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Application of Cognitive Graphics Tools in Intelligent Systems

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***Abstract*— Development background of Cognitive Graphics Tools is briefly presented. The implemented method of matrix representation of data and knowledge intelligent systems is described. The main concepts and definitions are provided. The invariants of areas of concern, which we developed, various cognitive graphics tools for display and analysis of information structures, as well as regularities in data and knowledge, decision-making and the bases for decision justification are given. Application areas of cognitive graphics tools are identified. Directions of follow-up research are provided.**

***Index Terms*—cognitive tools, intelligent systems, decision-making and its justifications, intelligent training and testing systems, blended education and training.**

I. INTRODUCTION

The development of cognitive graphics tools started relatively recently, in the seventies of the XX century [1], [2]. Cognitive graphics tools allow representing the contents of the studied object or process on a computer screen. A cognitive graphics tool visually and clearly reflects the essence of a complex object (phenomenon, process), and is also capable of providing a fundamentally new decision (idea, hypothesis). As correctly indicated in the publication [2], a remarkable example of unequivocal use of cognitive graphics tools is Leonhard Euler's "logical circles", which are used to visually represent all basic sets and classes operations and to perform imaging of Aristotle's syllogistics. Thus, an important feature of cognitive graphics tools is targeted influence on the intuitive imaginative thinking mechanisms. Dynamism represented by tools of cognitive graphics, can effectively track the dynamics of the patterns of objects under investigation in time. Thus, cognitive computer graphics (cognitive graphics tools) allows visualizing the content of the problem of scientific interest, and activating "the researchers to actively search for new knowledge with usage of higher creative mechanisms of thinking" [2]. R. Axelrod [1], R.G. Basaker [3], D.A. Pospelov [4]–[6], A.A. Zenkin [7], [8], V.F. Khoroshevskiy [9], B.A. Kobrinskiy [10] made an important contribution in development of cognitive science. Namely they, who saw the potential of using cognitive tools in various problem areas, and despite the meager technical capabilities available at the time, took the first steps in the development of cognitive graphics tools, and thereby formed a new research direction [2], [7]. Creation of information technologies, based on the use of cognitive graphics tools, implemented in intelligent systems for decision-making of different problems in various concrete and interdisciplinary problem areas, is now greatly actual. It should be noted that, given the urgent necessity for the information technology and in spite of the relatively small time period of development of these tools, there are significant both scientific and practical results. The proposed investigation is not from scratch [1], [4]–[24]. Currently, cognitive graphics tools are widely used in different areas of information technology for solving various problems in concrete and interdisciplinary problem areas, such as medicine (diagnosis of diseases, treatment and preventive measures, rehabilitation of patients as well as solving organizational and managerial problems), education, geology, engineering, electronics, sociology, psychology, psychiatry; ecobiomedicine; ecogeology. Cognitive graphics tools are used in a variety of intelligent systems for analysis of information structures of knowledge and data, identification of different kinds of regularities in data and knowledge, and decision-making and decision justification, in intelligent training and testing systems for optimization of the learning process, for visualization and prediction of education process results, etc. Thus, the urgency to improve and develop new cognitive graphics tools is beyond question. It should be mentioned, that to create a cognitive graphics tool the latest technologies are used, which allows to obtain various cognitive tools: desktop applications, applications for smart phones and tablets, WEB-applications. This article describes an unusual matrix representation of data and knowledge which is used in a variety of intelligent systems for analysis of information structures of knowledge and data, identification of different kinds of regularities in data and knowledge, decision-making and decision justification. Basic concepts and definitions are introduced. Various invariant to the problem areas cognitive graphics tools, which we developed, are described and their areas of application are given. Directions of follow-up research are proposed.

II. PRINCIPAL CONCEPTS AND DEFINITIONS

For further survey, we use the definitions and concepts described in [15], [24]. Description object under study is set by a values population of features the number of which, as a rule, is essentially less than numbers of the characteristic features. A diagnostic test (DT) is a set of features that distinguishes any pair of objects that belong to different patterns. The DT is called "irredundant" (dead-end [25]) if it includes an irredundant amount of features. An irredundant unconditional diagnostic test (IUDT) is characterized by simultaneously presentation of all features of the object under study included in test, while decision-making. Diagnostic tests tolerant to measurement errors of characteristic feature

