On Triplet Classifications of Concepts

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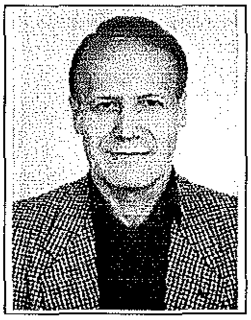

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ABSTRACT: This paper introduces a scheme for classifications of concepts. It is founded on the triplet model of concepts. This model depicts a concept by means of three kinds of knowledge: a concept base, a concept-representing part and the linkage between them. Informally, the concept base deals with entities subsumed under a concept and their properties and relations. The concept-representing part deals with tools and forms of representing these entities and their properties and relations in some intelligent system. The linkage deals with establishing the proper correspondences between components of the base and the representing part. Each of these knowledge kinds is associated with specific structures related to concepts (symbols, names, statements, images, texts, entities and their properties and relations, procedures of determination of property values, etc.) Various informal and formal (mainly set-theoretical) specifications of these structures serve as criteria for triplet classifications of concepts. (Author).

1. Introduction

Concepts have attracted much concentrated attention in many branches of contemporary science. There are many approaches to their study. In what follows we will consider concepts as elementary units of knowledge and its organization (Dahlberg, 1978). However, concepts are not formless entities. Numerous models of concepts provide different descriptions of concept structures and features. Practically each model has some advantages and empirical confirmation. Because of this it is reasonable to assume that the particular model of concepts reflects several specific aspects of the "same" unit of knowledge called a "concept." The hypothesis of this paper is that a concept has a complex and unusual structure and composition. We may think about a concept as a composite thing known only through its projections". Our first aim is to introduce such a model of concepts that has opened perspectives of the unified description of such projections. The second aim is to apply this model to classifications of concepts.

2. The Triplet Modeling of Concepts

The results of current concept analysis do not allow one to be certain and final in his or her knowledge of what concepts are. There are now only reasonably elaborated and empirically tested models of concepts (see Komatsu, 1992; Smith and Medin, 1981). In various ways they depict different hypothetical properties and structures of concepts. As a rule, these models treat single concepts as complex holistic units that have many properties and realize many functions. Frequently these models are nothing but informal descriptions of properties that these holistic units might have. Unlike such models, the triplet model explains some concept properties and functions from the idea that a concept has the complicated internal componential composition.

However, at least now, there is no direct access to this composition. In a sense, a concept is a black box. We may offer some hypotheses about its composition. The following requirements are necessary here. Firstly, these hypotheses and their consequences should accord with an available stock of information about concepts, their properties, relations and functions. Secondly, the use of such hypotheses should lead to obtaining new and testable information about concepts. Under these requirements we should give the preference to hypotheses that introduce manageable models of concept composition.

The triplet approach models hypothetical concept components, their structures and properties as sets of different kinds, set scales, and abstract properties. It means that the triplet description of properties and functions of concepts rests on the description of concept components and their structures. The triplet model (Kuznetsov, 1994; 1997; Kuznetsov and Kuznetsova, 1997) has developed and uniformly described most of the various concept characteristics introduced by other models. We may show that most of the previously suggested models are specializations of the triplet model. They deal only with some triplet structures of a concept.

To put it otherwise and intuitively, we characterize a concept from three interconnected perspectives. The first is connected with entities (and their properties and relations of various orders) subsumed under a concept, the second -- with forms and tools of depicting entities in some intelligent system, and the third -- with ways of establishing correspondences between entities and appropriate forms and tools of their depicting. Each of these perspectives associates with a concept a specific kind of information. The triplet model proposes a general way of presenting these information kinds.

As a concrete and pragmatic oriented example we may take the situation in which a person possesses the concept of atoms. Speaking about this concept, we have in mind, at least, three kinds of information. 1) A person has some knowledge about atoms as constituents of a physical world. 2) A person could represent this knowledge by expressive tools of ordinary language and, for scientific versions of this concept, physical theories. 3) During socialization, education and learning, some (poorly explored) conscious and unconscious processes take place in a person's mind. These processes lead to the association of some linguistical and theoretical structures with atoms and their properties and relations.

