

Universal Meta-Definition of Intelligence

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Abstract—A formal scientific definition of Intelligence is a topical problem not only of the synthesis of AI but of the world science as a whole as a product of exclusively intellectual activity. It is due to the fundamental shortcomings of the modern general scientific paradigm that is limited to particular dogmatic concepts. This problem is solved by the transition to the universal general scientific paradigm by increasing the level of knowledge abstraction. Achieving a uniform initial Universal Axiom, in principle, allows you to deduce a complete system of Universe's concepts and get a universal definition and formalism of Intelligence from it, which are supposedly applicable to all Universe's phenomena. The paper presents the main provisions of the new approach and deduces the initial components of the Universal Formalism of Intelligence, which follows directly from the Universal Axiom and is represented by exclusively the highest Universe's meta-concepts that can solve the said problem. The obtained results are pioneering in this area and have important general scientific significance and the initial application in many technical and humanitarian research and development.

Keywords—*The Universe; Universal Theory; Intelligence; meta-definition; meta-formalization; universalization*

I. INTRODUCTION

Despite the enormous efforts, modern science cannot give a formal definition of Intelligence, which delegitimizes all research in this area and science in general as a product of exclusively intellectual activity, and any scientific use of the term 'intelligence' in its strict sense remains unjustified [1-3].

This state has not been changed since the pioneering Dartmouth workshop in 1956, when, for the first time, J. McCarthy admitted: "The problem is that we cannot yet characterize in general what kinds of computational procedures we want to call intelligent. We understand some of the mechanisms of intelligence and not others".

As a result, in the 1980s, J. Searle's compromise philosophical hypothesis about the essential unity of any Intelligence was supported, which allowed us to divide it into two different concepts: 1) weak (private, machine) Intelligence, which performs separate intellectual functions that can be formalized and implemented now, and 2) strong (general, natural) Intelligence, similar to human, the formalization (understanding) of which is postponed until future [4].

However, such a division did not eliminate, but only transferred the said uncertainty to the problem of distinguishing intellectual functions in the diversity of all actions of living beings. The McCarthy-Searle paradigm has advanced, but has not legalized the above-mentioned works, and a person remained an informal general scientific standard of Intelligence, according to the well-known Turing test [5].

Obviously, the problem of a scientific definition and formalization of Intelligence is a consequence of the fundamental shortcomings of modern science and it can only be solved by substantiated development of a general scientific paradigm [6].

For the first time this was done by the authors by increasing the level of knowledge abstraction and moving from the modern system of particular Universe's axioms (in more general terms – dogmas), producing limited systems of concepts in the corresponding fields, to the uniform initial Universe's Axiom (Dogma, UA), producing the entire pyramid-like system of concepts/categories of the Universe (UAP) as the uniform Universal (Meta-) Formalism (UMF). If particular conceptual areas can describe only simple phenomena that fit entirely into one area, then the UMF must obligatory describe all phenomena, up to the most complicated ones, which the Universe and its Intelligence are (Fig. 1) [7-12].

The authors were able 1) to prove the possibility of obtaining the UMF, 2) to create the foundations of its structure and 3) to deduce from it the (Meta-) Formalism of Intelligence (UMFI), 4) that is universal for the entire living world. The UMFI revealed that Intelligence 5) comes from the highest meta-concepts of the Universe 6) directly from the UA 7) together with the Universe 8) as its most important property and 9) combines both of these concepts, 10) expanding the base of joint research.

Universalization radically develops the general scientific paradigm of cognition. If the particular axiomatic paradigm is based on the triad 'Observation of a phenomenon – Hypothesis of phenomenon formalization – Verification experiment' and is limited to the field of observation of phenomena, then the universal paradigm is based on the tetrad 'Obtaining some universal formalism (UF) – Identification of a phenomenon in the Universe – Identification of a phenomenon in the UF – Derivation of a phenomenon formalism from the UF', which is limited to the UF that is able to exceed the visibility scope (Fig. 2).