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values of the objects under investigation are called fault tolerant DTs. Regularities [24] are subsets of features with particular, easy-to-interpret properties that affect the distinguish ability of objects from different patterns that are stably observed for objects from the learning sample and are exhibited in other objects of the same nature and weight coefficients of features that characterize their individual contribution [26] to the distinguish ability of objects and the information weight given, unlike [27], on the subset of tests used for a final decision-making. These subsets can include constant (taking the same value for all patterns), stable (constant inside a pattern, but non-constant), non-informative (not distinguishing any pair of objects), alternative (in the sense of their inclusion in DT), dependent (in the sense of the inclusion of subsets of distinguishable pairs of objects), unessential (not included in any IUDT), obligatory (included in all IUDT), and pseudo-obligatory (which are not obligatory, but included in all IUDT involved in decision-making) features, as well as all minimal and all (or part, for a large feature space) irredundant distinguishing subsets of features that are essentially minimal and irredundant DTs, respectively. The weight coefficients of characteristic features are also included in regularities [26], as well as the information weight of characteristic features determined on the subset of tests used to find decision-making.

III. REPRESENTATION DATA AND KNOWLEDGE

We use unusual matrix model [15], [24] for representing of data and knowledge (learning sample consisting of object descriptions). The model includes an integer descriptions matrix (*Q*) and an integer distinction matrix (*R*). The matrix model of data and knowledge representation is given in Fig. 1. Rows of descriptions matrix *Q* is mapping objects from learning sample of a problem field. Columns of descriptions matrix *Q* is mapping integer characteristic features, which in set describe each object. The element q_{ij} of the matrix *Q* determines the value *j*-th feature for *i*-th object. Row q_i of the matrix *Q* is mapping object s_i ($i \in \{1, 2, \ldots, l\}$) where *l* is number of learning objects. A dash (–) in the respective element of the matrix *Q* shows that the value of the feature is not significant to the object. We give the interval of values for each feature z_j ($j \in \{1, 2, \ldots, m\}$).

$$
\begin{array}{c}
\quad z_1\ z_2\ z_3\ z_4\ z_5\ z_6\ z_7\ z_8\ z_9\ z_{10}\ z_{11} \qquad\qquad k_1\ k_2
\end{array}
$$

$$
Q=\begin{bmatrix}
1 & 4 & 6 & 3 & 2 & 2 & 1 & 2 & 3 & 4 & 1\\
4 & 4 & 5 & 2 & 3 & 2 & 7 & 8 & 3 & 4 & 1\\
3 & 4 & 5 & 3 & 3 & 2 & 4 & 5 & 3 & 4 & 1\\
3 & 4 & 4 & 1 & 4 & 4 & 2 & 3 & 1 & 5 & 1\\
2 & 4 & 2 & 1 & 6 & 3 & 4 & 5 & 2 & 3 & 1\\
2 & 4 & 5 & 1 & 3 & - & 4 & 3 & 1 & 2 & 1\\
1 & 4 & 3 & 2 & 5 & 2 & 1 & 2 & 3 & 4 & 1\\
3 & 4 & 2 & 2 & 6 & 2 & 2 & 3 & 3 & 2 & 1\\
5 & 4 & 2 & 2 & 6 & 3 & 5 & 6 & 2 & 4 & 1\\
4 & 4 & 6 & 1 & 2 & 5 & 5 & 6 & 1 & 4 & 2
\end{bmatrix}
\begin{matrix}1\\2\\3\\4\\5\\6\\7\\8\\9\\10\end{matrix}
\quad
R=\begin{bmatrix}
1 & 2\\ 1 & 2\\ 1 & 2\\ 2 & 1\\ 2 & 1\\ 2 & 1\\ 1 & 3\\ 1 & 3\\ 3 & 2\\ 3 & 2
\end{bmatrix}
\quad
R'=\begin{bmatrix}1\\1\\1\\2\\2\\2\\3\\3\\4\\4\end{bmatrix}
$$

Fig. 1. The matrix model of data and knowledge representation

Each row of the matrix *R* corresponds to the row of the matrix *Q* having the same index. Columns of the matrix *R* are mapping of distinction levels that is corresponding classification features. Classification features define the different mechanisms of objects partition into equivalence classes (mechanisms of classification). The element r_{ij} of matrix *R* sets a belonging *i*-th object to one of the selected classes at *j*-th mechanism of classification. The number of class is used for fact indication on the object belonging to this class. The set of all nonrepeating rows of the matrix *R* is compared to the number of selected patterns presented by the one-column matrix *R′* whose elements are the numbers of patterns. Elements of a pattern are the objects presented by rows of a descriptions matrix *Q*, associated to identical rows of a distinctions matrix *R*.

