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INFORMATION TECHNOLOGY AND PRAGMATIC ANALYSIS

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Abstract. Similarity method has been in science for several centuries. The basis of the study is closely connected with mathematical linguistics. This approach has allowed obtaining new results in the analytical geometry, which, in turn, is used in different applications in information technology. The results are described briefly. Binary relations in linguistics and geometry are compared with the position of system analysis. The modified hypothesis of space as a binary structure is put forward on the basis of singular linear transformations. The hypothesis of the human sensory system is given shortly. Architecture computing appliance for solving this class of problems is proposed. The modified method is also applied in pattern recognition. The presence of symmetry in natural languages is shown briefly.

Keywords: Symmetry, characteristic equation, singular transformations, sensor system, binary relations

Mathematics Subject Classification 2010: 68T30, 93A10, 51N20

1 INTRODUCTION

The software and hardware of the computer are determined by the theory of automata. Semiotic analysis of formal languages is the basis for software. There are two approaches to semiotic analysis, distinguished by the number and structural components: a proposal of Academician A. P. Ershov [1] and the theory of the American mathematical linguists [2]. Theory of formal languages involves three stages of semiotic analysis: morphological (lexical), syntactic and semiotic ones. Ershov does not share the analysis of the first two stages and offers another – pragmatic option. A group of scientists called "pragmatics is research" exists among Scandinavian information technology scholars. Pragmatic analysis as a method of study might not be supported, but the author's team uses it for a long time.

Linguists of natural languages offer the following definition of pragmatics: pragmatos (from Greek = business, action) is a branch of science (semiotics, linguistics) studying the functioning of linguistic signs in speech. We will expand the scope of this definition to information technology and not just linguistics. In fairness, we note that Ershov's structure was for the first time proposed by Charles Morris [3]. There is a distinction between the purpose of the work of Morris and Ershov. Morris developed linguistics and philosophy and Ershov wrote works for its actual implementation using a computer.

Modern linguists and scholars in the field of cognitive research divide pragmatics into two components: functional analysis (natural language, not mathematics) and directly pragmatic analysis [4]. Tasks of functional analysis are mathematically coinciding with the objectives of algebra. We have a lot of algebra in mathematics and information technology, such as universal, relational, etc., so this stage of solving problems is redundant for mathematical methods. Absolutely new knowledge to obtain is a complex process. It is hard to compete with a genius of the previous centuries. Let us try to get new results based on work from earlier ages and compare them with those of the XX century.

Main studies postulate ideas, following Galileo's quote: Mathematics is the language in which God has written the universe. Semantics moved from the last word to the entire aphorism. Similarity method of Leibniz allowed making a lot of discoveries in various fields of science, but it has been forgotten nowadays. H. Weyl argued that the similarity method is based on symmetries. Galileo's aphorism with Weyl-Leibniz's addition in the current study can be formulated like: the automorphisms of the space define the knowledge, on the basis of which the universe is built. But this idea is not a new one. Einstein said that his research is based on the harmony of the world. Analytic geometry was chosen as the base of research for its simplicity, accessibility and allowing multiple applications.

2 SEMIOTIC ANALYSIS OF MACHINE BUILDING DRAWING

The method was described first for applying to the problems of verifying vector geometric model after input from the digitizer in the early 80s. It singled to consider machine building drawing as a text. V. A. Zvegintsev proposed the levels of natural language study in linguistic semantics in the classical linguistics. He singled seven levels [5]: a sentence, phrase (syntagma), word, morpheme, syllable, phoneme, and a distinctive feature. The text (discourse) is included additionally as the eighth level of the synthesis. The second most important result of this study is the idea of binary structure of the levels of study. Structure with six levels of study of machine building drawing language was proposed on the Zvegintsev's basis [6]: a drawing, form, cut, geometric shape, point, and a hypercomplex number or scalar. The geometry and pattern recognition theory can alternate in the structure each by each. The method of semiotic analysis by A. P. Ershov interpretation is chosen for solving the verification problems. The means is the most powerful method of artificial intelligence according to the authors. The method is dividing into three components [1]: syntax, semantics and pragmatics. Semantics studies the relation of the structures on different levels. Communication construction of the language with the text subject is called pragmatics. All sections are combined in semiotics. An additional level is considered in natural languages and theory of programming languages [2]. The structure of the language by Zvegintsev was used to communicate with the computer in the natural language [5]. These assumptions were used for mechanical drawing language. The rule was allocated to resolve uncertainties [6] of the study structure. Each level of the study with the number was semantically related to the level and it is the rule of the relations of levels. The law applies to artificial intelligence and could not be proved in the last century. This rule and semiotic analysis are allowed both to conduct research on semiotics of language drawings and solve the problems of clarifying the geometric model.