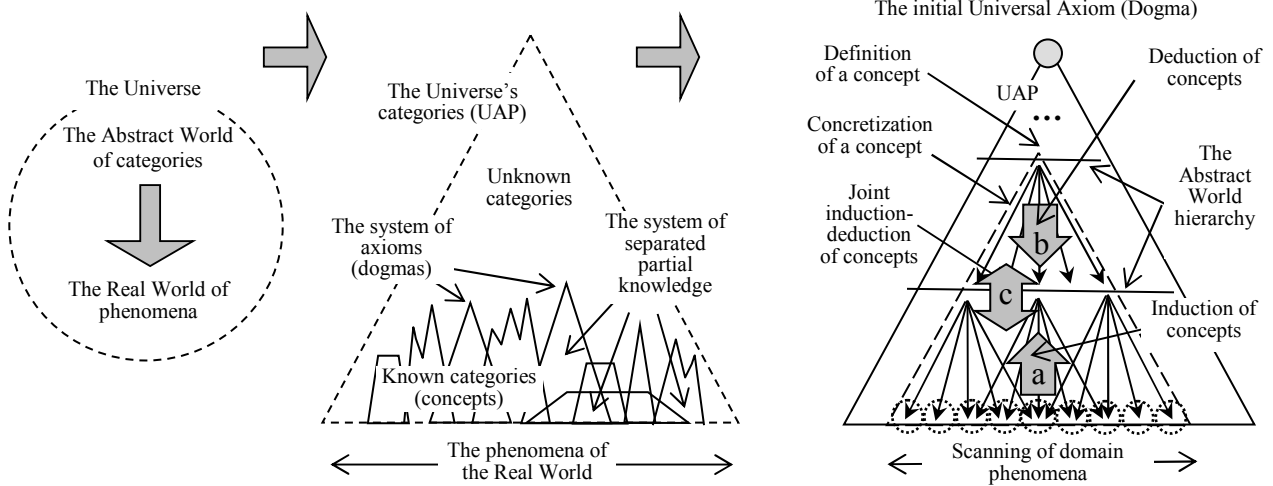


Fig. 1. The development of the world science scheme from Plato & Aristotle through dogmatization to universalization of knowledge

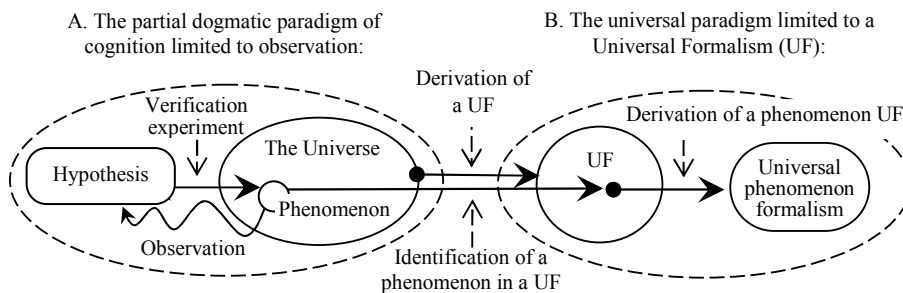


Fig. 2. The schemes of dogmatic (A) and universal (B) paradigms of cognition

The UF is a new scientific concept and its construction is problematic, however, it is simplified by the supposed homotropy and constancy of the categories of the Universe, allowing them to accumulate copies to form a uniform stable externally (with the Universe) and internally (among themselves) consistent system of concepts that is then tested in practice. Naturally, such a UF must be only one because our Universe has such a character, and the alternative attempts to create it must lead to a single result.

Thus, for the first time, it was possible to build the UF and deduce from it the UMFI that consistently coincides and extends the observed properties of Intelligence as its new cognition. The UMFI becomes a new standard of Intelligence, allowing for a deeper formal study of the origin, properties and classifications of the latter. Substantiation of the deduction of Intelligence concept is the goal of this work.

II. INITIAL ONTOLOGY OF INTELLIGENCE

Intelligence comes from the concept of relation, which, by all the signs of an axiom, is accepted as the UA (Fig. 3). Thus, Universe's entities presumably have a structural nature and are adequately represented by exclusively multiple set-theoretic and modified Entity-Relation (ER)-formalisms, which arrows correspond to copies of entities.