The matrix model provides for three types of distinction matrices [13], [24]:

1) Diagnostic type *(R1)* – with included mechanisms of classification.
2) Organization and management type *(R2)* – specifies a sequence of actions, for example, therapeutic and preventive measures.
3) Classification type *(R3)* – specifies independent mechanisms of classification, for example, the weight coefficients of various experts.

This model allows representing not only data but the expert knowledge, as one row of the matrix *Q* can be represented as a subset of objects in the interval form, which are characterized with the same final decisions, for the relevant rows of the matrix *R*.

The following regularities had been revealed on the matrices *Q* and *R* as is shown in Fig. 1:

1) z_2 is a constant feature.
2) z_3, z_4, and z_5 are obligatory features included in the kernel.
3) Features z_3 and z_5 are included in the first group of alternative features.
4) Features z_1 and z_8 are included in the second group of alternative features.
5) The feature z_7 depends on the feature z_8.
6) The feature z_{11} depends on the features z_1, z_4, z_6, and z_7, z_8, and z_9.

We use a binary matrix of tests (*T*) [26] to represent the constructed fault-tolerant IUDTs, with its columns matched to the columns of the matrix *Q* and the rows matched to tests. The binary matrix of tests is given on Fig. 2. Unit values in each row of the matrix *T* mark features which included in the test associated with this row.

$$
\begin{array}{c}
z_1\ z_2\ z_3\ z_4\ z_5\ z_6\ z_7\ z_8\ z_9\ z_{10}\ z_{11}
\end{array}
$$

$$
T=\begin{bmatrix}
1 & 0 & 1 & 1 & 1 & 0 & 1 & 1 & 0 & 0 & 0\\
1 & 0 & 1 & 1 & 1 & 0 & 1 & 0 & 1 & 0 & 0\\
1 & 0 & 1 & 1 & 1 & 0 & 1 & 0 & 0 & 1 & 0\\
1 & 0 & 1 & 1 & 1 & 1 & 0 & 1 & 0 & 0 & 0\\
1 & 0 & 1 & 1 & 1 & 0 & 0 & 1 & 1 & 0 & 0\\
1 & 0 & 1 & 1 & 1 & 0 & 0 & 1 & 0 & 1 & 0\\
1 & 0 & 1 & 1 & 1 & 1 & 0 & 0 & 0 & 1 & 0\\
1 & 0 & 1 & 1 & 1 & 0 & 0 & 0 & 1 & 1 & 0\\
0 & 0 & 1 & 1 & 1 & 0 & 1 & 1 & 1 & 0 & 0\\
0 & 0 & 1 & 1 & 1 & 0 & 1 & 1 & 0 & 1 & 0\\
0 & 0 & 1 & 1 & 1 & 0 & 1 & 0 & 1 & 1 & 0\\
0 & 0 & 1 & 1 & 1 & 0 & 0 & 1 & 1 & 1 & 0
\end{bmatrix}
\begin{matrix}1\\2\\3\\4\\5\\6\\7\\8\\9\\10\\11\\12\end{matrix}
$$

Fig. 2. Binary matrix of tests

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IV. VISUALIZATION OF INFORMATION STRUCTURE REPRESENTED BY DESCRIPTION AND DISTINCTION MATRICES

Further we present a cognitive tool for visualization of information structures, represented by description matrix (*Q*) and distinction matrix (*R*), in a tree-view form. This cognitive tool is necessary when the distinction matrix of diagnostic type is used (R_1), when in each case a subsequent column of the distinction matrix partitions a previous one into equivalence classes. Such specificity of data and knowledge representation is typical of medicine. Example of visualization of information structures represented by the description matrix and the distinction matrix of type 1 (R_1) is shown in Fig. 3. This cognitive tool is further development of cognitive tools given in [14], [23], [24].

