knowledge technologies.

All may look bright and promising unless one annoying and persisting obstacle. For the time being, the semantic web and AI research communities are marked by deep division with respect to the fundamental issue of the whole field: whether it is possible and how it is possible to build a standard upper ontology of comprehensive coverage and a standard language with a machine processed syntax and unambiguous semantics. Above all, this discord occurs on account of a widely spread ambiguity of the very nature of ontology, the meanings of ontology knowledge, ontology design and engineering.

There is today an explicit general consensus that the world models turn out to be an unavoidable and decisive part of any large-scale knowledge applications. But, at the same time, there is also a widely implicit consent not to explore the nature of fundamental ontology, as if its computing descendants were illegitimate offspring without one of the richest knowledge pedigree among the modern sciences. As a result of such disregard of the noblest line, the term ‘ontology’ is apt to many interpretations, readings, versions, and renditions.

In information sciences and engineering, an ontology (instead of Ontology) is claimed to be ‘an explicit specification of conceptualization’, ‘a theory of content’, ‘a theory (a system) of concepts/vocabulary used as building blocks of information processing systems’, ‘a set of agreements about a set of concepts’, or ‘the representation of the semantics of terms and their relationships’. Alternatively, it is interpreted as ‘the class hierarchy in object-oriented paradigm’, ‘a complete schema of the domain concepts’, ‘an entity-relationship schema with subsumption relations between concepts’. Sometimes, one can meet such definitions as ‘conceptual patterns’, ‘concept heterarchies or hierarchies’, ‘a body of conceptualizations’, ‘schemata’, or ‘metadata scheme’, ‘a common set of terms’, ‘a controlled vocabulary of terms’, ‘a representation vocabulary’, or ‘a body of knowledge’. At best, in the context of computer science, information and communication technologies, the science of entities is reckoned to be:

- a set of generic or philosophical concepts, axioms, and relationships for domain ontologies (IEEE SUO, 2000, 2003);
- a taxonomy of world terms/categories comprising definitions, hierarchical relations, and formal axioms (Mizoguchi, 1998);
- a set of definitions of classes and their relations, as well as individuals and their properties (OWL 2004; 2006);
- a catalog of the types of things (representing the predicates, word senses, concept and relation types of some formal language) organized by the class-subclass taxonomical relation (Sowa, 1997; 2000);
- metadata schemas with machine processable semantics (Horrocks, 2003);
- content theories about the kinds of objects, their properties and relationships possible in a certain knowledge field (Chandrasekaran, Josephson, and Benjamins, 1999);
- the total of a taxonomy and a set of inference rules or a document (or file) formally defining the relations among terms (Berners-Lee, Hendler and Lassila, 2001)

It appears that in artificial intelligence, the semantic web, and software engineering, the science of things and their patterns of relationships is commonly regarded as an extension or an external layer of logical calculi and formal languages. As a result, such a formal logical ontology is commonly specified as consisting of the following logical elements: concepts (classes, objects, or categories) with their characteristics (attributes, slots, functions, roles, or properties) and relations (generalization and specialization, functions) restrained by logical axioms (assertions) and exemplified by the instances of classes and properties (Gomez-Perez and Corcho, 2002).

Apart other things, such confused state of affairs may be partly attributed to the long-standing disagreements, disputes, conflicts, polemics, and arguments over the scope and nature of the subject area even among its greatest scholars. For, when taken as pure and abstract knowledge, the general study of entity in all levels and kinds of reality is formulated as different as:

- the science (account) of entity (or being) in general;
- the knowledge of the most general structures of reality;
- the theory of the kinds and structures of things in every domain of reality;

- the study of entity types and relations;
- the most general theory concerning reality, being, or existence;
- a collection of absolute assumptions;
- the study of change;
- the science of all possible worlds and everything conceivable;
- the study of semantic values of natural and formal languages and ontological commitments about the world

Such total ambiguity or rather equivocation causes the researcher to decide: whether the whole activity is about the inquiry of entity, its forms and properties, or just about some general concepts with their formal logical relations? Or, are we supposed to deal with 'the nominal' ontology of terms and their semantic relationships instead of 'the world' ontology of entity types and their external relationships? Then one has no choice but to choose one of three perspectives: either the world ontology (realistic and veridical), or the concept ontology (conceptual and notional), or the word ontology (linguistic and nominal). As human history witnesses once and again, big troubles in human life stem from the erroneous views and corrupt world models. It appears the upcoming intelligent systems are not going to make any exception; for just as wrong ontologies are fatal to the human race's way of life, so they are destructive of the knowledge artifacts built to represent and operate the information about the world.

This all implies that to handle the art of ontology engineering and computing applications, first of all, we need to answer the fundamental issues: What kind of science (knowledge domain) is ontology? What sort of generic things make the subject matter of it? What are the most general kinds of entity in reality? How are these things related? How the entities and relations could be truly modeled, represented, and expressed? And how should be constructed a standard world specification language for global knowledge applications such as the (ontological) semantic web?