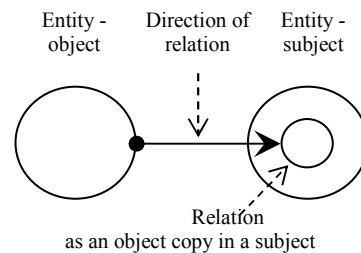


Fig. 3. The scheme of a meta-concept relation

Definition. A relation is a copy of a certain entity (object) in another entity (subject).

Definition. An entity is part of the Universe, singled out by a certain relation as a unitary whole.

Definition. The Universe is a complete set of directly or indirectly related entities.

Consequence. The Universe and its entities have a structural nature that is extremely infinite into breadth and depth.

Consequence. The Universe is its entity.

Consequence. The Universe is a self-determined entity.

Definition. Knowledge is a copy of an entity.

Definition. Cognition is the establishment of relations with entities.

Consequence. Cognition of the Universe is the establishment of relations by its entities with it as a unitary whole.

Consequence. The Universe is a mutual cognition of its entities.

An elementary combination of relations generates the initial ontology of cognition.

The advancement of an object copy generates 4 stages of cyclical cognition of a subject: 1) on the border of a subject (information), 2) inside a subject (knowledge), 3) coordination of the copy with other knowledge of a subject (understanding) and 4) additional cognition of an object (research) (Fig. 4).

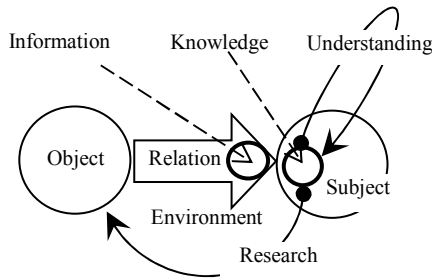


Fig. 4. The scheme of meta-concept cognition

Cognition of a multitude of objects gives rise to the scheme in Fig. 5.

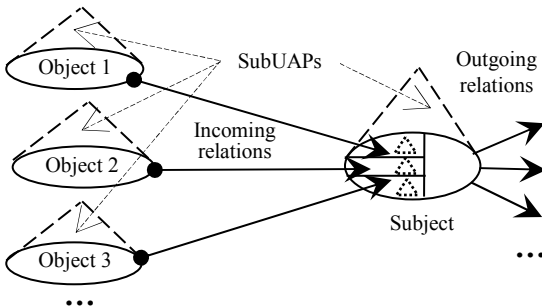


Fig. 5. The scheme of mutual meta-concept cognition

Transferring a copy of an object through an intermediate subject is teaching (Fig. 6).

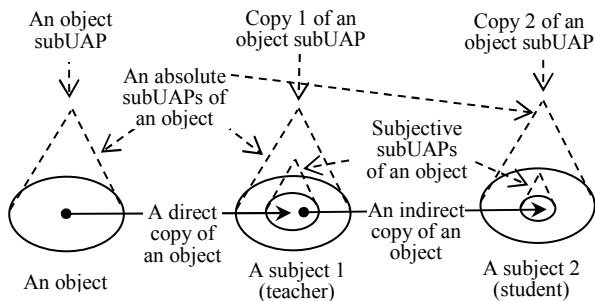


Fig. 6. The scheme of meta-concept teaching

Virtualization of a copy of an object within a subject (virtualizer) is an excess of the categories of an object on their copies (Fig. 7).

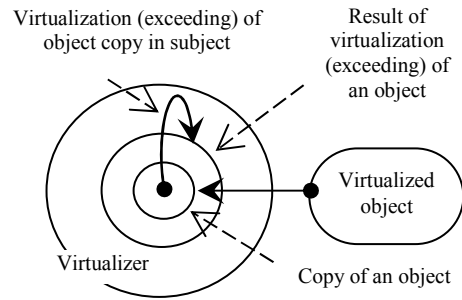


Fig. 7. The scheme of meta-concept virtualization

III. ABSTRACT / REAL DICHOTOMY OF THE UNIVERSE

According to Plato and Aristotle, the Universe is divided into the World of categories (Abstract World (AW)) and the World of phenomena (Real World (RW)), which, according to the modern understanding, have the scheme in Fig. 1. According to the universal ideas, the AW begins in the UA and develops further into a pyramid-like system of categories/abstracts/concepts, built into the RW in the form of Space-Time-Matter Complex (STM-Complex), consisting of interrelated Complexes of Space, Time and Matter, the initial properties of which are generally understood (Fig. 8).