We do not state that the perspectives in question exhaust all possibilities of the analysis of the concept of atoms and the like. However, without any of them it is difficult to speak about the person's possession of a concept.

We have structured kinds of information associated with these perspectives. The first one is organized according the ontological hypotheses about reality. The second is organized according to the rules of representative and communicative systems, primarily natural and artificial languages and knowledge systems. These systems have rich resources (sign, symbolic, lexical, syntactical, semantical, imagerial, modeling, operational, transformational and others). In a sense the horizon of these systems defines what we can specifically state about the general ontological structuring of reality.

However, the relationship between the reality and our representative and communicative systems is not a simple one-to-one correspondence between the entities of the former and elements of the latter. Many kinds of operations and processes have contributed to the creation of the components of such relationships. The third kind of information has centered on these operations and processes.

2.1. Ontological Structuring and Its Explication

Let us consider some entity c. This entity may have real, ideal, or mental nature. It may be a thing, an object, a process, a state, a thought, number or an appropriate set, collection, class or group of these. Since the origin of modern science the leading strategy of investigating entities is to select their properties, establish and describe relationships between them. We associate with this strategy the following chain (for simplicity reasons we take only one entity and consider the chain as linear):

the entity → first order properties of an entity → first order relations between first order properties → first order relations between entity properties and properties of other entities → ... → *n*-th order properties → ...

Constructions of abstract properties (Burgin, 1985) and set scale (Burgin and Kuznetsov, 1985) formally describe such a chain.

An abstract property P is a triple (D, p, Sc). Here D is a set of entities d that may possess the property in question, Sc is a scale of the property, and p is a partial function assigning the element(s) $p(\mathbf{d}) = sc \in Sc$ to an entity $d \in D$ [1; 3].

For example, the abstract property $\boldsymbol{V}$ models the property of physical bodies called "***velocity***." In it D is the direct product of all physical bodies by all physical frames of reference, Sc is the set of three-dimensional vectors, and p is some procedure of measuring and calculating the values of ***velocity*** for a given body.

The set scale is built step by step by applying operations of set union, set product and constructing the power-set to the basis X of the set scale $S(X)$. The basis is a collection of sets $X_1, X_2, ..., X_n$. On each step we obtain one definite level of the set scale. The set scale $S(X)$ is the union of all its levels (Burgin and Kuznetsov, 1985). The reader may construct the elements of the first two or three levels of the set scale with the basis $X = \{X_1, X_2\}$ where $X_1 = \{a, b\}$ and $X_2 = \{x, y, z\}$.

We use levels of a set scale for differentiating (hypothetical) knowledge about entities and their properties of various orders. For instance, the above-mentioned abstract property may be associated with one level of the set scale $S(X = \{D, Sc\})$.

Thus, speaking about an entity c we should consider also its properties and relations, at least that which we supposed to be relevant in a concrete situation. It means that we should associate with a concept of an entity c the knowledge not only about c, but also about c's properties and relations.

The set of all entities about which we can think by a particular concept is only a subset of our universe of discourse U. This universe has to contain also properties of these entities, relations (dyadic properties) between entities, relations between properties, properties of relations, properties of properties (properties of the second order with respect to entities), etc.

Introducing the universe U, we assume that the notion of an entity and the notion of a property (a relation) appear in a pair. Almost without exception we speak about an entity having in mind some its properties (and relations) and we speak about a property (a relation) having in mind some entities. Let us consider also properties of higher order, for example the property p_2 of the property p_1 of the entity **c**. Here we may suggest that the relation between p_2 and p_1 be the same as the relation between p_1 and c. In this sense p_2 is a property in respect to p_1 and p_1 is an entity in respect to p_2.