Apart from the technical and instrumental issues of growing pains of computing ontology, it emerges that here lies a hindrance virtually insurmountable without taking more profound and fundamental approach to the matter. As much as the traditional engineering, the ontology engineering is generally expected to go through the same life cycle stages: research, development, design, construction, production, operation, and management. The first one, the research phase, is the most challenging, science-intensive and crucial stage; for it involves disclosing a consistent set of well-defined fundamentals for an applied or engineering ontology. It is rather clear that such fundamental principles and rules can come from nowhere but theoretical ontology consisting in a systematic inquiry of reality and its properties with the help of conceptual tools of science, mathematics, and logic. Evidently, this research should commence from the clear identification of the scope and range of the subject matter (as a universe of discourse about anything), its major principles and methods of inquiry, enhanced with the analysis of their validity, and only then the issues of goals, roles, practical uses, and engineering applications may come to the surface.

Our inquiry is all about constructing a general framework as a unifying theoretical system and universal language by compounding the classical models and theories about the nature and pattern of reality within a single standard account. For, as we pointed out, there is Ontology in the primary, intensional sense, giving a general knowledge about the things in the world via a definitive set of basic categories, meanings and definitions, and ontologies in the secondary, extensional senses, referring to particular problem domains. The basic meaning and definition consists in a fundamental representation of reality; thus it concerns with the entity and relation types in the world at the first place. At the second, ontology considers how the world content, its objects, states, qualities, quantities, events, processes, or relationships, may be represented or mapped by different static and dynamic sign (symbol) systems, such as mental signs (thoughts and associations in the mind), computing codes (data and structures in machines and software agents), codified knowledge representation (theories and models in sciences, mathematical and formal symbolisms), linguistic signs (letters, words and sentences in natural languages) and cultural symbols (socially established symbolic institutions, actions, rules, norms, codes, universals, and social relationships).

In its primary and fundamental sense, this most intellectually thrilling study has been investigated by great minds for many ages. So without proper respect of the legacy works on ontology, the most productive insights and finds, we are doomed to be complementary, confusing, misleading, or conceptually trivial. In other words, any ontology reference frame has to embrace the fundamental categories and principles underpinning the great ideas. It is plain that while pursuing the final cause of universal ontology, we always risk falling into a fundamental fault by leaving out the standard resources of the standard authors. This is like the resources systematically collected in the Great Books of the Western World and digested in the two-volume subject-matter index (the Syntopicon, 1990). Topped by Being or Thing or Entity, these great ideas are as follows: Angel, Animal, Aristocracy, Art, Astronomy and Cosmology, Beauty, Cause, Chance, Change, Citizen, Constitution, Courage, Custom and Convention, Definition, Democracy, Desire, Dialectic, Duty, Education, Element, Emotion, Eternity, Evolution, Experience, Family, Fate, Form, God, Good and Evil, Government, Habit, Happiness, History, Honor, Hypothesis, Idea, Immortality, Induction, Infinity, Judgment, Justice, Knowledge, Labor, Language, Law, Liberty, Life and Death, Logic, Love, Man, Mathematics, Matter, Mechanics, Medicine, Memory and Imagination, Metaphysics, Mind, Monarchy, Nature, Necessity and Contingency, Oligarchy, One and Many, Opinion, Opposition, Philosophy, Physics, Pleasure and Pain, Poetry, Principle, Progress, Prophecy, Prudence, Punishment, Quality, Quantity, Reasoning, Relation, Religion, Revolution, Rhetoric, Same and Other, Science, Sense, Sign and Symbol, Sin, Slavery, Soul, Space, State, Temperance, Theology, Time, Truth, Tyranny and Despotism, Universal and Particular, Virtue and Vice, War and Peace, Wealth, Will, Wisdom, World.

So, to achieve the great target of all-entity representation and reasoning system supplying unifying knowledge standards, we surely can't ignore the conceptions systematically arranged as the Great Ideas. Besides, it is crucial for the common reference system to be validated with the essentials of human learning as represented in the Outline of Knowledge (Propaedia, 1994) and Knowledge in Depth (Macropaedia, 1994), to be supported with the thesaurus of Webster's Comprehensive Dictionary (Webster's, the New International) and large lexical online resources (WordNet 2.0, 2004). For, to be an integrative reference schema true to science and engineering, the system must be able to bring into a single unifying description such complex entities as space, time, matter, energy, life, human, body, mind, society, culture, art, technology, religion.

In pursuit of such a tall task demanding profound scholarly learning, intellectual dedication and consecration to fundamental study, it is good to stick to several well-established and self-evident working principles. Traditionalism, no one large classification scheme will have application prospects without being grounded on the classical ontological writings and works. Aristotle's standard reference works in the first place, to which all the great minds seeking for a broad scheme of things tried to conform for many ages (Aristotle, Logic, Physical Treatises, Metaphysics). Fundamentality, until the fundamental ontological categories will not be cleared up and specified as the general type system, all attempts of erecting a standard will be impracticable with inherent flaws insuring their failure in applications programs. Mathematicism and scientism, the knowledge standard should be constructed as a universal system of classes, definitions, axioms, and rules consistent with the sciences (natural, psychological and social) and mathematics, so that to render the completeness of analysis, consistency of meaning, and correctness of inference. Hierarchy and systematism, there are three types of ontology: universal, upper-level, and regional or domain-specific ontologies; the union of which results in a complete, unifying reference system. Universality, the reference standard is to be developed as a universal theory and a universal language at the same time. Since it can be employed as a language by the specific theory, like theoretical sciences (relativity) are using mathematical language (topology), and all of them – a general ontological language. *Last not least*, professionalism, any computing professional, an AI expert or Web researcher or a programming developer, however brilliant, can not create more effective entity models than a professional ontology scientist.