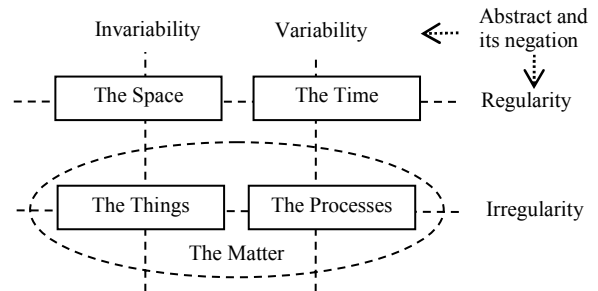


Fig. 8. The scheme of the Complexes ontology

Definition. The World is a relatively integral part of the Universe.

Definition. A category (abstract) is an entity of the AW.

Definition. A phenomenon is an entity of the RW.

Definition. A Complex is a phenomenon that is present in all the RW phenomena.

Definition. Space is a regular and invariable Complex of the RW.

Definition. Time is a regular and variable Complex of the RW.

Definition. Matter is an irregular Complex of the RW.

Definition. A thing is an invariable part of the Matter Complex.

Definition. A process is a variable part of the Matter Complex.

The RW (STM-Complex) consists of interrelated phenomena with built-in categories that determine their properties. The existence of phenomena is determined solely by its categories. Presumably the categories of phenomena do not have internal contradictions. The nature of the category carriers is unknown, but it does not prevent formalization.

Consequence. Concepts are cognition of the abstract part (categories) of phenomena.

Consequence. Facts are cognition of the real part of phenomena.

Consequence. Due to indirect actions (through other categories), the categories are poorly recognized by phenomena.

Consequence. Due to the direct action, phenomena are strongly cognized by phenomena.

Hypothesis. The system of categories is the same throughout the (infinite) Universe.

Consequence. Facts determine the activated categories of phenomena.

Consequence. Knowledge is the concepts of facts and categories of phenomena.

Definition. A formula (formalism) is the system of categories / concepts of an entity.

Definition. An axiom (definition) is initial formula of an entity.

Definition. SubUAP is an abstract part of an entity.

IV. UNIVERSAL HARMONIC CLASSIFICATION OF PHENOMENA

Phenomena 1) exist in an STM-Complex and 2) are divided into 3 non-empty groups of relations: internal, external and intermediate among them (Fig. 9). Additionally, these relations are divided into the Past, Present and Future (Fig. 10).

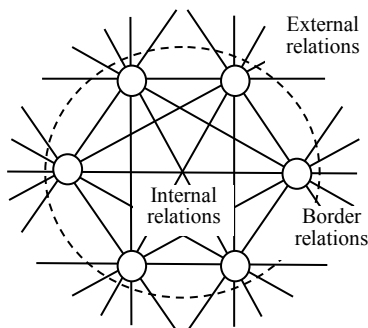


Fig. 9. The scheme of a phenomena harmonic structure

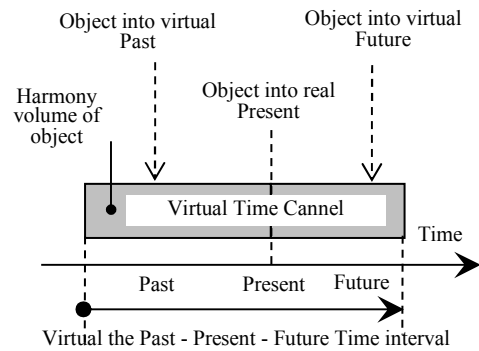


Fig. 10. The scheme of a phenomenon dividing into the Past, Present and Future and its Virtual Time Channel

Special states of internal relations development give rise to the universal harmonic classification of phenomena, the simplest (initial) of which is shown in Table. 1.

Definition. A virtual relation is a copy of a real relation.

Class 1 (Thermodynamics) has relatively weak real intermediate relations and exists exclusively at the point of the Present, continuously moving from the Past to the Future.