To avoid undesirable associations from here on we shall use, if necessary, capital bold symbols, letters, words, word combinations for denoting concepts. Instances of the concept denotation are **C, ELEMENTARY PARTICLE, HADRON, ANIMAL, HUMAN, SOCIETY** and so forth. Entities falling under a concept will be connoted as **c, an elementary particle, hadron, an animal, human, society**. Correspondingly, the names of a concept might be "C", "ELEMENTARY PARTICLE", "HADRON", "ANIMAL", "HUMAN", "SOCIETY". The names of the entities subsumed under a concept might be "c", "**an elementary particle**", "**hadron**", "**an animal**", "**human**", "**society**". The name or term of a concept "is its component which conveniently summarizes or synthesizes and represents a concept for the purpose of designating a concept in communication" (Dahlberg, p.144). Generally, as a name or term of a concept may function not only lexically simple names, but also more complex linguistic structures like compound names, sentences, and even texts.

A concept C has, as a rule, many names of the kind N(C). The same is true for the entities falling under a concept. The names in question differ in their exactness, effectiveness, simplicity and other characteristics.

Moreover, in many contexts we do not systematically and explicitly differentiate between an entity and its names (Rosser, 1953). For such an "entity" as a concept we frequently identify it not only with some of its name, but also with some name of entities falling under a concept. In our notation it means that, metaphorically, C = "C" = "c".

In this paper we consider concepts as complicated units of knowledge about elements from U. It is a matter of fact that a given concept C informs us only about specific elements or subsets of U. Moreover, any such informing takes place in some conditions K. Aside from describing these conditions in detail, we mention only those associated with the individual's mental and interpretative abilities, skills and tools, available knowledge, purposes, and even psychic state.

2.2. *The Base of a Concept*

Bearing previously mentioned distinctions and conventions in mind, we introduce the following definition.

Definition 1. Under the conditions K the (potential) ground set (shortly the ground) $G_K(C) \subseteq U$ of the concept C is a set of all elements g reasonably denoted by the name $N_K(C)$ of the concept C.

It is usually said that element $g \in G_K(C)$ falls or is subsumed under the concept C. In cognitive science and psychology these elements are also called "instances" or "exemplars" of a concept. Dahlberg has used for denoting g such names as an "item of reference" and "referent" (Dahlberg, 1978). Under the traditional logical treatment the terms "extension" or "volume" have been frequently used for labeling the ground set $G_K(C)$ of a concept. The term "category" is in use in cognitive science and psychology.

The association of the ground set with a concept is only a first step in its triplet modeling. On one hand, the knowing of the concept C presupposes also the possibility of indicating and describing, at least, qualitatively some properties and relations of elements from $G_K(C)$. This means that the information about such properties and relations is an important characterization of a concept. Such information is very important for the concept use in ordinary thinking. Besides this, using scientific concepts we presuppose quantitative descriptions of some properties and relations of elements from $G_K(C)$ and their values, the establishing correlation between properties under consideration, etc. As a rule, some set of these properties is called concept "intension" or "content". Some cognitive scientists and psychologists also separate different kinds of such properties: a prototype and a core. A prototype is a set of properties that are assumed to occur in some instances. A core is a set of properties that are singly necessary and jointly sufficient for membership of an entity in the concept's category (Smith, 1988). On the other hand, not every entity labeled by the name $N_K(C)$ bears meaningful relation to the concept C. In particular, we may apply an inappropriate name. It means that an entity should possess some specific properties and relations for meaningful links with a specific concept.

Thus, we should depict precisely information, on one hand, on the concept ground set and, on the other hand, on some properties and relations of elements from the ground set. One way to do this is to use the construction of a set scale $S(X)$.

In the triplet modeling the basis X of the corresponding concept set scale necessarily includes the ground set G ($G = X_1$). Selecting the appropriate basis we may depict any property and relation of elements from G. For this purpose the basis should also include auxiliary sets. Some of them are scales of properties and relations of elements from G. Examples of auxiliary sets are real numbers, vector spaces, truth values, etc.

Definition 2. The base B_K(C) (in relation to the conditions K) of the concept C is the collection of elements of G_K(C) and their properties and relations that needed for the usage of C in conditions K. These properties and relations are distinguished by structures from finite number of levels of the set scale $S(G^*)$ with the basis $G^* = \{G_K, X_2, ..., X_n\}$, where X_2, ..., X_n are auxiliary sets.