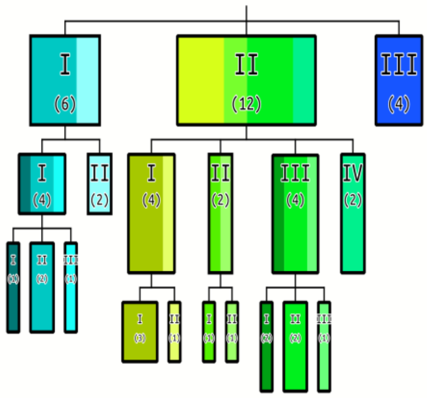
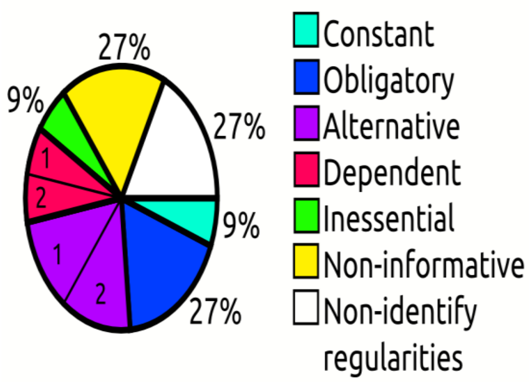


Fig. 3. Visualization of information structure

As shown in Fig. 3, each rectangle of a higher level of the hierarchy is partitioned into the number of rectangles painted in different colors, equal to the number of equivalence classes by the corresponding classification mechanism that allows to more clearly observe the distribution of the objects included in the corresponding equivalence classes [28]. In the present visualization, the number of the hierarchy levels for each equivalence class is equal to the number of classification mechanisms. It should be noted that two classification mechanisms (see matrix R) are used for the example, represented in Fig. 1. For better visual presentation of information structure the three classification mechanisms are presented on the example in Fig. 3. The height of the rectangles, corresponding to the equivalence classes in case of one classification mechanism is directly proportional to the number of these classes, and the width of the rectangles is directly proportional to the number of rows of description matrix. The first level of the tree structure (Fig. 3) shows three equivalence classes I, II, III according to the first classification mechanism. The second classification mechanism partitions the first equivalence class in case of the first classification mechanism into two equivalence classes - I, II; and the second equivalence class in case of the first classification mechanism into four classes of equivalence – I, II, III, IV. Partition according to the third classification mechanism is similar. Application of three cognitive properties, namely the height and width of the rectangles, colors to select different equivalence classes under the same mechanism of classification.

V. VISUALIZATION OF REGULARITIES IN DATA AND KNOWLEDGE

One of the main subsystems in intelligent systems is a knowledge optimization subsystem, designed to analyze the knowledge base for representativeness and consistency and to revealing various kinds of regularities, including finding the IUDT set providing distinctiveness of any pair of objects from the sample set belonging to different patterns. For this subsystem it is suggested to use a cognitive graphical tool which visualizes the relation between different regularities [13], [14], [17], [28], [24]. This cognitive tool is presented by a circular chart with groups of regularities and subgroups of some regularity, that is, dependent and alternative regularities (Fig. 4).



Group of			
Alternative		Dependent	
1	z3, z5	1	z7<= z8
2	z1, z8	2	z11<=z1, z4, z6, and z7, z8, and z9

Fig. 4. Diagram of regularities visualization

Each group of features is correlated with a sector of a circle, a central angle of which is directly proportional to the number of characteristic features of the corresponding group. Each sector is colored with preselected color. Also, sectors representing a set of alternative and dependent features are partitioned into groups by number of relevant regularities groups separated by a solid thin line. Characteristic features included in the regularities subgroup for alternative groups and dependent features are indicated under the circular chart.

The information legend with displayed regularities groups is right of the circular chart. Unfortunately, it is impossible to give the percentage for sectors representing a set of alternative and dependent features, as some characteristic features which are part of a set of alternative and dependent features may be common. The example in Fig. 4 visualizes the regularities listed in section III. A circular chart shown in Fig. 4, is a development of previous investigations [28] in plan of display detalization increase of regularities subgroups and information legends go with the circular chart.

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VI. COGNITIVE GRAPHICS TOOLS FOR DECISION-MAKING AND DECISION JUSTIFICATION

Further on, a detailed description of cognitive graphics tools used for decision-making and decision justification are considered.

A. Cognitive Tool Based on the 3-simplex

A cognitive graphics tool, based on a 3-simplex is appropriate to use both for decision-making and decision justification as well as to decision some of the following problems in intelligent training and testing systems. It is further development of investigation in [13], [15], [21], [24].