Let us consider any area of knowledge $\mathbf{K}$. Let us propose that knowledge was produced on two theories: $\mathbf{K'}_1$ and $\mathbf{K'}_1$. Let the theory $\mathbf{K'}_1$ have of study levels $\mathbf{L}_{ij}$, where i is a number of theory, j is a routine number of study levels. The question is how to deduce new knowledge from the existing knowledge. This question is solved by the methods of logical deduction, anthologies, etc., but the relationship between knowledges has not been identified so far. Completeness and consistency of the acquired knowledge is tested poorly. Incomplete knowledge of the initial theories also can adversely affect the output. Check the completeness of the basic theory, the generation of new knowledge, and and we get the relations between different theories offered by the similarity method. The levels of the study can be further detailed and explained by various mathematical descriptions. Let any binary normalisation f be applied to the rule $\mathbf{L'}_{ij}$ so that $\mathbf{L'}_{ij} = f(\mathbf{L}_{ij})$, where $\mathbf{L}_{ij} \in B$, B is the Boolean lattice. Nowadays, the structural linguistics may be used to the study levels (symmetries in Euclidean plane) $\mathbf{L'}_{ij}$ by Zvegintsev's interpretation. Relationships of $\mathbf{L'}_{1j}$ and $\mathbf{L'}_{2i}$ is the main question in theory $\mathbf{K}$.

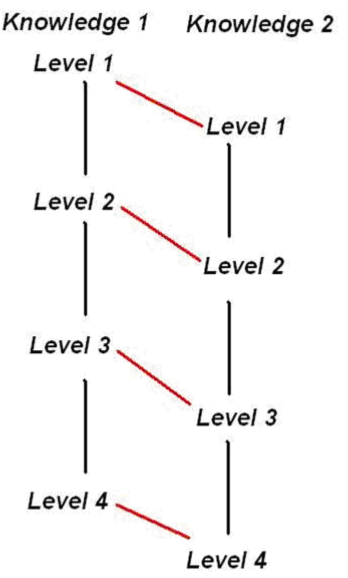

Figure 1. Knowledge symmetry

We may suggest that the study levels in generic theory $\mathbf{K}$ are positioned by law: $\mathbf{L'}_{11}$, $\mathbf{L'}_{21}$, $\mathbf{L'}_{12}$, $\mathbf{L'}_{22}$, $\ldots$, $\mathbf{L'}_{1i}$, $\mathbf{L'}_{2i}$ (knowledge symmetry Figure 1) with the analogy of H. Weyl transfer symmetry [7]. Any rule $\mathbf{L'}_{ji}$ is unique. The practical use of it shows that if the cardinality of a set is different then the addition rules appear in law: $\mathbf{L'}_{11}$, $\mathbf{L'}_{21}$, $\mathbf{L'}_{12}$, $\mathbf{L'}_{22}$, $\ldots$, $\mathbf{L'}_{1m}$, $\mathbf{L'}_{2n}$, where $m \neq n$. Let us define the rule of equality of power studying level $m = n$ by simplifying. Study level $\mathbf{L'}_{ij}$ for knowledge area $\mathbf{K_i}$ may be defined in another descriptive language. This notation seems to be distant from mathematics.

Therefore, syntax rules must be formulated:

1. Binary rule $\mathbf{L'}_{ij} \in B$;
2. Rule of definition punctuality. For example, the rule of accessories of an element in the set by Fraenkel. ZFC-axiomatics (Zermelo-Fraenkel-Curatowski) follows from this notation.
3. Implication rule: $\mathbf{s}_{ijk} \to \mathbf{s}_{ij+2m} = 1$, where semantic rule $\mathbf{s}_{ijk} \in \mathbf{L'}_{ij}$.

