Dichotomous Systemic Analysis

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Abstract. The article describes the basic principles of dichotomous systemic analysis and the features of how people perceive dichotomous concepts. Besides, the article shows the difference between the dichotomous analysis and dichotomous systemic analysis. It gives paradigmatic expressions for the assessment of system properties and for such notions as "system" and "non-system". Moreover, the article reveals the essence of parse tree used in dichotomous analysis and gives a method to detect system properties and to assess the complexity of a system.
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Introduction

Dichotomous analysis is one of the main types of analysis used in practical activity. This is caused by the specificity of human perception. Human memory stores constructions which are some images. These constructions are grouped into chunks. Chunks are a mechanism for fixing facts [1]. Every chunk is built as a set of facts and internal links between them. It is memorized and recalled as a single unit. Chunks form a system and are stored together with the system links between them. Man can process and interpret efficiently not more than 4-7 chunks.

At the same time, many dictionaries simplify or narrow the term "dichotomy". As a rule, it means the contraposition of two parts of the whole. This is a special case which leads to opposition variables [2]. However statistics considers dichotomy as a variable with only two values [3]. This is a broader notion. Another oversight in dichotomy's definitions is that they do not take into account the criterion of division and relations between the objects of dichotomous division. There are cases when elements of a dichotomous division object are divided conventionally, and they can move from one dichotomous object to another [4].

Methods

Methods of dichotomous analysis consist in comparing two notions on the basis of a chosen comparison criterion. This is because the dichotomous analysis uses a system of chunks. In simple form, this analysis uses paradigms: "object – non-object", "category – non-category", "process – non-process". This analysis can be designated by a triad which is perceived well by the system of chunks. Such a triad includes a comparison criterion and dichotomous pair "yes – no" or "factor – non-factor". It should be emphasized that a factor connecting the dichotomous pair is always present in dichotomous analysis.

The drawback of analysis based on the "yes – no" principle is the ambiguity or multiple values. For example, there is comparison "man – non-man". "Non-man" factors include a table, a pencil, an automobile, an animal, a natural phenomenon and so on.

That is why if we perform a dichotomous analysis of some object we will choose a category this object belongs to. Then the analysis of "non-object" is performed inside this category. This fact causes the definiteness of the connection and practical results of the analysis. Analysis is aimed at obtaining new knowledge about the object of study.

Main part

The principle idea of dichotomous analysis is to identify differences between the object of analysis and other objects, and between one characteristic of the object and its other characteristics. Besides, one should bear in mind the division criterion and relations between objects of dichotomous division. Dichotomous analysis can be systemic or non-systemic. This is another example of dichotomy.

"Non-systemic" dichotomous analysis is aimed at studying certain characteristics of an object. The tasks of this analysis do not include the obligatory identification of systemic attributes of an object or the investigation of an object as a system. This kind of analysis uses the following notions: "fragmentary analysis", "partial analysis" and "incomplete analysis".

Systemic dichotomous analysis has a double interpretation (an example of dichotomy). On the one hand it is a kind of analysis aimed at identifying

system attributes of the object of study or at studying object as a complex system [5, 6]. The main thing in this interpretation is the studied object as a system. In this case, the dichotomous analysis is based on the triad: is object a "system" or "non-system"? This interpretation reflects the empirical direction of research.

On the other hand the systemic analysis can be interpreted as a complex system of processes with system attributes, completeness and integrity. The processes of analysis as a system are the principal thing in such interpretation. In this case, the dichotomous approach is based on the triad: is the set of research methods a "system" or "non-system"? This approach is used in theoretical research and in the interchange of knowledge and experience between disciplines.

The systemic analysis is used in various spheres. It is used in information processing and analyzing information. Now we will describe different application levels of the systemic dichotomous analysis in information processing.

The first or the lowest level of systemic dichotomous analysis includes the fragmentary study of system attributes of information collections, their sorting on this basis and further processing. Such a study allows us to make descriptions of certain system attributes.

The second or middle level of applying systemic analysis includes the full study of system attributes of information collections as a system. This study makes it possible to create a system information resource.

The third level of applying systemic analysis includes the study of two systems: the full study of information collection as a system and the study of dichotomous analysis as a system. The set of these two systemic models gives the fullest processing of information and gaining knowledge on this basis.

Information units play an important role at all levels of research, especially at the second and the third ones. Any system includes elements as the smallest parts. Information units are elements of information systems. The thing is that these units can be different for different information processes: structural information units, information transmission units, semantic information units, educational information units and others.

System is and abstract notion [5, 7]. It is an attributive characteristic as it correlates with something. For instance, it can be the system of notions, the system of modules, the system of relations, etc. System can describe processes, phenomena, objects and their characteristics. The generality of notion "system" allows us to move knowledge gained with the help of different systems from one discipline to another.

The notion of system can have different descriptions and interpretations depending on the aspect of consideration. The aspect of description determines the number of factors taken into account and gives different options for the description of notion "system". Dichotomous (or more rarely – oppositional) analysis is based on identifying some characteristic and its opposite. It clearly differentiates some characteristics of an object. The simplest dichotomous analysis is performed in order to study one aspect of the studied object.