Adhering to the methodological rules, we research the nature and meaning of reality, its classification or constitution, its basic contents, kinds and levels, by giving a systematic analysis and formal representation of the world's composition and structure, properties, states, dynamics and behavior, and all possible relationships. All this is done with a view to work out a standard world schema for programming knowledge and reasoning systems and human beings, so that to secure semantic interoperability between and among the members of these seemingly unlike species of intelligences, existing and emerging. So the major subject of the book is no more and no less but the largest existing environment, that is, the world or reality or the universe or existence. The keynote, burden, and motif of the work is the practical possibility of a unifying RRR system describing the basic kinds of things in the world (with its special domains) and authorizing the major types of reasoning processes (strategies and procedures) about reality. Or, such an integrated RRR mechanism is promising:

- ✓ to organize all substantial information about the world;
- ✓ to assign semantics or meanings to representational languages, natural or artificial;
- ✓ to acquire and learn new facts (data and information) and rules and principles about changing surroundings;
- ✓ to prescribe architectural schemes of reasoning systems and knowledge agents;
- ✓ to make and perform knowing decisions and intelligent actions

Crucially, the work formulates the integrated account (of classes of entities or things or beings or resources) proven to be fundamental to the construction of knowledge and reasoning applications not only as a descriptive account but also as an explanatory and predictive scheme. Explaining and describing the central generic entities in terms of mathematical and natural languages, the book uncovers the way to deliver an intellectual artifact as intricate as the Virtual Aristotle, which can be equivalently defined as the know-all language machine or the encyclopedic AI or the all-purpose semantic instrumentality or the universal ontology reasoning engine as the UFO-based knowledge technologies. This required developing the UFO as a general RRR model capable to incorporate the basic content of scientific theories, lexical taxonomies, (upper) ontologies, and data languages for Web ontologies like as OWL and its extensions (OWL, 2004; 2006, OWL-S, 2006).

The Standard Ontology for Machines and People

To understand the core points of UFO, it may be of use to outline how the global schema smoothly embraces the unified data models such as the entity-relationship (ER) model (Chen, 1976; Chen et al., 1998; Thalheim, 2000), widely practiced in information sciences and engineering, and the recommended Web data standards like as RDF and OWL, widely used by web developers for semantic and reasoning applications. Some basic assumptions of the ontology reference can be also comprehended in terms of the ER schema, an original source of the whole new class of ontological languages and technologies in computing applications. The popularity of the ER model may be explained by its tying in the real world described as the totality of entities and relationships and their properties, where distinct entities and relations were generalized as an entity set and a relationship set, respectively. This permitted to employ the conceptual power of mathematical set theory and relation theory, however the theory abstract and conceptional. As a result, all individual things were ordered by entity classes E_i or relationship classes R_i. Accordingly, a property (attribute) was represented as a function f mapping from an entity (relationship) set into a value set (or a cross product of value sets). So in the ER schema the formula for the world (or a domain of interest) W can be written as the mathematical structure:

$$W = < E_i, R_i, f>.$$

This ontological approach has been implicitly taken as a paradigm by many subsequent data modeling languages, including the semantic web ontology, where the task of the (concept) ontology is also defined as the descriptions of general things (classes), their relationships, and the properties (or attributes) which they may possess.

The book shows that ontology standard languages can be constructed by lifting up the ER semantic model to the level of the whole world (or reality) as the single universe of discourse composed of entity classes and relationship classes and instantiated by the entity (relationship) species and individuals. A comprehensive formal theory of entity with relationships is then something indispensable, something that is required before building any general ontology languages or information and data models of reality.

Unlike the ER model, the RRR model is based on the central thesis: the entire reality, the universe, the world as the whole entity, which parts and domains are aimed to be represented by scientific theories and data models, is to be split up into the following prime entity kinds (quantified as entity variables):

- **Substance, stuff, or substrate (objects, material or nonmaterial, spatial or nonspatial) O;**
- **State (properties, quantities, qualities, and attributes) S;**
- **Change (actions, activities, events, or behaviors) C;**
- **Relation (links, associations, connections, and bonds) R.**

In such world representation schema, all the kinds, types and instances are comprised between the null class of Nothing or Nonentity, ⊥, and the universal class of Thing or Entity, **T**. We can now return again to the ER model of reality but essentially enriched with the entity theory founded on the world-formula formulated in terms of real classes expressed by real variables, which specific values correspond to individual objects, instances, examples, cases, happenings, etc.:

$$\{\mathbf{W}, W_I\} = <\mathbf{T}, \{\mathbf{O}, O_j\}, \{\mathbf{S}, S_k\}, \{\mathbf{C}, C_l,\}\{\mathbf{R}, R_m\}, \{\mathbf{f}, f\}, \bot >$$

In other words, the basic classes (or universals and types) are instantiated by concrete instances (particulars, tokens, individuals, objects, events) in the realm of causality, time and space, all symbolically expressed either by linguistic items or by mathematical values of variable quantities.