Class 2 (Mechanics / Natural selection) has real intermediate relations comparable to internal and external ones at the point of the Present and is supplemented by virtual relations with the Past that make up an internal structure of a phenomenon (a copy of the Past in the Present of the phenomenon). Mechanics inherits and develops Thermodynamics.

Class 3 (Life / Intelligence) inherits Thermodynamics and Mechanics and is supplemented by virtual relations with the Future (the forecast of a phenomena) by predicting the development of a phenomena over a certain time interval.

Class 4 (the Highest Reason) inherits Thermodynamics, Mechanics and Life and is supplemented by real relations along the entire axis of Time.

Thus, Classes 2-4 are directly related to Intelligence, have specific formalisms, definitions, properties, and further are concretised into the following subclasses. Class 2 conditionally got into this group due to the importance of natural selection for living phenomena.

V. VIRTUAL TIME CHANNEL, BASIC DEPENDENCIES AND CHARACTERISTIC VALUES OF CLASSES

Intelligence sequentially forms and develops a Virtual Channel in Time (VTC), which is fundamentally different from the Shannon channel in Space and provides additional internal (subjective) Time commutation of phenomena, creating a harmonious superiority of the upper Classes over the lower Classes (Fig. 10). The VTC

TABLE I. UNIVERSAL HARMONIC CLASSIFICATION OF PHENOMENA

Class	Name	Internal structure	Harmonious Resource	Harmony Type	Characteristic quantity
1	Quasi-chaos (Thermodynamics)	No	Real relations in the Present	Starting	Entropy
2	Natural selection (Mechanics)	Present	+ virtual relations during the interval in the Past	Passive	Energy
3	Life (Intelligence)	Copy of STM-Complex	+ virtual relations during the interval in the Future	Active	Harmony
4	The Highest Reason	Real STM-Complex	+ real present on all Time axis	Highest	Harmony
5	The Harmon	Absolute	Absolute connectedness	Absolute	Harmony
6	Absolute Chaos	No	There are no relations	No	No

is a key indication of Intelligence, in contrast to purely logical phenomena.

The VTC radically changes the interaction of phenomena (Fig. 11). Thermodynamic phenomena almost do not interact with external relations and pass them with small changes. Mechanical and living phenomena strongly influence external relations with an increase in the VTC and from the passive turn to active and destabilizing ones. The Universe is completely self-determined and depends only on internal relations.

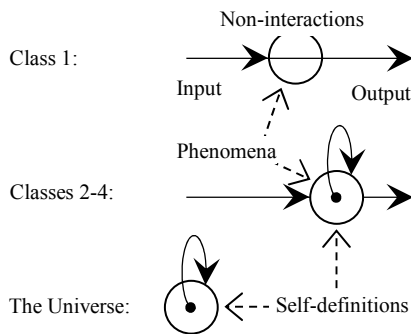


Fig. 11. Classification of the phenomena Classes interaction

The VTC radically changes the characteristic quantities of phenomena from passive entropy (that tends from complex to the simplest states) and conservative energy (that preserves phenomena) to active harmony that gathers itself back from the simplest to the highest states and thereby creates complex phenomena (Fig. 12).

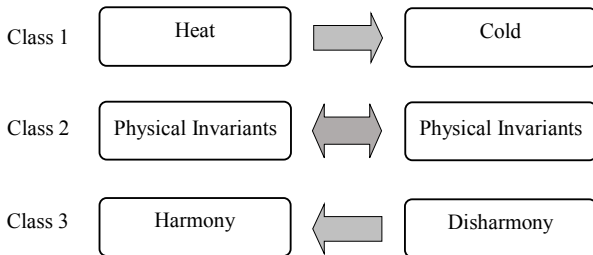


Fig. 12. The scheme of action of characteristic quantities on phenomena Classes

Accordingly, Class 1 destroys, Class 2 saves, and Class 3 develops phenomena (Table 2).

The VTC and additional Time harmony correspond to the desired negative entropy of E. Schrödinger [13-14].