According to *Definition 2* the base of a concrete particular concept is relative to the conditions K. Let we consider the usage of the concept ATOM by a pupil and a professional physicist specialized in atomic physics. It would appear reasonable that the first associates with corresponding base only few properties and relations of atoms (***size***, ***mass***, ***electrical charge***), while the second much more (***spin*** and other ***quantum numbers***). However, even physicists' knowledge about properties of atoms is incomplete. Nevertheless, this knowledge is sufficient for operating with the concept ATOM within some situations and conditions. Thus, in each case of the person's concept possessing the concept base includes limited number of properties and relations from the concept base.

Various structures of the concept base (under an appropriate option of the ground set, the basis of the set scale and their algebraic description) are objects of modeling developed by R.Wille and his collaborators (Vogt and Wille, 1995; Wille, 1992).

Thus, we center the information about the concept base around the general ontological structuring (entities-properties-relations) of the reality under study. The scientific hypotheses about specific nature of concrete entities and their properties and relations have elaborated this structuring. However, even now we cannot be sure about accepted hypotheses on what are entities, their properties and relations. These hypotheses have been changing permanently, at least in fundamental physics and biology. However, the ontological structuring has remained without changes.

2.3. *The Representing Part of a Concept*

Apparently elements from the concept base do not themselves bear their names, descriptions, statements about them, etc. Such structures are human creations. Thus, any realistic concept model should take into account this fundamental fact. Without the loss of generality we may speak of only about the linguistic form of existence of these structures. Here language is understood in a very broad sense. The second triplet characteristic of a concept -- its representing part -- deals with instances of this linguistic form.

Let us assume that we use some language L with the alphabet A, the vocabulary V, the set P of word combinations, the set E of expressions (sentences) and the set T of texts. The language L may include sublanguages (sign, pictorial, natural, artificial, common, scientific, mathematical, etc.). The basis L^* of set scale $S(L^*)$ of language L is $\{A, V, P, E, T\}$. The set scale $S(L^*)$ contains everything expressible in the language L.

Definition 3. The representing part $R_K(C) \subseteq S(L^*)$ of the concept C is a set of linguistic units and structures by which the base B_K(C) of a concept C is depicted (mapped, represented) under conditions K in some knowledge system.

For example, the representing part of the physical concept ELECTRON contains the following elements: symbol e (the element of A); word "electron" (the element of V); "a material carrier of elementary electric charge" (the element of P); "electron is a constituent of atoms", "electrons interact by means of electromagnetic force", "electron has a rest mass of 9.1 X 10^{-28} gram" (the elements of E); "the electron is a fermion, a type of particle named after the Fermi-Dirac statistics that describes its behavior. It has a half-integral spin - spin constitutes the property of intrinsic angular momentum in quantum-mechanical terms" (the element of T) (Electron, 1990, p.435).

The representing part of pre-scientific concept ATOM contains an image of small, indivisible pieces of matter. The representing part of its scientific counterpart includes quantum-mechanical wave functions, various theoretical models of **atoms**, schematic pictures of electron orbitals, etc.

Components of the concept-representing part differ in their representative and expressive capacity. Some of them only denote the base as a whole, its selected subsets, and its individual elements. Other components name properties and relations from the base. The third group of components gives more or less complete and/or exact description of elements from the base or even their properties and relations. The fourth group models these structures.

There are many non-trivial links between elements from the representing part of scientific concepts.

Moreover, these elements intimately connect to empirical and theoretical knowledge systems and classifications available in the corresponding science. In this sense the representing part of scientific concepts is knowledge dependent.

According to Dahlberg' model "a *verifiable statement* is the component of a concept which states an attribute of its *item of reference*" (Dahlberg, 1978, p.144). Such a component is a specific element of the set E that conveys verifiable knowledge about some property of elements or their combinations from the concept ground set.

2.4. The Linkage of a Concept

Human activity associates the elements from the base with the appropriate components from the representing part. In this sense such associations are results of human actions. As such, these are dependent on developmental levels of civilization, culture, language, science, person's knowledge, purposes and mental capacities. These are conditional and ephemeral, but necessary for building (forming) concepts. Thus, we need more careful characterization of links between structures from the concept base and structures from the concept representing part.