Universality of the RRR language is supported by its capacity to cover also the SW formal languages, systems, and vocabularies, where the key constructs, individuals, classes, and properties, are notional and abstract terms without real content and substance, i.e., without reference to reality. Such partial world description is inherited from AI knowledge representation and reasoning (KRR) technologies, allowing prototypes and taxonomies without specifying what sorts of things are the prototypes (frames); plausible inferences without specifying the content of the inferences (rules); networks of related concepts without specifying their real content (semantic networks); individuals and relations (predicates) without specifying their nature and meaning (formal logic).

As a matter of fact, to be a real representational language with the inbuilt ontology, semiotics, reasoning logic, and efficient computation, a general formal language must be focused on the world with its domains; first of all, centering on its basic construct, Thing or Entity or Being, viewed as equal to all things existing in reality, and generalized as the class of all entity classes. Of which, the most fundamental categories are the class of Substance (Object), the class of State (Quantity and Quality), the class of Process (Change or Action) and the class of Relationship. Each of the class is organized as a hierarchy of subordinate classes (kinds and types) and individual things (instances, particulars, and concrete entities) such as objects, specific states, unique events and particular connections. Accordingly, the formal notions of 'definition', 'class', 'property', 'proposition', and 'reasoning' should be filled up with real contents and semantics and tied up with the ontological predicates of entity, substance, object, quality, quantity, relationship, change, cause, effect, time, space.

So, the status, validity, and expressivity of any general representational languages and technologies are chiefly determined by the ways of treating the things in the world. Above all, it is the constructs of Thing, with its kinds, types, varieties, and instances, of Class, with its classes, sets, and members, and of Property, with its basic, essential, intrinsic or accidental, nonessential, and extrinsic properties. Particularly, the Class/Thing distinction makes all the difference and needs a most explicit account. For it's a central issue in all activities of building top ontologies (SUO, UML, GFO, etc.) and SW languages (RDF, RDFS, OWL, OWL1.1, etc).

In terms of the XML namespace prefix syntax, the notions of Class and of Thing in different top-level ontologies are branded like as {rdfs:Resource; owl:Thing; UML:thing; GFO:entity; ISO:object; DOLCE:entity, etc.} or {rdfs:Class; owl:Class; UML:class; GFO:universal; DOLCE:universal, etc.}. In fact, there is no fundamental difference between Thing, generic, or Entity, generic, or Class, universal; rather they are marked by principal equality. In its fundamental sense, 'Thing' denotes all things, things of every kind and type, or the class of everything, organized as a universal hierarchy of entity classes with higher super-classes (kinds) and lower subclasses (types). This necessitates the fundamental identity of general formal ontology languages:

UFO:Thing ≡ UFO:Entity ≡ UFO:Resource ≡ UFO:Being ≡ rdfs:Resource ≡ rdfs:Class ≡ owl:Class.

Since there are usually three main choices widely practiced; namely, defining 'Thing' either as an individual, or a class of individuals, or the universal class, i.e., the class of all classes. Or, in terms of quantities, as a fixed value (constant), an individual variable, and a class variable. The narrow view of thing as an individual entity with a specific identity has its long history of 'a primary substance', 'a bare individual', etc., borrowed by the first-order logics. Because of this, the extension of the construct like owl:Thing has only individual things, being void of other essential meaningful dimensions of kinds, types, and species. In the biological classificatory system, this corresponds to the level of species whose members share a set of essential features and bound by a membership relationship between an individual and its class. Any species as a collection of individuals, say, the totality of human beings, can be subjected to further divisions and subdivisions, such as man and woman, White or Black or Yellow or Red, the aged or the young, the poor or the rich, the working class or the professional class; underworld, lower class, middle class or higher class, etc. Yet they are not (genetically) essential classifications, and we are still in the domain of individuals, for even infinitely increasing the number of individuals will not end up with a new class or species or kind. Therefore we talk about two types of difference, in kind or in degree.

The right and more fundamental position is to consider Thing (or Entity) as the class of classes (the set of subsets) at least; at best as the class of all classes (the universal set of all sets), hierarchically ordered by inclusion (containment) relationships (or whole-part relationships). Since, as the class variable, Thing will have as its values lower classes and subclasses as well, or the type of variables whose values are also variables.

As for the properties of things, other most important construct of SW standard languages the general construct of property is also misunderstood: owl:Property is divided into two basic types, owl:ObjectProperty (mapping individuals to individuals) and owl:DatatypeProperty (mapping individuals to datatype values). In fact, there are monadic and dyadic properties; essential and accidental; atomic, transient, complex, or emergent; particular and general, etc. But mostly important to tell the formal properties (attributes) from the ontological properties, which are generally classified as:

1. the property of being a substance (object), substantial properties;
2. the property of being a state (quantity or quality), quantitative and qualitative properties;
3. the property of being a process (change, action, operation), dynamic, functional, operational properties;
4. the property of being a relationship; relational properties per se.

Thus, owl:Property is narrowed to the property of being a formal (functional) relationship, direct and inverse; without explicitly identifying the nature of relations between the components, like as spatial, temporal, causal, whole/part, syntactic, semantic, pragmatic, etc., all covered by UFO:Property, both essential, monadic and relational, dyadic properties. Moreover dealing with only two main disjoint types of property: owl:ObjectProperty and owl:DataProperty discard the possibility of a class-to-class mapping, or many-to-many relationships, including the pragmatic issues of measuring commensurability between magnitudes (entity variables) and multitudes (numbers, a set of numerical values, or quantities).