TABLE II. CHARACTERISTIC QUANTITIES OF HARMONIC PHENOMENA CLASSES

Class	Class name	Characteristic quantity	Degree of phenomena harmony
1	Quasi-chaos (Thermodynamics)	Entropy	Degradation
2	Natural selection (Mechanics)	Energy	Conservation
3	Life (Intelligence)	Harmony	Development

VI. THE HARMONY, META-LAW AND THE HARMON

Cognition is embedded in the definition of the Universe and its UA, and therefore the highest Universe's characteristic quantity (that is based on connectedness) is naturally assumed. Let us call it 'harmony', the exact formula of which has not yet been obtained, but it is qualitatively confirmed everywhere. The initial (Meta-) Law of the Universe assumes its successive increase (harmonization): all entities tend to increase their harmony.

The Meta-Law is the initial functionally complete method of harmonization that provides all the opportunities for ubiquitous increase in the connectivity of Universe's entities, the particular case of which is cognition.

The limit of an entity harmonization is the state of complete connectivity (local harmon) – a complete graph built on the components of an entity (harmony), the added arcs of which are the chaos of an entity (Fig. 13).

Definition. Harmony is connectedness of entities.

Definition. Chaos is the lack of connectedness of entities.

Consequence. Chaos is a resource of harmony of entities.

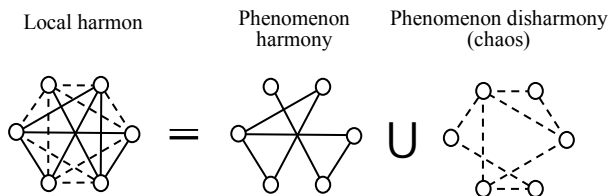


Fig. 13. The scheme of a dichotomy of a phenomenon into harmony (solid lines) and chaos (dotted lines) for $n = 6$

The limit of harmonization of the Universe is the state of the Harmon as the Complete Infinite Oriented Graph $CIOG(CIOG) = \lim COG_n(COG_n)$, number of vertices $n \rightarrow \infty$, whose vertices are the same graphs (Fig. 14). Harmon is a central concept of the Universal Theory as an initial and final Universe's entity, the study of which is beyond the scope of this topic.

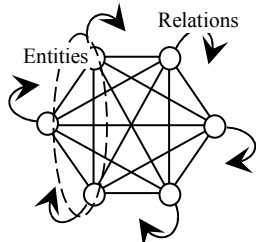


Fig. 14. The scheme of the Harmon (for $n = 6$), $n \rightarrow \infty$

VII. THE UNIVERSAL COGNITION METHODOLOGY

Harmonization begins with the cognition of phenomena, which in itself is an act of harmonization

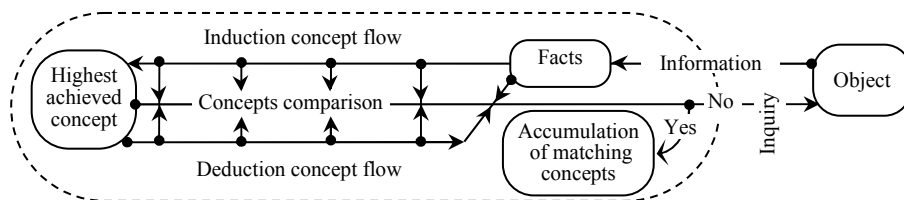


Fig. 15. The scheme of a conditioned reflex

Consequence. Knowledge is hypothetical.

Definition. A hypothesis is a statement, the falsity of which has not been proved. Consequence. The elimination of external (with the Universe) and internal (with themselves) contradictions of knowledge is a necessary method of cognition because our Universe has such a character. Definition. The truth is the Universe.

Consequence. The criterion of the truth is the value of externally and internally consistent knowledge. Consequence. A conditioned reflex provides unlimited knowledge of the Universe, starting with the zero ability of cognition.

A conditioned reflex and the elimination of contradictions substantiate the derivative method of sequential concretization of concepts by introducing additional hypothetical concepts with the supposedly overcome distance between the conflicting concepts to

through the access of a subject to an object and copying its real and abstract parts. The real part activates the categories of an object, and the abstract part selects and transfers them into the concepts of a subject. This is implemented by various combinations of the available means of a subject at all stages of harmonization: access, selection, copying, formation of the VTC-representation, search and implementation of the required harmonic state of an object.