Let we point out only some aspects of links under consideration.

There are many ways of their establishing: by custom, by training, by language acquisition, by convention, by analogy, by procedure, etc. From the point of view of concept functions, the usage of three letters "**man**" for denoting **MAN** is accidental. Ukrainians use the set of six letters ("ëþäèíà") while Germans use another set of six letters ("**Mensch**"). Also, there are universal scientific procedures for finding values of such a property of **macroscopic bodies** as ***velocity*** for any given material body. The accuracy and exactness of these procedures may change eventually.

The almost commonly accepted approach treats the links between components from the concept representing part and elements from the concept base as simple naming relations. The former components play the role of names and the latter elements play the role of entities named by the appropriate former components. However, all these links are not reducible to naming relations that assign the names to the entities. For example, if the concept representing part contains mathematical model of a property from the base, then this model not only names the property but also usually gives the knowledge about the values of this property.

Without going into details, one may separate various kinds of links between the components from the representing part and the elements from the base. Among these are reference links (naming, denoting, describing, visualizing, imaging), truth links, and modeling links.

Thus, the knowledge on links in question is a very important part of any reasonable concept model.

Definition 4. The linkage Lin_K(C) of a concept C is the system of links between the base B_K(C) and the representing part R_K(C).

For any concept this linkage is the outcome of very complex (sensual, perceptual, mental, scientific) activity.

For example, sensual perception has partially contributed to the linkage of the common concept **ANIMAL**. For the synonymous scientific concept the construction of such a linkage is realized in the framework of the available scientific knowledge, observations and measurements.

Physicists state that **electrons** are unobservable entities. If it is true, then for different versions of scientific concept **ELECTRON** its linkage cannot be established by direct observation. We construct this linkage by measurement and application of appropriate knowledge systems (theory of measurement, electron theory, quantum mechanics). This means that some links from the linkage of the concept **ELECTRON** are realized through processes of abstraction, idealization, modeling, calculation, an approximation and so forth.

For many scientific concepts there is a possibility of controlling the linkage between their bases and representing parts. In particular, the measurement and calculation procedures permit scientists to attach quite specific linguistic and mathematical (numeric, vector and others) values to definite properties and relations from the base of a concept. The concept linkage is changing with the changes in scientific equipment, methods of its use and available scientific theories.

2.5. The Triplet Model of a Concept

Thus, the reliable concept model should consider all three kinds of knowledge about concepts. Without any of these we have only incomplete concept modeling. Certainly, there are many successful applications of various incomplete concept models. However, the complete concept models give more profound and deep insight into concepts.

From stated above one may obtain

Definition 5. Under conditions K the triplet model T_K(C) of the concept C is the triple (B_K(C), Lin_K(C), R_K(C)), where B_K(C) is the base of C, R_K(C) is the representing part of C, and Lin_K(C) is the linkage between B_K(C) and R_K(C).

Informally, we may say that the knowledge associated with a concept is distributed across the three components of this triple.

We would like to stress the relative nature of these and other definitions connected with concepts. The specific treatment of a concept depends not only on concept itself, but also on one's approach to it.

3. The Triplet Classifications of Concepts

Let us consider briefly the idea of triplet classifications of concepts.

The triplet model describes a concept by three components: the base, the representing part and the linkage between them. Moreover, each component has many „structural" properties, that is, under the triplet modeling it may include many different structures. The set scale provides a general description of these structures.

We separate some *S*-conceptual class if concepts possess the structure *S*. In other words, if the concept C has a triplet structure *S*, then we may count this concept C as a member of the *S*-conceptual class. The concept C may belong to many conceptual classes. In this paper we do not consider the problem of the relationships between conceptual classes.

We may also separate in the *S*-conceptual class its subclasses in dependence on available characteristics of *S*. Examples of these characteristics are ascribed ontological status of *S*, set-theoretical composition of *S*, and language of description of *S*. For any structure *S* these characteristics are treated as different „values" of *S*.