The structure of knowledge symmetry is very similar to the structure of DNA but one can understand more of it once it was discovered for the first time in nature. Analytic geometry does not allow solving all problems to increase the accuracy of geometric modeling. The differential and algebraic geometry helped only in minor matters. Authors present the theory of analytic geometry from the standpoint of artificial intelligence and relational algebra. Let us try to consider the symmetry from a new viewpoint.

3 AUTOMORPHISM OF KNOWLEDGE AS THE MAIN SYMMETRY

Axioms for Euclidean plane was formulated by Hilbert. He suggested that the construction of linguistic rules must be considered additionally. We obtain the Euclidean plane as a text by analogy with semiotic analysis of drawings according to Leibniz's method of similarity. Levels of study of the text are internal relations in plane. The following basic postulates were used: permutation, mirror, and unitary matrix symmetries by Dieudonne [8]; table automorphisms and transfer symmetry by H. Weyl [7]; definition of symmetry by M. Born [9]; and binary automorphisms by F. Bachmann [10].

Cartesian product was studied within limits of ZF-set theory (Zermelo-Fraenkel) because the set $\{\langle x, y\rangle, x\}$ created asymmetry in $\mathbf{R}^2$. Let us consider the ZFC-theory of sets without Curatowski's axiom. This theory was used in many applications quite a few times, but this supposition is in conflict with ZF-theory due to its primary property: connections by Codd and set by A. Fraenkel. ZF-theory was built from the automorphic rule $a \in A$ [12]. This rule is senseless without relation $\in$. The relational algebra is not used if $A \equiv \emptyset$. Therefore, relational algebra is the part of ZFC-theory.

The Euclidean plane is a relation table. The proof is easy, because relation algebra can work with both finite and indefinite tables. The conduct of symmetry was considered by relation algebra and semiotic analysis. Application of the method to the Dieudonne automorphisms shows that binary symmetry belongs to two mathematical disciplines: the set theory and the universal algebra.

Extended table of Dieudonne symmetries was built on the basis of knowledge symmetry and relational algebra:

1. Existence of set ($A \neq \emptyset$ Zermelo).
2. Existence of relation ($a_1 \mathbf{R} a_2$ Codd).
3. Membership element of set ($a \in A$ Fraenkel).
4. Universal relation ($f : \Omega \to \Omega'$ implication).
5. Linguistic description of the set (Descartes).
6. Linguistic presentation of the relation (Descartes).
7. Perdurability cardinality ($\mathbf{m}(A) = const$ Lagrange).
8. Perdurability power relations ($n = const$ in $C_1 x^n + C_2 y^n + C_3 x^{n-1} y^{n-1} + \ldots + C_{k-1} x + C_k y + C_0$ Klein).
9. Linguistic order ($\vec{v} = xi + yj + zk + w$ Hamilton).
10. Mathematical order ($a_i \prec a_{i+1}$, where $a_i, a_{i+1} \in \mathbf{R}$ Cantor).
11. Permutation ($a_i \leftrightarrow a_j$).
12. Mirror ($a_i \bullet -1 = -a_i$).

Since the connection between automorphisms 10 and 12 was for the first time opened by Gilbert, the symmetry of structure symmetries (knowledge) may be named in his honour. Gilbert opened the structural properties of symmetry, and Euler's formula $e^{i\pi} = -1$ is to determine the relationship between them in universal algebra. The main feature of the table is a hierarchy. The higher symmetries determine the manifestations of lower automorphisms. Symmetry with numbers one and two are combined on the plane in the unitary matrix. The unitary features are derived from this.

The table joined symmetries by Dieudonne (1, 2, 11, 12) and Weyl (10). Zvegintsev proposed to consider the floors for dividing the levels in the semantic load. The first floor is the floor of existence. It combines the first four symmetries and flows out of the unitary matrix. The last four automorphisms can be combined as numeric. Their influence on the plane (space) is particularly bright. Middle symmetries do not have a unifying semantics. It can be assumed that there may be more automorphisms. The presence of additional symmetries follows from the discovery of Klein (automorphism 8) and is confirmed by Klein's and Born's invariants theory. The completeness of the symmetries system may be insufficient. Additionally, we have noted an important property of the table that a dual symmetry is arranged twice in each floor.

Thus, mathematical linguistics, relational algebra and structural linguistic analysis allowed defining new types of symmetry. Let us try to analyse how accurately the new symmetries describe the nature. The analysis should begin obviously with the analytical geometry.