For example, the integrity aspect of system (S) as its ever-present characteristic [5] leads to its definition "System is something integral". When definition is used through the presence (absence) of one characteristic, it causes a dichotomous description in which the presence of integrity is marked 1 and the absence is marked 0. The presence of integrity is characterized as integrity=1. The absence of integrity – integrity=0.

This dichotomous consideration of system through the system attributes of integrity leads to the following description of system:

$$S=A(integrity=1) \quad (1)$$

We can introduce an opposite notion "non-system" (NS) for system [2]. For "non-system", the dichotomous approach gives the following description:

$$NS=A(integrity=0) \quad (2)$$

Description $S=A(1,0)$, where 1 means integrity and 0 means its absence, should be considered incorrect for two reasons:

- Firstly, system cannot contain two mutually exclusive system attributes: systemic and non-systemic.
- Secondly, system is defined through the system attributes of integrity, thus it cannot contain non-integrity.

Expression (1) is an obligatory but not sufficient condition for the presence of system. There can be several characteristics of that kind.

The dichotomous approach makes it possible to create a universal form of the condition for the existence of system through other systemic attributes of system. For example, the presence of connections between elements and subsystems of a system is an obligatory condition for the existence of this system. The presence of structure is also an obligatory condition for the existence of the system. For system attributes (SA) in the dichotomous analysis of object, there is the following expression (O):

$$S=O(SA=1) \quad (3)$$

This expression is interpreted the following way: "Object O is system S if it has all system attributes SA".

For "non-system" (NS), the dichotomous approach gives the following description:

$$NS=O(SA_i=0) \quad (4)$$

This expression is interpreted the following way: "Object O is "non-system" NS if it lacks for at least one attribute SA_i".

Expression (3) gives us the opportunity to identify system attributes. The system attributes of a complex system are attributes with dichotomous description characterized by such expressions as (3), and the opposite attributes are excluded for this system.

Dichotomous analysis allows us to use a "non-system" formula in order to clarify whether this notion refers to system or not. In accordance with expression (4), "non-system" can be anything that lacks for at least one (any) system attribute SA.

In addition to system attributes, system can also contain non-system attributes. For example, stratification is an optional attribute of system. This means that mutually exclusive non-systemic attributes can exist in a system:

$$S=A(stratification\ (1,0)) \quad (5)$$

Values (1,0) identify the truth area of arguments for expression (5). The presence of stratification (stratification=1) identifies the system as a stratified one. The absence of stratification (stratification=0) identifies the system as a not stratified one.

Expression (5) allows us to differentiate systemic and non-systemic attributes. If we find an attribute for which the presence or absence in system is possible, then such attribute is not a systemic one, according to expression (5).

Systemic dichotomous analysis makes it possible to make a distinguished boundary or difference between studied objects. Dichotomous analysis determines the difference between "system" and "non-system", "attribute" and "non-attribute", "object" and "non-object" and so on. Dichotomous analysis leads to oriental methods of cognition.

We should note the difference between European and eastern schools. European schools use direct reference to the object of study. Hence this method can be called a direct one. European schools give the attributes of "necessity" and "sufficiency". This type of education takes less time. If examined deeply it can be called a compulsory one. Such method is good for training soldiers.

Eastern schools use a method of comparison (indirect reference) in education. As a rule, they give one group of attributes – either "necessity" or "sufficiency". This method motivates a student to search for the other group of attributes by himself. It develops intelligence and creative abilities. However this method takes much more time.

Indirect reference was broadly used in many ancient Greek schools, for example by Diophantus whose works survived to the present day.

Zen Buddhism is quite interesting from the point of view of indirect study. The author is not either an adherent or an opponent of this teaching. In compliance with the foregoing, this means that attributes of Zen Buddhism are non-systemic for this article.

The study of Zen Buddhism shows that knowledge is passed from teacher to student not only by comparing objects but also by the examples of negating objects of other classes. This develops such student's abilities as searching for differences and essential features through the negation of secondary ones.

So, dichotomous analysis makes it possible to draw a line between systemic and non-systemic attributes, and between "system" and "non-system". Dichotomous analysis as such can be "non-systemic" (fragmentary) if it forms an integral and full complex for study.

In numerous works on systemic analysis, they pay much attention to factor "system" and less – to factor "non-system". From the point of view of dichotomous analysis, these factors are connected. That is why we use factor "non-system" in order to consider a number of incorrect definitions for the notion of system.

One of the drawbacks of notion "system" is connected with the one-sided or narrow consideration of system. Practically, any person can "invent" his own definition for system. However these definitions do not always meet the requirements of completeness. Let us consider a number of examples.

Example 1. "System is an organized multitude". The inaccuracy of this definition consists in the fact that every multitude is organized. The difference is in the degree of organization and in the method of organization. But not any multitude can be a system. For example, the multitude of whole numbers includes ordering relationships but does not include links. This definition is an example of indistinctness and incompleteness because it does not shows the clear difference between "system" and "non-system".