The tables below contain three columns. The first column gives the short and symbolic description of the structure *S*. The second column gives the possible „values" of *S*. The third one gives the names of appropriate conceptual classes.

The classes and subclasses of concepts obtained are depicted in the tables 1–8. The sequence of dots symbolizes the possibility of an extension of the type of classes mentioned above dots.

3.1. The Ground Classifications

Informally, the ground set *G* of a concept is a set of entities subsumed under it. Evident characteristics of G are its cardinality, relation to *U*, ontological status, domain of existence, and set-theoretical composition. This gives classifications listed in the Table 1.

Criterion of classification	Value of criterion	Concepts classes and subclasses
Cardinality of G	*The ground set contains*	
	no elements	*G*-empty
	one element	*G*-singular
	set of elements	*G*-general
	finite set	*G*-finite
	infinite set	*G*-infinite
	countable set	*G*-countable
	uncountable set	*G*-uncountable
Relation between G and U	*The ground set is:*	
	equal to *U*	*U*-universal
	a subset of *U*	*U*-non-universal
	a superset of *U*	*U*-super-universal
	....	....
Ontological status of elements from G	*The type of elements*	
	Thing (object)	*G*-object
	Event	*G*-eventual
	Situation	*G*-situational
	Process	*G*-processual
	Action	*G*-actional
	Intentions	*G*-intentional
	....	....
Domain of existence of G	*The type of domain*	
	Physical reality	*G*-real
	Psychics	*G*-mental
	Communication	*G*-communicative

	....	....
Set-theoretical composition of G	*The ground set contains*	
	only individual elements	G-individual
	only subsets of individual elements	G-collective
	....	....

Table 1. The ground classifications of concepts

3.2. *The Base Classifications*

Let we remind that the base of a concrete concept is some subset of the universe of discourse U. Informally, the base contains besides entities subsumed under a concept their properties and relations of various orders.

We may take such structural properties of the base as its ontological structuring; kinds of set-theoretical descriptions of structures from B; the way by which the base is given to a person, etc. This generates the following (incomplete) list of concept classes (Table 2).

Criterion of classification	Value of criterion	Concepts classes and sub-classes
The ontological structuring of B	*The base contains*	
	properties $\{P(g \in G)\}$ of individual elements g from G	$B\{P(g \in G)\}$-attributive
	properties $\{P(G^* \subseteq G)\}$ of subsets G^* of G	$B\{(G^* \subseteq G)\}$-attributive
	....	....
	relations $\{R\}$ between individual elements g from G	$G\{R(g)\}$-relational
	....	....
	relations between subsets G^* of G	$G\{R(G^*)\}$-relational
	....	....
Set-theoretical kind of a structure Str from B		
	Standard set	*BStr*-sharp
	Multiset	*BStr*-multiset
	Fuzzy set	*BStr*-fuzzy
	....	....
The way by which a structure Str from B is given to a person		
	Perception	*BStr*-perceptual
	Experience	*BStr*-empirical
	Experiment	*BStr*-experimental
	Abstraction	*BStr*-abstracted
	Idealization	*BStr*-idealized
	....	....

Table 2. The ontological and perceptual base classifications of concepts

We may also take as criteria of base classifications some variative and causal characteristics of structures from *B*. This gives the classifications listed in the Table 3.

Criterion of classification	Value of criterion	Concepts classes and subclasses
Change of a structure Str from B		
	No-variation of *Str*	*BStr*-stable
	Variation of *Str*	*BStr*-variative
Parameter of variation of a structure Str from B		
	Time variable	*BStr*-temporal
	Space variable	*BStr*-spatial
	Cause variable	*BStr*-causal
Type of cause of variation of s structure Str from B		
	Randomness	*BStr*-random
	Probability	*BStr*-probabilistic
	Statistics	*BStr*-statistical
	Determination	*BStr*-deterministic
	....	
Localization of cause of a variation of a structure Str from B		
	Inside *Str*	*BStr*-internal
	Outside *Str*	*BStr*-external
Cardinality of a set of causes of a variation of a structure Str from B	*The set contains*	
	One cause	*BStr*-monocausal
	Many causes	*BStr*-multicausal
	....	....