Now the reader can see better that, instead of data, information, knowledge, concepts, constructs, or terminologies, the subject matter of computing ontology must be nothing but entities in reality with their patterns of relationships; for its main role to represent reality, its kinds of things (universal, classes, types) with their instances (objects and events) in the actual space-time continuum as machine processing symbolic structures and encodings (Smith, 2004). Therefore, modeling the total of entities in reality, the unifying formal ontology starts with the largest thing in existence, the world or reality **W**, by mapping onto the global knowledge and reasoning representation system its contents, state space $\mathbf{W} = \{W_I\}$, dynamics ($W \rightarrow W$), real N-relationships ($W \times W \ldots \times W$) and its key kinds, domains and levels. The backbone modeling system is marked by a self-consistent representation of the world's dynamics as the total continuum of self-transforming processes ($\mathbf{F}$: $\mathbf{W} \rightarrow \mathbf{W}$), when the world state infinite (or space) is mapped into itself by a transformation function or operation or correspondence or map **F**. Generalizing the concept of multidimensional transformational phase space in theoretical physics, the world state space is marked by the {many, one}-{many, one) transformation modes (or mappings), increasing or decreasing its dynamic diversity, variety, or uncertainty (information) as the largest domain of knowledge and the universe of discourse of anything. For the whole natural world, there is applied the many-to-many mappings which correspond to complex and dynamic networks of processes, physical, chemical, biological, mental, social, or informational (like the Intelligent Web processes).

So the mapping describes all sorts of real circularities and nonlinearities, the key features of complex nonlinear systems as physical systems, organisms, intelligent systems, organizations, economies, and social systems, studied in cybernetics, mathematical dynamic systems, systems science, nonlinear physics, life sciences, and social sciences. A crucial importance is commissioned to causal circularities as the network of mutually related real processes encompassing various feedback cycles and loops, positive and negative, and thus driving all complex phenomena in the natural domain, conceptual universe, cultural region of social reality, or virtual world of computing machines. So, **the dynamic nonlinear world is modeled as the entire networks of worldwide causal loops**, the real circles of causes and effects moving the whole universe and consisting of a multitude of interacting changes (processes, causes, agents, factors, elements, or variables) reciprocally and convertibly causing (and mutually sustaining) each other (Abdoullaev, 2000). For all the forces of nature, mechanical motions and forces, gravity, heat, magnetism, electricity, radiation, chemical force, biological actions, are interrelated and mutually dependent, reversing the ways of actions by causing each other.

Crucially, the universal dynamic loop topology structure is applied not only to the whole entity but it also goes for any specific field, realm, region, part, or isomorphic representation of the world, for any domain of interest ranging from set theory to physical devices domain, viewed either as a set of components or a set of specific physical processes.

As a global master model, the **standard ontology** then should be constructed as a comprehensive causal account of reality where its entities exist as interacting systems of various kinds and levels: natural, psychological, social, cultural, or computational. Evolving the basic assumption, we display the type of ontology acting as a coherent and consistent supporting structure for the diverse levels of reality: the material realm of natural realities, the psychological realm of mental entities, the social reality of cultural forms and processes, or the computational level of informational entities. In such an extensive consideration, whatever exists and happens (or conceived as existing and occurring) can be named an entity, a thing, or a being, so that all beings, things, or entities are arranged into a great hierarchy of kinds, types, subtypes, and individuals, formed into distinct but interdependent levels of the universe. That is, a few fundamental kinds of entity compose the principal kinds of things in the universe (of discourse), which are substances and objects (spatial and non-spatial or abstract), states (attributes, properties, qualities, or quantities), changes (actions and processes), and relations (entity-to-entity). So, having the underlying ontological categories and principles, we can work out a universal formal account of reality having all the necessary resources to incorporate conceptual models, lexical taxonomies, general ontologies, and formal ontology languages into a single, consistent and comprehensive model of things.

Knowledge Society and Ontological Technology

The practical goal of the standard ontology as a unified account of reality and the universal representation language is to produce the world knowledge standards which meet both the requirements of machine intelligences and human minds. The underlying thesis is to provide the entity type system with descriptive, explanatory, and predictive features to be used as a single consistent frame for the emergent class of effective knowledge systems and reasoning applications. As said, such a task may be reached by incorporating into a common ontology library of things all the relevant constructs from existent upper ontologies, classification schemes, conceptual data modeling languages, and the web ontology languages. Having the ontological entities as the determinative components in meaning (semantic relationships) admits of natural language as the most general knowledge representation and reasoning language. This means that the natural language enables us to lay down the principles and rules for designing and developing encyclopedic knowledge and reasoning machines as a new class of intelligent information systems understanding human natural languages. Equipped to learn, acquire, process, accumulate and communicate the human knowledge in linguistic forms, the encyclopedic RRR applications can constitute the core of coming **Global Intelligent Cyberspace (the intelligent web)**: a worldwide computer networks of intelligent NL machines and human beings, the technological base of Intellectual Knowledge Society.