4 APPLICATION IN ANALYTIC GEOMETRY

One of the biggest problems in the geometry which has a wide application in science and engineering is to find the solution of the characteristic equation $\mathbf{T}\vec{v} = \lambda \vec{v}$, where

$\mathbf{T}$ – the matrix of transformations, $\vec{v}$ – vector, λ – set of scalar. The solution of the characteristic equation is required for many sciences. It is particularly important in cryptography.

A proper angle of rotation of the quadratic form α for the linear transformation is usually considered. Mirror symmetry is determined by the set $\mathbf{R}$, and there is no permutation symmetry. Permutation symmetry is determined on a direct $x = y$ on plane. Hence the angle α exists with this direction for the angle β by symmetry. The set of unit vectors along these angles gives its own non-orthogonal basis (Figure 2).

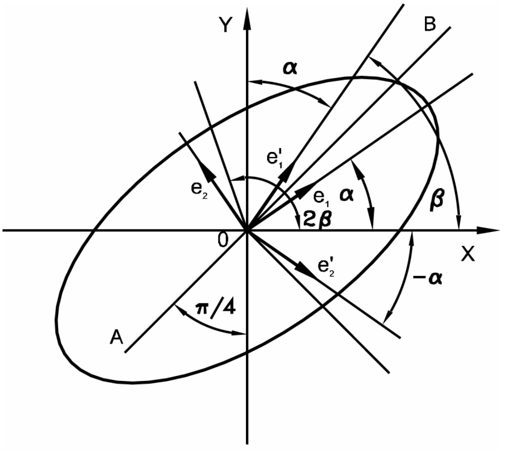

Figure 2. Own non-orthogonal basis

The symmetries table is combined of the two sciences, so there are two methods for solving the trajectories calculation. Direct analytical method of linear transformations of central symmetric conic sections was found [13, 14]. Elliptic and hyperbolic trajectory can be calculated using non-projective transformations by the classical method [15] or direct analytical method. Non-projective solutions for Jordan curves are absent.

Let there be an arbitrary figure Φ – Jordan curve in the Euclidean plane $\mathbf{R} \times \mathbf{R}$ in a Cartesian coordinate system defined by the parametric equation

$$\begin{cases} x = f_x(t), \\ y = f_y(t) \end{cases} \tag{1}$$

where $x, y, t \in \mathbf{R}$, $t \in [-\pi, \pi]$. Functions $f_x(t)$ and $f_y(t)$ are piecewise continuous. If the equation's figure is defined $y = f(t)$, it is always possible to write $\begin{cases} x = t \\ y = f(t) \end{cases}$. Class of shapes defined only by the implicit function $F(x, y) = 0$ will be not considered in this research. We carry out any transformation of the figure Φ defined by the matrix $\mathbf{T} = \begin{pmatrix} a & h \\ g & b \end{pmatrix}$, where $a, b, h, g \in \mathbf{R}$. It is necessary to obtain the parameters of the transformed figure (to solve the characteristic equation).

Let us consider the solution of the characteristic equation for the centre symmetric conical sections, where the own α angle takes the form [15]:

$$\tan 2\alpha = \frac{2\,(bh + ag)}{(a^2 + h^2) - (b^2 + g^2)}. \tag{2}$$

Parameters semiaxes are considered as difficult using the classical method since they represent a radical dependence.

A new direct analytical method for the linear transformation was proposed earlier. It is free from radicals, so it is more simple and accessible for further mathematical derivations. The method is based on the permutation symmetry and other symmetries [8, 14].

We calculate the angle β

$$\tan 2\beta = \frac{2(gb + ha)}{a^2 - h^2 - b^2 + g^2} \tag{3}$$

in the first step. The angle α is determined from the two equations

$$\tan \alpha_1 = \frac{a \tan \beta - h}{b - g \tan \beta} \tag{4}$$

and

$$\tan \alpha_2 = \frac{b \tan \beta + g}{a + h \tan \beta}. \tag{5}$$

Angles are equal if the calculation and transformation are correct. The coefficients $\lambda_1 = \lambda_2 = d$ are equal