Visualization of data and knowledge, as well as decision-making and decision justification on the basis of a 3-simplex is based on the theorem of conservation of the sum of the distances from the point to the edges of the n-simplex and the relationship between these distances [11], [12]. Detailed description of visualization of objects in a 3-simplex is presented in [29]. Sample set and the object under investigation are visualized on the base of 3-simplex, as shown in Fig. 5.

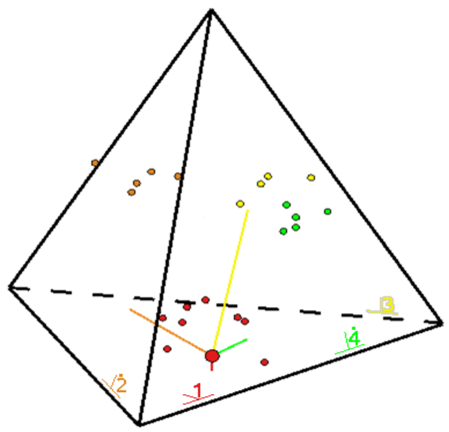

Fig. 5. Cognitive Tool Based on the 3-simplex

Since this figure displays the objects related to the four patterns, both the objects belonging to the corresponding pattern and the patterns are painted in different colors for better perception, as shown in Fig. 5:

1) *Pattern 1*, corresponded to the lower edge is painted in red.
2) *Pattern 2*, corresponded to the near left edge is painted in orange.
3) *Pattern 3*, corresponded to the distant edge is painted in yellow.
4) *Pattern 4*, corresponded to the near right edge is painted in green.

The same colors are used to display the distance from the object under investigation to the corresponding edge of the 3-simpex.

Points over the pattern numbers 2, 4 indicate that these 3-simplex edges are visible.

Objects from the sample set and the object under investigation are presented by filled circles of different sizes, the sample set objects have a smaller radius. Location of objects for rendering in a 3-simpex as shown, for example, in Fig. 5 is calculated by converting the space of features, describing these objects, into space of patterns [29]. The use of the 3-simplex allows to analyse the object under investigation for four patterns simultaneously, which is important for some subject areas, such as assessment of learning results, when using points 2, 3, 4, 5, which can not be achieved by applying the 2-simplex. An important advantage of a 3-simplex is a clear visualization of the dynamics of the process under investigation and visual comparison of the dynamics of different processes under investigation. However, a 3-simplex has a disadvantage compared to 2-simplex, as it may lose its visibility when displayed in the printed version, which lacks the possibility of interactive angle change available on the monitor screen. Next, the use of the 3-simplex for display of the results of the learning process will be considered. Examples of learning results visualization are given to demonstrate the dynamics of the process under investigation with usage a 3-simplex. Patterns 1-4 correspond to marks 2-5, which are given in depending on the learning result. This fact is presented in Fig. 6.

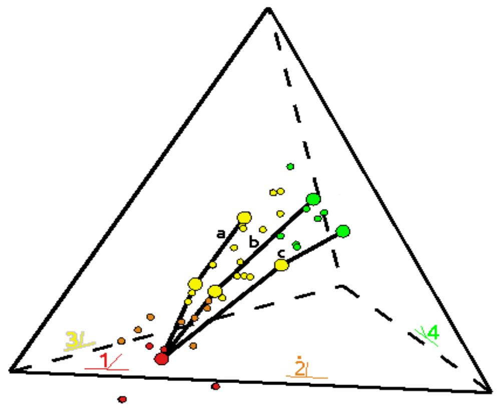

Fig. 6. Visualization of the dynamics in the-simplex

Fig. 6 demonstrates comparison of learning dynamics of three respondents (a, b, c) in the form of broken lines connecting the circles of larger radius, corresponded to the results of the test passing. Each respondent had three tests: before the learning course, after completing the most part of the course, after completing the entire course. The results of the first test are represented by one big red circle, because the respondents showed the same unsatisfactory result. Results of the second test clearly show differentiation of the respondents according to the learning rate: respondents *a* and *b* show approximately the same rate of learning, but the respondent *b* shows a slightly higher rate, while the respondent *c* demonstrates a significantly higher rate, which indicates a more successful learning process (closer to the excellent mark). This information form the basis of the forecast of the learning process dynamics. After passing the third test the respondent *a* receives a good mark, while the respondents *b* and *c* were given excellent marks. It should be noted that it is possible to predict this result of the respondents by increasing the number of the tests in the earlier stages. In addition to

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direct display of dynamics process, when using the 3-simplex, it is possible to present partitioning of dynamics of different processes under investigation into subgroups, which is also an important advantage of using a 3-simplex. It is appropriate to indicate such subgroups with different colors, for example, Fig. 7. Shows partition of different dynamics into 2 subgroups - red and green.