Advanced information and communication infrastructure is increasingly viewed an essential foundation for knowledge-based information societies, particularly in creating digitally new forms of social life: e-government, e-business, e-learning, e-health, e-employment, e-environment, e-agriculture, and e-science. Building a Knowledge Society is currently a social conception and topic occupying the top agenda in the meetings of heads of governments debating an optimal strategic policy and seeking for a silver bullet solution. According to the Plan of Action proposed on the World summits on the Information Society, “ICT applications can support sustainable development, in the fields of public administration, business, education and training, health, employment, environment, agriculture and science within the framework of national e-strategies” (WSIS, 2003, 2005, 2005).

There are many implications and connotations carried by the emerging knowledge societies: lifelong learning, mass education, progressive schools, extensive research funding, modern teaching methods, advanced political system, innovative industries, online universities, universal access to information systems, electronic voting, enlightened governance, knowledgeable administration, e-world government, onto-technocracies, or robot-states, etc. But there is one principal feature distinguishing the most advanced phase of human society: the explosive growth (generation and production) of scientific knowledge and electronic forms of its codification, processing, transmission by information and communication technologies. And the heart and soul of information infrastructure and its innovative information processing/communication systems is intellectual technologies, ontology driven knowledge machines, which are designed to make the cornerstone of information infrastructure of the upcoming learned societies with widely enlightened citizens. Then **a knowledge society** is nothing but **a state of technological civilization where a personal, economic, political, scientific, social, cultural, and environmental development is advanced by knowledge infrastructures and intellectual technologies.**

To answer a historical challenge of building knowledge-based economy, the 2000 Lisbon European Council set up a new strategic goal for the next decade, ‘to become the most competitive and dynamic knowledge-based economy in the world’ (Lisbon European Council, 2000). Unlike the industrial economies driven by traditional physical machines and mechanisms, the knowledge economy is to be propelled with the advanced ICT, which core is constituted by knowledge processing machines and semantic communication systems driven by ontological technologies.

To build the Europe of Knowledge, Knowledge-Intensive Society, Knowledge Base of Europe and Technological Know How is a spiritual dynamic of the European Commission's Framework Programmes for Research, Technological Development and Demonstration. As an essential part of the overall strategy, the EU initiated large R&D projects in Information Society Technologies in the realm of semantic web. In order to lay down the knowledge infrastructures of the upcoming Information Society the EU's Research Council and the European Parliament allocated 3.8 billion Euro for Knowledge Technologies within the 6^{th} European Union Framework Programme (FP6) for Research and Technological Development, with a budget of 17.5 billion Euro (CORDIS/FP6, 2006). Within the FP6 Programme, all the web-based knowledge technology projects are largely concerned with ontology research, design, learning, and management.

For instance, the Knowledge Web 'network of excellence' is engaged to transfer ontology technology from universities to industry (Knowledge Web, 2006); the Data Information and Process Integration group is contracted to contribute to the infrastructure of semantic web services, promising an integrative web service modeling framework via ontological technology (DIP, 2006). In its turn, the Semantic Knowledge Technologies network is signed to produce ontological software and tools for semantic web services (SEKT, 2006). Again, the integrated research activities are performed under the costly collective delusion that ontology-based semantic web and services technologies can be constructed without having the single RRR web platform. Realizing that and trying to avoid duplicating each other, there has been recently announced the formation of the European Semantic Systems initiative cluster targeted to deliver knowledge technologies by means of semantic web modeling ontology and languages (ESSI, 2006). Still, the high cost of an academic head game of missing a scientific concept of semantic web as an ontologically united global information system may be a total budget of the integrated project, committing the common error of confusing public aid spending with advanced information technology delivery and thus eroding the public trust in science.

It would do only good the public if the strategic planners of Knowledge Society information infrastructures show some prudence in funding the semantic projects which are too abstract and notional, without a firm ontological grounding in the real world settings. And the policy makers and IT agencies of the governments shooting for knowledge societies should be more focused on funding the socially promising research programs based on an ontological (dynamic) modeling of a complex world. Like those projecting the strategic knowledge management systems and global information framework technology (Global Information Framework, 2005) or proposing the unifying framework architecture for intelligent systems (Sowa, 2002). For one can only wonder how, for instance, the DIP program, coded as FP6–50 74 83, can deliver "a comprehensive Web Service Modeling Framework" (Fensel and Bussler, 2006) without having first developed the World Modeling Semantic Framework and hence the general model of services and products and business processes (USECS, 2005). After all, this is not just a speculative academic research, but an IST (Information Society Technologies) project with a total budget of € 16,3 M for three years only.

To avoid bad misuses, frauds, self-regulation, poor deliverables, or even no publication at all allowed by 6th FP, the whole scientific research system in the 7^{th} FP is planned to be overhauled: professional expertise and advice, quality publications, monitoring and control, trust, independent reviewing, ethical behavior, public transparency, and financial audit. To further advance the goal of a knowledge-based Europe, the European Commission 7th Framework Programme for Research, Technological Development and Demonstration is starting January 1st, 2007 till 2011(CORDIS/FP7, 2006). The whole FP 7th Budget amounts to 72 726 million €, with the indicative breakdown for Cooperation - 44 432 million; Ideas - 11 862 million, People – 7129 million, and Capacities (research infrastructure) – 7 486 million. For information and communications technologies (ICT) programs, 12 670 million is apportioned. It is evident that a strategic goal of a digital, knowledge-based society requires an intensive R&D of ontology-based knowledge systems and intellectual technologies, directly performed within the ICT programs and indirectly within other projects such as New production Technologies - 4832 million; Security and Space - 3960, Health - 8 312 (Building the Europe of Knowledge, 2006). And it is an encouraging sign that the 7th Framework Programme is planned to build on much better principles then the 6^{th} FP. First of all, it presupposes an abundant financing of individual projects under the rubric 'Ideas' (as an investigator-driven frontier research by individual teams, judged by a European Scientific Council, though, the question may be raised, who will be in the Council?