Due to the direct invisibility of the AW in the RW, the biggest problem is the abstraction of an object, which performs a subject with logical induction and deduction operations (id-operations) that are understood to mean generalization and combination of selected concepts respectively (Fig. 1).

As a result, two opposing flows of inductive and deductive concepts arise in a subject, which coincide in nature and must coincide in a subject. The coinciding concepts form a certain subjective system of concepts, and the mismatched concepts are sent for additional cognition as initiators of new knowledge (Fig. 15).

This scheme corresponds to a conditioned reflex [15] and determines a typical dichotomy of the brain into two hemispheres, presumably specializing in induction and deduction, which fundamentally ensures complete cognition, starting with the zero cognitive ability of any subject, which any Universe's phenomenon is (Fig. 16).

Consequence. Knowledge is subjective.



Fig. 16. Typical brain dichotomy

achieve the target formalization, which are then verified by the subsequent factual analysis as any consciousness does. The volume of such a system of concepts is the main measure of the required formalism truth (Fig. 17).

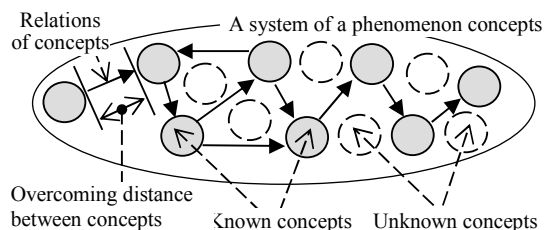


Fig. 17. The scheme of a concepts sequential concretization method

VIII. THE UNIVERSAL META-DEFINITION OF INTELLIGENCE

The Universe has 3 main divisions: 1) the AW and the RW, 2) Time (Past, Present and Future) and 3) categories as limiting harmonization, which are overcome only together under the influence of the Meta-Law through virtualization using the above-mentioned harmonization tools that make up the initial formalism (definition) of the UMFI as an important tool of the Universe, further developed by the Highest Reason (Fig. 18).

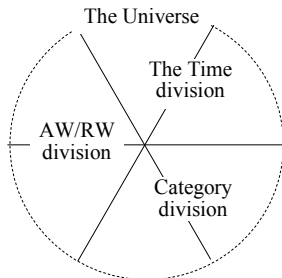


Fig. 18. Illustration of the Universe main divisions

IX. CONCRETIZATION AND MATERIALIZATION OF INTELLIGENCE

The UA is directly included in the definition of Intelligence, which is further specified, presumably, in all places of the Universe through an endless hierarchy of ecological niches of existence (ENE) with different categorical systems up to materialization at the lowest real level of abstract hierarchy.

Accordingly, the UMFI receives numerous additional concretizations up to and including materialization, which are consistently complicated various low-level formalisms up to the achievement of the status of phenomena that makes it possible to cognize the entire Universe (Fig. 19).

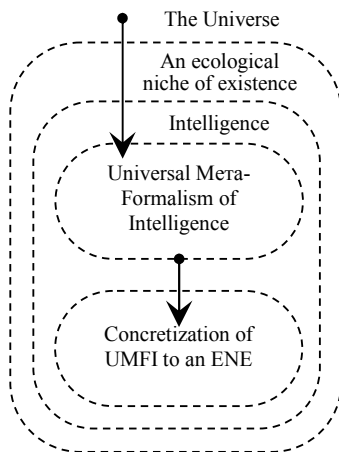


Fig. 19. Intelligence concretization scheme

CONCLUSION

Thus, this study has made it possible to substantiate and deduce as per the universal paradigm of knowledge a full-fledged scientific definition and structural formalization of strong Intelligence that is presumably universal in our Universe and allows in case of its further development a set-theoretical interpretation and implementation on modern logical machines. Particular attention is paid to the substantiation of all the concepts used as parts of the Universal Meta-Definition of Intelligence. The obtained results have general scientific significance and great prospects for further development in all intelligent applications.

This study was carried out according to the plan of AI Problems Institute of the MES and NAS of Ukraine.

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