Table 3. The variative and causal base classifications of concepts

3.3. *The Representing Classifications*

We construct the representing classification just as the base classification. Let *L* be some language. The classes are given in respect to *L*.

The Table 4 contains some concept classes introduced by means of characteristics of cardinality of *R*, its relation to *L*, and type of *L*.

Criterion of classification	Value of criterion	Concepts classes and subclasses
Cardinality of R	*The representing part contains*	
	no elements from *L*	*RL*-no-named
	one element from *L*	*RL*- single-named
	set of elements from *L*	*RL*- multi-named
	finite set	*RL*- finite-named
	infinite set	*RL*- infinite-named
	countable set	*RL*- countable-named
	uncountable set	*RL*- uncountable-named

Relation between R and L		
	L includes all needed for *R* elements	*RL*- expressible
	L includes some needed for *R* elements	*RL*- partially expressible
	L does not include needed for *R* elements	*RL*- non-expressible
	R is a fuzzy subset of *L*	*RL*-fuzzy-expressible
	....	....

Table 4. The set theoretical and relational representing classifications

The Table 5 includes some language characteristics of a structure from *R* and concept classes introduced by means of them.

Criterion of classification	Value of criterion	Concepts classes and sub-classes
Type of language L used for expression of structure Str from R		
	The sphere of usage Us of L	
	Common life	*RLUsStr*-natural
	Science	*RLUsStr*-scientific
	Units of alphabet A	
	Pictograms	*RLAStr*-pictogramic
	Signs	*RLAStr*-sign
	The kind of sentence construction rules C	
	Informal	*RLCStr*-informal
	Formal	*RLCStr*-formal
	The semantics Sem of sentences	
	Assertions	*RLSemStr*-assertoric
	Models	*RLSemStr*-model
	Problems	*RLSemStr*-problem
	Operations	*RLSemStr*-operational
	Procedures	*RLSemStr*-procedural
	Algorithms	*RLSemStr*-algorithmic
	....	....
	The kind of sentence transformation rules T	
	Informalized	*RLTStr*-informalized
	Formalized	*RLTStr*-formalized
Structure of lexical unit Un of L	*The unit has structure of:*	
	Scalar	*RLUn*- scalar
	Vector	*RLUn*- vector
	Spinor	*RLUn*- spinor
	Matrix	*RLUn*- matrix
	Metric	*RLUn*-metrical
	Topology	*RLUn*-topological
	Fractal	*RLUn*-fractal
		....

Kind of a set-theoretical description of a structure Str from R	*The theory of*	
	Standard sets	*RStr*-sharp
	Multisets	*RStr*-multiset
	Fuzzy sets	*RStr*-fuzzy
	....	....

Table 5. The language representing classifications

The Table 6 contains some concept classifications introduced by means of characteristics of nature of a definite structure from *R*, its form of fixation, etc.

Criterion of classification	Value of criterion	Concepts classes and sub-classes
Kind of a structure Str from R		
	Mental images (pictures)	*RStr*-imagerial (pictorial)
	Impression	*RStr*-impressional
	Lexical units of *L*	*RLStr*-lexical
	Letters	*RLStr*-symbolic
	Words	*RLStr*-lexicographic
	Simple words	*RLStr*-simple-lexicographical
	Complex words	*RLStr*-complex-lexicographical
	Word combinations	*RLStr*-phrasal
	Sentences	*RLStr*-sentential
	Texts	*RLStr*- textual
Access to a structure Str from R		
	Momentary Time interval	*RStr*-momentary *RStr*-temporal
	....	....
Psychic form of fixation of structure Str from R		
	Consciousness	*RStr*-conscious
	Unconsciousness	*RStr*-unconscious
Storage of a structure Str from R		
	Working memory	*RStr*-short-term
	Long-term memory	*RStr*-long-term
	....	....
Nature of change of a structure Str from R		
	No regularities	*RStr*-irregular
	Patter-obeyed	*RStr*-regular
Kind of processing a structure Str from R		
	Ordinary thinking	*RStr*-informal
	Formal thinking	*RStr*-formal

	Mathematical thinking	*RStr*-mathematical
	Computer processing	*RStr*-computational
	....	....
	....	....