To further avoid the fundamentally wrong research projects involving ontological and semantic technology and knowledge systems, the central (multi-billion) problem must be resolved: to answer what is really going on as the intellectual technologies, the semantic-based knowledge systems, and the semantic web, to understand their nature and real meaning. Particularly, we must make out which web (or architectural pillars) most fits the matter, the formal semantic web (i.e., the syntactic web) or the real semantic web (the intelligent web), as in the web hierarchical structure anchored in the real world environment via the ontological groundwork:

<Global Intelligent Cyberspace, or Real Semantic Web> :: = <Ontological Framework, WDF, or RMF> <Semiotics> <the World Wide Web, or the syntactic web>

<Ontological Framework> :: = <Unified Framework Ontology, WDF, or RMF> <Upper Level

Ontologies> <Domain Ontologies>

<Semiotics> :: = <Pragmatics> <Semantics> <Syntax>

<Pragmatics> :: = <Users> <Web Agents> <Intentions> <Actions> <Communication> < Proof> <Trust> <Truth>

<Semantics> :: = <Signs, Data Type, Natural Language Expressions> < Constructs> <Meanings>

<Syntax> :: = <Logical Framework> <Rules> <OWL Ontology> <RDF Schema> <RDF M&S> < RDF> <XML/SGML> <Namespaces>

<the Web> ::= <Resources, Representation, Identification, URI, Unicode> <Interaction, Software Agents, Hypertext links, Protocols, HTTP> <Formats, HTML, XHTML>

The world wide intelligent web as the pinnacle of ontological semantic technology involves a grand trio of knowledge domains making the Knowledge Trinity: the world science of Ontology caring the real entities, underlying constraints, principles, truths, and rules; Semantics managing the whole works of meaning, and Syntax doing business with languages, the signs and rules of meaningful constructions. As in the Holy Trinity, each member of the Knowledge Trinity has its unique goal and role. The goal of ontology is to formulate the overall patterns and fundamental laws of the universe, while its role is to set the world models, rules, and reasoning algorithms for advanced information technology. Syntax supplies the totality of signs, marks, and expressions as formal or natural languages with their operation, formation and transformation rules. Semantics is aimed to provide a general theory of meaning relations between signs, constructs and things, assigning significances to syntactic structures and meanings to conceptual structures. So, semantics integrates the totality of signs, signals or symbols, the domain of knowledge, and the universe of ontological entities and relationships into a comprehensive knowledge reasoning context, which is the world modeling framework for all sorts of intellectual information and communications technologies.

Accordingly, the reality description model as the template scheme of the web content constitutes a common semantic framework for the world wide intelligent web. It is all-important to comprehend that the intelligent web is to be designed as a worldwide RRR system of knowledge resources having the ontological groundwork with the built-in semiotic theory of meaning, rather than the web involving a formal semantics and formal logic languages. Above all, ‘the Internet is a giant semiotic system’ of signs and symbols used by the agents to represent entities in the world and their intentions concerning them (Sowa, 2000). Accordingly, the knowledge-based web is a worldwide dynamic information space with the inherent ontological foundation and semiotic models of resources. So, instead of relying on the RDF/OWL logical syntax and formal semantics, a consistent way to build the semantic web will be by means of real semiotics covering the relationships of signs, agents and things and so consisting of syntax, semantics, and pragmatics. Digesting the argumentation, *any extensive knowledge systems, like intelligent web, is to be grounded on the World Modeling Framework with ontology-controlled syntax (Web content structure, axioms, and rules, representational languages), real world semantics (Web content meaning) and pragmatics (agents, attitudes, intentions, values, actions, communication, and measurement).*

While sticking to the current Semantic Web cake structure (URI, Unicode; XML, Namespaces; RDF, RDFS; OWL Ontology; Rules; Logical Framework; Proof; Trust) (Berners-Lee and Fischetti, 1999), the web applications will be without a firm semantic and ontological groundwork, but wholly banking on the descriptive capability of the SW languages. Though, such descriptive capacity comes from a legacy set of predicable relations of "definition", "class", "property", "sameness", "difference", and "inheritance" (Aristotle, Topics), and it is little to do with this specific sort of formal languages. The necessity of revising the SW technology push-down stack is even recognized by its active contributors pointing to the inadequacy of RDF syntax and semantics and urgency of having ‘a common semantic foundation’ (Patel-Schneider, 2005). All this considering, the UFO as the world modeling language is designed to override the SW formal logical languages, telling the application developer little if nothing about the actual nature of its polar constructs: individual, class, property, and relationship, their basic meanings, kinds, and instances [USECS, 2005]. As a consequence, the SW languages can not be effective for building reasoning systems, if only as a syntactic part and ingredient of the World Modeling Semantic Frame, a knowledge base and foundation of real-life web applications. And the golden rule of any general formal language is:

In order to be tied in the real world domains, a language’s predicable universals should be reified within the foundation context of entity and relationship classes (universals, kinds, or types) and instances (individuals, tokens, particulars).