$$c_1 = \frac{a \cos \beta + h \sin \beta}{\cos \alpha} \tag{6}$$

and

$$c_2 = \frac{b \sin \beta + g \cos \beta}{\sin \alpha}, \tag{7}$$

$$d_1 = \frac{a \sin \beta - h \cos \beta}{\sin \alpha} \tag{8}$$

and

$$d_2 = \frac{b \cos \beta - g \sin \beta}{\cos \alpha}. \tag{9}$$

The initial system will be: $\begin{cases} x = c_1 \cos(t + \alpha) \\ y = d_1 \sin(t + \alpha) \end{cases}$ and $\begin{cases} x = c_2 \cos(t + \alpha) \\ y = d_2 \sin(t + \alpha) \end{cases}$. Both solutions are valid and the choice is not necessary. Semiaxes are equivalent $c_1 = c_2$

and $d_1 = d_2$. For example, let us consider the motion of a point located outside the axis of a flat rod. The system of equations describing the motion of the third point is $\begin{cases} x = e\cos t + c\sin t \\ y = c\cos t + (d-e)\sin t \end{cases}$, where d – crank length, e, c – coordinates of the point (x, y) in the coordinate system of the flat rod. Solution using proposed method is $\begin{cases} x = (d - e + c\cot\alpha)\cos(t+\alpha) \\ y = (e - c\cot\alpha)\sin(t+\alpha) \end{cases}$ and $\begin{cases} x = (e + c\tan\alpha)\cos(t+\alpha) \\ y = (d - e - c\tan\alpha)\sin(t+\alpha) \end{cases}$, where $\tan 2\alpha = 2c/(2e-d)$.

Solution using classical method for the transformation matrix $T = \begin{pmatrix} e & c \\ c & d-e \end{pmatrix}$ by the inverse matrix $T^{-1} = \frac{1}{\det T}\begin{pmatrix} d-e & -c \\ -c & e \end{pmatrix}$ is $\begin{cases} x = \lambda_1\cos(t+\alpha) \\ y = \lambda_2\sin(t+\alpha) \end{cases}$ or $\begin{cases} x = \lambda_2\cos(t+\alpha) \\ y = \lambda_1\sin(t+\alpha) \end{cases}$, where $\lambda_{1,2} = \frac{d \pm \sqrt{d^2 - 4((d-e)e - c^2)}}{2((d-e)e-c^2)}$. Angle α is not changed.

As can be seen from the results, the proposed method allows to be used in subsequent calculations easily. For example, for solving differential equations.

Unfortunately, general solution for Jordan curve could not be obtained. The solution may be found when four systems are obtained [16]. The characteristic parametrical system $\mathbf{T}\vec{v} = \lambda\vec{v}'$, where $\mathbf{T}$ – matrix of transformations, $\vec{v}$ – vector, λ – set of scalar, is used in many fields of science, such as mechanics, physics, economics, cryptography, etc. The main result of research by the authors is the vector's belongs $\vec{v}' \in \left\{ \begin{pmatrix} x \\ y \end{pmatrix}, \begin{pmatrix} -x \\ -y \end{pmatrix}, \begin{pmatrix} y \\ x \end{pmatrix}, \begin{pmatrix} -y \\ -x \end{pmatrix} \right\}$. The result of the conversion depends on the permutation and mirror symmetries. We continue to study the general case [16]. Point change direction is reversed for some linear transformation additionally. Geometric modeling transformations were carried out separately (Figure 3). The calculation method is verified on mechatronic systems in the laboratory [16, 17, 18, 19].