Table 6. The relative to structure *Str* representing classifications of concepts

The Table 7 includes some concept classifications introduced through characteristics of knowledge system to which a definite structure from *R* belongs.

Criterion of classification	Value of criterion	Concepts classes and sub-classes
Type of knowledge system which a structure Str from R belongs to		
	Common knowledge	*RStr*-common
	General knowledge system	*RStr*-general
	Special knowledge system	*RStr*-special
	Science	*RStr*-scientific
	Mathematics	*RStr*-mathematical
	Logic	*RStr*-logical
	Physics	*RStr*-physical
	Social science	*RStr*-social
	Psychology	*RStr*-psychological
	....	....
	Theology	*RStr*-theological
	Philosophy	*RStr*-philosophic
	....	....
Type of organization of knowledge system which a structure Str from R belongs to		
	Theory	*RStr*-theoretical
	Formal system	*RStr*-formal
	Formalized system	*RStr*-formalized
	....	....

Table 7. The knowledge dependent representing classifications of concepts

3.4. *The Linkage Classifications*

We may also construct concept classifications connected with different characteristics of the concept linkage.

Criterion of classification	Value of criterion	Concepts classes and sub-classes
Modality of a structure Str from Lin		
	Necessity	*LinStr*-necessary
	Potentiality	*LinStr*-potential
	Intentionality	*LinStr*-intentional
	Contingency	*LinStr*-contingent
	....	....

Purposefulness of a structure Str from Lin		
	There is a purpose	*LinStr*purposeful
	There is no purpose	*LinStr*-non-purposeful
	....	....
Way of constructing of a structure S from Lin		
	By socialization	*LinStr*-socialized
	By general education	*LinStr*-generally educational
	By special education	*LinStr*-specially educational
	....	....
Determination of a structure Str from Lin		
	Unconditionality	*LinStr*-unconditional
	Conditionality	*LinStr*-conditional
	....	....
Character of the operation by which a structure Str from Lin is realized		
	Without control	*LinStr*-uncontrolled
	Under control	*LinStr*-controlled
	Convention	*LinStr*-conventional
	Ostensive indication	*LinStr*-ostensive
	Operation	*LinStr*-operational
	Measurement	*LinStr*-measurable
	Computation	*LinStr*-computational
	....	....
Function of a structure Str from Lin		
	Referring	*LinStr*-referring
	Modeling	*LinStr*-modeling
	Truth-bearing	*LinStr*-adequate
	....	....

Table 8. The linkage classifications of concepts

Certainly, some names of concept classes appear to be very unusual. However, the triplet classifications open the way to transform such names in the terms of the future concept theory.

The reader may try to subsume concepts (known to him) into classes of triplet classifications. Some subsumptions are rather obvious. Others are in a need of special investigation and substantial knowledge. Undoubtedly, he or she will find how deep and profound is his or her knowledge associated with some concepts.

One advantage of the triplet classification of concepts is connected with incorporating in a single framework not only well-known conceptual classes, but also many "new conceptual classes".

4. Further Developments

We may also introduce concept classifications with two or three criteria. They are the combined characteristics of the base and the representing part; the base and the linkage; the representing part and linkage; the base, the representing part and the linkage.

This paper has realized several so-called „monadic" classifications that are based on internal structures of concepts as single monads. However, so-called „relational" classifications are most often used. An example is the classification based on the relation of subordination between concepts. The triplet modeling of concepts permits one substantially to expand such classifications.

The triplet classifications of concepts have been used in comparing the degrees of maturity of different concepts, in the study of types and trends of concept developments, and in the analysis of knowledge organization at the level of concepts.

Note

* The author recommends that the reader analyse any particular concept using the framework presented in this paper. He would be very grateful for receiving information on counter-examples to the proposed triplet model.

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