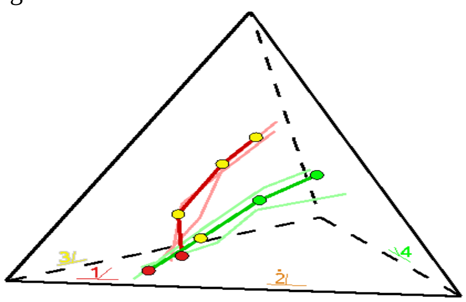

Fig. 7. Visualization of fragmentation in the 3-simplex

It should be mentioned that for better visual presentation, the dynamics of the process under investigation, which are the average rate of learning in the subgroup, are highlighted with brighter color in Fig. 7; for the remaining dynamics (in each of the subgroups) of the process under investigation, visualization of test results, marked with bigger circles, is omitted.

B. Cognitive Tool "Target with Display of Additional Dependencies"

A cognitive tool in the form of a circular chart partition into sectors displaying additional dependencies is proposed for intelligent systems to improve the visual presentation of the results dynamics of the process under investigation, for example, training. The proposed cognitive tool is designed to display various parameters of objects under investigation and the dynamics of the processes under investigation, and to compare them with each other. There can be multiple dependencies for each object: one from theirs for the main parameter under investigation and a few extra for the additional parameters interested for analysis of one or another process.

Fig. 8 and Fig. 9 demonstrate examples of cognitive visualization tools of learning results. Respondents (students) act as objects under investigation, and the result obtained by the respondent after the test passing as the main parameter. Additional observable parameters are:

1) Level of course attendance (blue dashed-dotted line).
2) Level of additional course attendance (green dotted line).
3) Amount of debts a student had the previous semester, for example, failed exams, tests, etc. (red solid line).

There are two different modes of visualization, which differ in the way of primary parameter dependence display. Visual appearance of a cognitive tool and a way of display of additional dependencies coincide in both modes. In case of the first visualization mode (Fig. 8), the circle is partitioned into sectors 360°/n, where *n* is number of objects under investigation (respondents). Each set of parameters recorded in a certain moment corresponds to an arc located in a sector corresponding to the object under investigation. Distance from the arc to the center of the diagram (arc radius) corresponds to the value of the main observed parameter. Each part of the sector, separated with an arc, has a color that is associated with the moment of registration of the parameters (see Fig. 8 Right - Passing Test Date). Dotted arcs indicate threshold values of the main parameter, which are necessary for an expert for decision-making (Balls Per Test), a bold dotted arc indicates the maximum value of the main parameter. Broken lines inside the sector correspond to the additional dependencies. The three additional dependencies are presented on the Fig. 8, but in this case, a maximum of two of them is present in each sector. The parameter value for each additional dependence corresponds to the angle located off clockwise from the start of the sector. Also Fig. 8 and Fig. 9 show the partition of the objects under investigation into groups according to various criteria, using bold lines located between the subgroups of the objects represented by the relevant sectors. Fig. 8 and Fig. 9 show the subgroups, partitioned according to the criterion of similarity of respondents' learning ability. This cognitive graphics tool is called "Target with the display of additional dependencies" what is stipulated to the similarity of a proposed target used to display the test results [30].