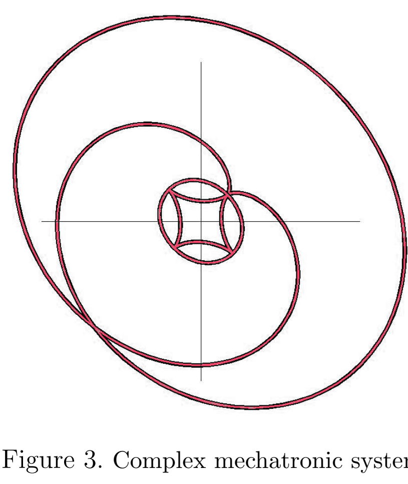

Figure 3. Complex mechatronic system

5 SINGULAR TRANSFORMATIONS

The differences between the methods are described in references [20]. Singular conversions are paramount. The confluent conversion transforms the plane in a straight line [15]. This definition by Efimov allows distinguishing six groups of linear transformations: $S_1 = \begin{pmatrix} a & a \\ b & b \end{pmatrix}$, $S_2 = \begin{pmatrix} a & b \\ a & b \end{pmatrix}$, $S_3 = \begin{pmatrix} 0 & a \\ 0 & b \end{pmatrix}$, $S_4 = \begin{pmatrix} a & 0 \\ b & 0 \end{pmatrix}$, $S_5 = \begin{pmatrix} a & b \\ 0 & 0 \end{pmatrix}$, $S_6 = \begin{pmatrix} 0 & 0 \\ a & b \end{pmatrix}$, where $a, b \in \mathbf{R}$ and $a, b \neq 0$. Groups define the singular transformation of universal algebra automorphisms.

Theorem about algebraical singularity 1. Any singular transformation in geometry algebraic branch of arbitrary figure - Jordan curve belonging to the plane described by the parametric system of equations with continuous functions defined on the interval of the real axis, transforms this figure in a straight line, a straight line segment, or a ray.

Proof. Let there be an arbitrary figure Φ to be the Jordan curve in the Euclidean plane $\mathbf{R}^2$ in a Cartesian coordinate system defined by the parametric equation. Functions $f_x(t)$ and $f_y(t)$ are piecewise continuous.

Let us apply singular transformation $S_1 = \begin{pmatrix} a & a \\ b & b \end{pmatrix}$, $S_2 = \begin{pmatrix} a & b \\ a & b \end{pmatrix}$, $S_3 = \begin{pmatrix} 0 & a \\ 0 & b \end{pmatrix}$, $S_4 = \begin{pmatrix} a & 0 \\ b & 0 \end{pmatrix}$, $S_5 = \begin{pmatrix} a & b \\ 0 & 0 \end{pmatrix}$, $S_6 = \begin{pmatrix} 0 & 0 \\ a & b \end{pmatrix}$, where $a, b \in \mathbf{R}$ and $a, b \neq 0$.

Let us consider the transformation $S_1 = \begin{pmatrix} a & a \\ b & b \end{pmatrix}$. The resulting system of equations is $\begin{cases} x' = af_x(t) + af_y(t) \\ y' = bf_y(t) + bf_x(t) \end{cases}$, $\begin{cases} x' = a(f_x(t) + f_y(t)) \\ y' = b(f_y(t) + f_x(t)) \end{cases}$. Let us consider three arbitrary parameter values $t \in \{t_1, t_2, t_3\}$, where $t_1 \neq t_2 \neq t_3$, and substitute them in the system. Let us choose the settings so that the function $f_x(t_i)$ and $f_y(t_i)$ had no breakage and parameters $t_j \neq t_k$ were not equal to each other. Let the function $f(t)$ to be the sum of functions $f_x(t) + f_y(t)$, then the coordinates of the points will be given by the vectors $v_i = \begin{pmatrix} af(t_i) \\ bf(t_i) \end{pmatrix}$. If we take the result of the conversion to get a straight line, then any three points lie on it and the determinant $\begin{vmatrix} x_2 - x_1 & y_2 - y_1 \\ x_3 - x_1 & y_3 - y_1 \end{vmatrix} = 0$. We form the determinant D of the obtained $D = \begin{vmatrix} af(t_2) - af(t_1) & bf(t_2) - bf(t_1) \\ af(t_3) - af(t_1) & bf(t_3) - bf(t_1) \end{vmatrix}$. Let us disclose the determinant: $D = \begin{vmatrix} a(f(t_2) - f(t_1)) & b(f(t_2) - f(t_1)) \\ a(f(t_3) - f(t_1)) & b(f(t_3) - f(t_1)) \end{vmatrix}$, $D = a(f(t_2) - f(t_1))b(f(t_3) - f(t_1)) - a(f(t_3) - f(t_1))b(f(t_2) - f(t_1))$, $D = ab((f(t_2) - f(t_1))(f(t_3) - f(t_1)) - (f(t_3) - f(t_1))(f(t_2)$

$- f(t_1)))$. The determinant is $D = 0$. Consequently, a straight line is obtained by a singular transformation $S_1 = \begin{pmatrix} a & a \\ b & b \end{pmatrix}$ always.