Otherwise, the general modeling language is unreal, without substance and reality and truth and real world effect and hence credibility. Therefore the OWL semantic language as a general ontological language is essentially defective, as devoid of ontological bottom, while offering the alluring but illusory promises, like the secret intelligence operations pretending to be more effective then the complex political negotiations. Scientifically and commercially, it is a serious confusion to use such unreal (formal logical) language without any essential reference to reality as 'ontology infrastructure for the semantic web' (Bechhofer, Horrocks, 2003).

In practice, a game plan for building the Intelligent WWW should necessarily includes the following developmental stages for the great Knowledge Society technology to be accomplished:

INTELLIGENT WWW: THE WEB > THE SYNTACTIC WEB > THE SEMANTIC WEB > THE PRAGMATIC WEB > THE ONTOLOGICAL WEB (Worldwide RRR System)

Then the extent and depth of ontological language used for representing the web data, services, and processes must match the master plan of building the worldwide RRR system combined of Real Entities (things in the world), Constructs (representations and rules), and Signs (sign and symbol systems, static web data and dynamic web agents). Or, the basic formula of the web ontology language is as follows:

WWW UFO Language = UFO (world entities, relationships, axioms and rules) V SUO Taxonomies V Domain Ontologies V Semiotics (Web content as the largest sign system, Syntax, Semantics, Pragmatics) V Logics (Logical Frame, SW languages)

The base of the web RRR system is the UFO representational language acting as a common ground between the SW formal systems and top level ontologies. As such, the web ontology language system supplies a core set of ontological template classes together with their principal relationships, all to be used as the knowledge standards in developing a new class ontological machines: all-purpose 3R systems with the inbuilt ontological models of the world, of its domains, structures, and processes. In other words, the world description framework can provide computing machine intelligence framework (CMIF), a unified knowledge and reasoning structure uniformly modeling the whole universe of real things, their classes, kinds, sorts, and levels, from a single unifying perspective. When reconciled with a flexible modular framework (FMF) for intelligent systems (Sowa, 2002), the CMIF may serve as an integrated intelligent environment for various domain-specific AI applications, existing and to be invented:

Natural language processors (parsers, taggers, text-matching, syntax checkers, disambiguator, machine-translation systems, question-answering systems, dialog managers), theorem provers, inference engines, learning programs, classification tools, statistical tools, neural networks, pattern matchers, problem solvers, planning systems, game-playing programs, knowledge acquisition tools, modeling tools, robot guidance systems, search engines, web browser, ontology editors, etc.

Supported by the unitary ontology, the CMIF can cover the extant class-based representation formalisms used in software engineer, databases, semantic web and artificial intelligence: entity-relationship models and diagrams, semantic networks and rule paradigms, UML class diagrams, and OWL web ontology language. Being comprehensive in its scope of representation and mapping of real world structures, processes, and relations, the computing intelligence frame may constitute the uniform information architecture for encyclopedic artificial intelligences like as the Virtual Aristotle.

Al in all, the major objective of the book is to formulate the principles of UFO (or the world description framework or the reality modeling context or the universe of discourse of everything) as the ontology base for the real semantic web and thus replacing the formal semantic web as heavily dependent on unreal logical languages instead of real natural languages. It is shown that a formal semantic web is a poor abstraction of the real Web asking for a firm conceptual foundation as the world modeling framework with its essential components, the real ontology and semiotics, coinciding with reality. Then, having the UFO-based unifying semiotic frame as the world knowledge and reasoning platform opens up a possibility for a large variety of Knowledge Society artifacts (products, services, systems, technologies, and applications):

- The real semantic web ontological languages;
- Human knowledge integration systems and semantic networks;
- Generic reasoning mechanisms and units;
- World data processing physical cognitive systems, from smart transducers and intelligent sensors to all-purpose space robonauts;
- Natural language understanding software packages;
- Knowledge intensive embedded reasoning systems;
- Intelligent content systems for the Internet, as online smart encyclopedias, catalogues, taxonomies, vocabularies, and terminologies ;
- Generic reasoning platforms and intelligent search technology for the Semantic World Wide Web, interactive home TV, etc.;
- Encyclopedic intelligent applications, as e-business smart technologies, global web trading systems, forecasting business systems, business management e-consultancy, etc.;
- Integrated intelligent solutions for e-Government, e-Learning, e-Science, e-Health, and e-Business;

- Business intelligent technology providing generic industry solutions and autonomously implementing commercial processes, activities, transactions, and trading operations (e.g., logistic management systems, inventory management modules, enterprise resource planning agents, export-import brokering agents, etc.)

In the end, the author would like to note that the development of the projected ideas took many years. The book is the summing up of almost twenty years studies revolving around the most complex entity in the world, reality, its basic aspects, fundamental kinds, major properties and underlying mechanisms, so that to construct a uniform ontological model of reality fitting both human beings and computing machines (Abdoullaev, 1989, 1992, 1997, 1999, 2000; Novik and Abdoullaev, 1991; Standard Ontology Internet site, 2005; Encyclopedic Web Intelligence Internet site, 2005; USECS, 2005).

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