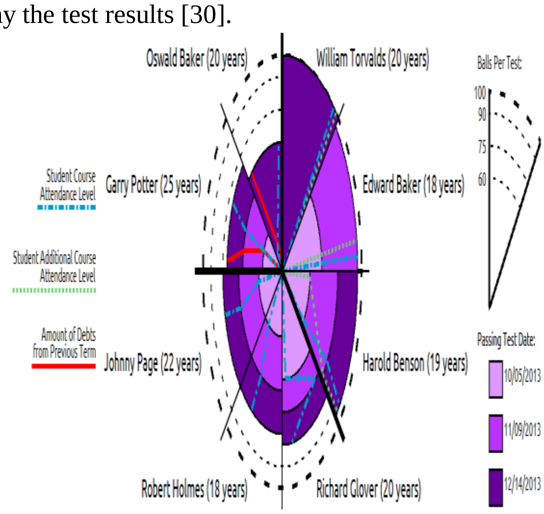

Fig. 8. Example of a cognitive tool for the first display mode

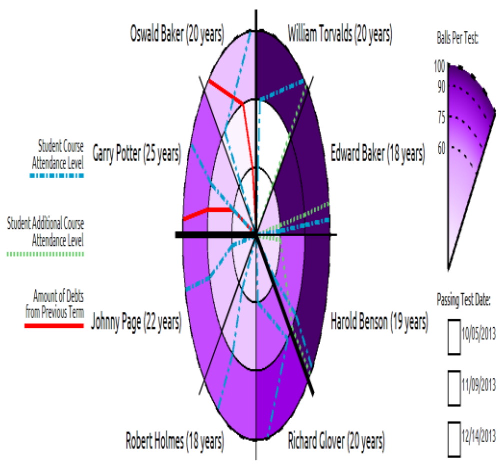

Fig. 9. Example of a cognitive tool for the second display mode

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Unfortunately, it may be difficult to observe additional parameters for some sets of initial data, in case there is a slight change in the main observed parameter (including data displayed in Fig. 8). The second visualization mode of cognitive tool is proposed (Fig. 9) to solve this problem.

The second mode repeats the first one except for two differences:

1) Distance from the arc to the center corresponds to the date of parameters registration. The distance between any adjacent arcs is equal.
2) The main parameter value corresponds to the color of the part of a sector, cut off by the corresponding arc.

Additional dependencies are displayed more clearly than in the first mode since all sectors now have the same and sufficiently large area. Unfortunately some accuracy in determining the values of main dependence parameters by an expert is lost.

Application of the proposed cognitive tool allows to:

1) Intuitively visualize the dynamics of change of the observed parameters in time.
2) Arrange objects under investigation and carry out their clustering according to certain criteria.
3) Display additional dependencies for each object under study.

VII. CONCLUSION

Improvement of cognitive graphics tools allowed visualizing information structures and presenting various kinds of regularities in more detail. More detailed visualization of information structure, i. e. matrix representation of data and knowledge, reveals more deep regularities in the data and knowledge. Cognitive properties of revealed regularities representation are expanded with new circular chart options developing, which allowed to visualize the regularities themselves more clearly. Analysis of such representation of revealed regularities activates "the researchers to actively search for new knowledge with the usage of higher creative mechanisms of thinking" [2]. The idea of original cognitive tool in the form of a 3-simplex, previously proposed by A.E Yankovskaya, have progressed. The use of a 3-simplex for visualizing and assessing the results of tests and monitoring the dynamics of learning process of each respondent, as well as all respondents from the same group was proposed for the first time. It allows partitioning the group into subgroups consisting of students with similar learning abilities.

A new cognitive graphics tool called "Target with the display of additional dependencies" was developed. Its application allows to:

1) Visualize the dynamics of change of the observed parameters in time.
2) Arrange observed objects and carry out their clustering according to certain criteria.
3) Display additional dependencies for each object under study.

The elaborated cognitive graphics tools are invariant to problem areas. The cognitive graphics tools, elaborated by us, are recommended to use for decision-making and decision justification, visualization of different kinds of regularities and new regularities revealing in data and knowledge in such areas as medicine, psychology, geology, as well as climatic zoning for road building, etc. The cognitive graphic tools developed by us will be implemented in intelligent training-testing systems and will allow forming criteria of learning success. Application of the intelligent training-testing system based on fuzzy and threshold logics and cognitive graphic tools, will allow to increase motivation of respondents to training, to stimulate respondents to active studying of disciplines related with a technical education, to increase quality of competences diagnosing results the respondents related with engineering activity, to present a new possibility of designing of an individual trajectory of training and development, to provide teachers with modern educational methods and tools, to increase quantity of respondents with high level learning rate. Further investigations are aimed at expanding the cognitive properties of cognitive graphics tools presented in this paper. The presented cognitive graphics tools are implemented as a research prototype. The presented cognitive graphics tools are implemented in software as visualization modules for intelligent instrumental software (IIS) IMSLOG [19], designed to revealing different kinds of regularities, decision-making and decision justification with the usage of graphics tools, including cognitive ones. The applied intelligent systems, including intelligent training and testing systems, intelligent information systems for road climatic zoning, intelligent system for diagnostics and intervention of organizational stress, as well as diagnostics and prevention of depression will be constructed on the basis of IIS IMSLOG.

VIII. ACKNOWLEDGMENT

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