Let us consider the kind of figures obtained after the conversion. Values in line coefficients are expressed by the determinant $\begin{vmatrix} af(t_2) - af(t_1) & bf(t_2) - bf(t_1) \\ x - af(t_1) & y - bf(t_1) \end{vmatrix} = 0$, $(af(t_2)-af(t_1))(y-bf(t_1))-(x-af(t_1))(bf(t_2)-bf(t_1)) = 0$, $(af(t_2)-af(t_1))y-bf(t_1)(af(t_2) - af(t_1)) - (bf(t_2) - bf(t_1))x + af(t_1)(bf(t_2) - bf(t_1)) = 0$, $a(f(t_2) - f(t_1))y - b(f(t_2) - f(t_1))x = 0$. We turn out a few equations of lines for different values of the parameters t_1 and t_2, since the coefficients depend on the magnitude $f(t_2) - f(t_1)$. This problem is solved, if we consider the normal equation of the line, which in this case would be $\frac{a}{\sqrt{a^2+b^2}}y - \frac{b}{\sqrt{a^2+b^2}}x = 0$.

Coordinate of a point t_0 different from the point t_1 by a small amount ε such as $f_x(t_0) - f_x(t_0 + \varepsilon) = \varepsilon_x$ and $f_y(t_0) - f_y(t_0 + \varepsilon) = \varepsilon_y$, where ε_x and ε_y are small quantities, define by linearly dependent conversion S_1 for functions $f_x(t)$ and $f_y(t)$ on the continuous range $[t_2, t_3]$.

Let us consider the difference in the coordinate x is $x_{t_0} - x_{t_1} = a(f_x(t_0) + f_y(t_0))-a(f_x(t_1)+f_y(t_1))$, $x_{t_0}-x_{t_1} = a\left((f_x(t_0) - f_x(t_0 + \varepsilon)) + (f_y(t_0) - f_y(t_0 + \varepsilon))\right)$, $x_{t_0} - x_{t_1} = a(\varepsilon_x+\varepsilon_y)$. The difference coordinate y similarly to be equal to $y_{t_0} - y_{t_1} = b(\varepsilon_x + \varepsilon_y)$. Since $\varepsilon \approx \varepsilon_x \approx \varepsilon_y$ then $x_{t_0} - x_{t_1} \approx 2a\varepsilon$ and $y_{t_0} - y_{t_1} \approx 2b\varepsilon$. Let us select an infinitely small ε, so that $1/\varepsilon \gg 2\max(a, b)$. It follows that the line differential is not equal to the differentials of functions $f_x(t)$ and $f_y(t)$, but a sequence of points is provided. Like in previous reasoning, if there is a parameter t_0 to the function $f_x(t)$ or $f_y(t)$ in which at least one function has a break, get a direct break at the point $x = a\left(f_x(t_0) + f_y(t_0)\right)$ and $y = b\left(f_x(t_0) + f_y(t_0)\right)$.

Branch proved for a singular transformation S_1. The proof is similar for the other groups. The full text of the theorem is presented by Theorem 2 [21]. □

We have not reviewed the singular groups $S_7 = \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix}$ and $S_8 = \begin{pmatrix} \infty & \infty \\ \infty & \infty \end{pmatrix}$. These groups will transform the figure into a point. The zero rates is manifested in different ways in the singular transformations. Therefore two groups are proposed.

Bachmann proposed to consider automorphisms of the binary, but the binary relations are absent in the classical axioms of Euclidean space. Let us consider the function of the algebra of statements by their properties. We assign a variety of functions to the first subset $BF_1 = \{x, y, \bar{x}, \bar{y}, x \oplus y, x \equiv y, 0, 1\}$. They depend only on a single utterance. Truth and false are not dependent on the statements, but we will consider them as belonging to this set. Power of the first subset is equal to 8. Let us consider that all other functions belong to the second set BF_2. A second plurality of power is equal to the first power.