Example 2. "System is a set of things,

characteristics and relations". This definition is narrow because it does not contain the essential element of system – links.

Example 3. "System is a set of elements which form a structure and ensure a certain behaviour in environmental conditions.

$$S=(\varepsilon, ST, BE, E), \quad (5)$$

where ε is elements, *ST* is structure, *BE* is behaviour, *E* is environment".

This is a narrow definition because it does not contain the essential element of system – links.

Example 4. "System is a set of entrances, exits and states characterized by transition operator and exit operator:

$$S=(X, Y, Z, H, G), \quad (6)$$

where *X* is entrances, *Y* is exits, *Z* is states, *H* is transition operator, *G* is exit operator". This definition takes into account basic components studied in management and information management. This is a narrow definition because it does not contain the essential element of system – links.

Definitions considered above characterize system but they are not complete definitions.

The more tasks system has, the more parameters will be needed for its description.

Example 5. For organizational system [8], they use the following set of parameters taken into account wile defining the notion of system:

$$S=(PL, RO, RJ, EX, PR, DT, SV, RD, EF), \quad (7)$$

where *PL* is aims and plans, *RO* is external resources, *RJ* is internal resources, *EX* is executors, *PR* is processes, *DT* is disturbance, *SV* is control, *RD* is management, *EF* is effect.

We can use the following definition of system as a "generalized" one: system is a set of linked and interrelated elements which forms certain integrity, has a functional purpose and can be used to attain various aims.

Dichotomous systemic analysis makes it possible to identify all significant parameters by the successive steps of analysis. Such parameters are presented in expression (7). This analysis allows us to assess not only parameters of objects but also parameters of situations [9] and aims of systems [10].

The figure shows the scheme of dichotomous systemic analysis. At the first stage, we choose systemic attribute P_1. Then we analyze it for this attribute. The object of study is divided into two parts: "P_1" and "Non-P_1". Then we continue to analyze part "Non-P_1". As a result of the analysis we get part "P_2". If we find out that part "P_2" is compound, it is analyzed additionally. The additional analysis (shown by dotted line) detects constituents P_{21} и P_{22}.

The dotted line shows the possibility of such process and its optionality. After the analysis, part "Non- P_1 and P_2" remains at this stage. It undergoes further dichotomous analysis. At the final stage, we detect systemic attribute P_E and some remainder. We neglect this remainder because its influence on object's attributes is insignificant.

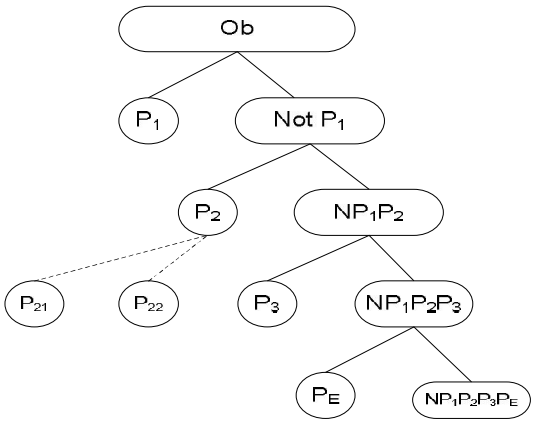

Figure. The dichotomous analysis of an object

After the analysis, in compliance with the scheme, the studied object will look like this:

$$Ob=F(P_1, P_2, P_3, \ldots P_E) \quad (8)$$

The scheme shown in the figure is called "a parse tree". This scheme helps to solve many problems. For example, if structure is a division criterion, parameters included in expression (8) will act as structural elements [11] for a complex system. In the structural analysis of information object, parameters included in expression (8) will act as structural information units [12]. In the semantic analysis of information object, parameters included in expression (8) will act as semantic information units [13].

Dichotomous analysis makes it possible not only to identify the systemic attributes of studied object but also to assess its complexity [14]. According to dichotomy, objects can be divided into groups "simple – complex".

Object is simple if its description corresponds to expression (8). Parameters included in expression (8) are called primary. The description of simple object turns out a linear passing through a parse tree. Object is complex if its primary

parameters include secondary parameters. For instance, if we substitute the dotted line in figure for a solid line, we will get the description of studied object in the following form:

$$Ob=F(P_1, P_2[P_{21}, P_{22}], P_3, \ldots. P_E) \quad (9)$$

The number of parameter included determines the level of complexity. For example, the level of complexity is equal to 1 in figure and expression (9).

Conclusion

The contemporary situation in the sphere of dichotomous analysis shows that the theory is considerably behind the practice. In practice, dichotomous analysis is often performed only in one subject area, without generalization.

Findings

Systemic dichotomous analysis is a tool for identifying the systemic attributes of studied object and for answering the question "is this object a complex system or not?"

Systemic dichotomous analysis gives us the opportunity to introduce alternative notions: "non-system", "non-object", "non-factor", etc.

The advantage of dichotomous analysis is the possibility to draw a clear line between "system" and "non-system", and between "attribute" and "non-attribute".

Systemic dichotomous analysis makes it possible to assess the complexity of a system with the help of parse tree and the degree of this complexity.

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