Let us look at the singular transformations of universal algebra branch in information – linguistic interpretation of the geometry [13, 21]. Automorphisms trans-

Value	Function Name	Dependence on Two Variables
0	Identical zero	no
1	Pierce's arrow	yes
2	Inversion of direct implication	yes
3	Inverse of the second operand	no
4	Inversion reverse implication	yes
5	Inversion of the first operand	no
6	Excluding or	no
7	Sheffer's stroke	yes
8	Conjunction	yes
9	Equivalence	no
10	First operand	no
11	Backward implication	yes
12	Second operand	no
13	Implication	yes
14	Disjunction	yes
15	Tautology	no

Table 1. Boolean functions

form any curve in a couple of lines (line segments, rays) in the plane. Let us look at the properties of a given set of functions in detail. Each function is subject to the law, and then there is a symmetry in the classical definition. The result of the singular transformation of the curve in the geometry set-theoretic branch depends on the type of the curve. The number of elementary functions (line, trigonometric function, shot, etc.) is limited and less than 8, which makes the discovery of new elementary functions possible. Thus, it is possible to build a much-to-one correspondence between the propositional algebra and singular linear transformations in their properties, algebra utterances take features of a single point in space. The theoretical basis of a computer are algebra statements. Since $\mathbf{R}^0 = \mathbf{Z}^0 = \mathbf{C}^0 = \ldots$ then a computer can work with different types of data: numbers, text, images, etc. The versatility of a computer prevents effective way of recognition, which is doubled at least.

Let us consider the dependence of Boolean two-place functions on the number of operands in more detail (Table 1). The structure of the table for this parameter differs from the table of automorphisms of the Euclidean plane at first glance. Let us assume that Boolean functions are located in three-dimensional space. Let their order determine a double helix similar to the DNA structure. Then the non-orthogonal projection onto some plane gives an alternation similar to the automorphism's table. A special case of the location of functions with values of seven and eight. We are dealing with additional symmetry. It allows traversing both from top to bottom and back.

Mathematical basis for the nature computer should consider the relational algebra as possible. It is unclear what to do with the theory of automata for such a device. Building it with the current theoretical framework is difficult.

The binary principle of the structure of the language was for the first time proposed by Ferdinand de Saussure and much later by Bachmann's automorphisms. It has been applied in natural language linguistics during 150 years and it was used, for example, in Zvegintsev's works. The main conclusion of our material is that space can be studied as a pure computer science object. Every point in space can be seen as an elemental part of the global supercomputer.

Unfortunately, the authors do not offer additional results in the formulation of research. Let us try to do it in the theory of pattern recognition as an informational science closely related to the geometry.

6 SENSE OF BEAUTY

Let us start with the repeat information about the stages of development of a human vision.

The main sensoric organ, which is responsible for spatial orientation in humans, is the vision. It is generally known that there are several view types [22]. For each type of a view there is a person at a certain age range. In physiology we distinguish the age of appearance of the binocular, colour, and spatial type of a person. Binocular (two-eyed) vision appears in the first few weeks of life. Colour is formed by 4–5 years of age. The spatial orientation, especially the ability of a particular person to accurately design, for example objects of engineering, may not ever be developed. Apparently, one should speak about the absolute mechanism of symmetry on the level of reflex. Previously, there was a brief study on the presence of symmetries in the work of children [23]. Small children without colour vision have several kinds of symmetries (Figure 4).

Figure 4. Picture of small children

Figures of people look alike (the symmetry of 3), but each has its own unique features. It is the hair, facial expressions, and hands (symmetry 9). The child is painted big almost as parents, only a little smaller (symmetry 10). Those are the last symmetries on the picture. The author does not have a colour vision. Work of an older child in another figure is shown for comparison (Figure 5). Colour plays an important role in this picture. We are dealing with a product of education. Girl is the biggest, mom is a little smaller, and father is very small.

Figure 5. Children's picture

The authors are not specialists in biology, medicine or physiology, so we turn to the research of psychologists. Since the beginning of the psychology development as an independent science it appears in nonverbal tests for diagnosing mental condition of the person [24].

Rorschach offered the first nonverbal test for the analysis of human psychological state. The test consists of several pictures, but each of them presents a mirror symmetry (Figure 6). The test does not have much reliability, but it is used so far. The test uses the simplest symmetry.

Luscher Colour Test (1948) was widely adopted. The test results are frequently used to analyse the nature of the individual. Each colour in the palette is unique, so it must be concluded that Luscher uses linguistic symmetry order. The same type of test should may be psycho-geometric test by Delinzher [25]. Testing is carried out on five different pictures: a square, triangle, zigzag, ellipse, and a cross. Although geometric shapes test also uses only the uniqueness of each picture, that is, linguistic symmetry order (Figure 7).

Figure 6. Picture of Rorschach

The creative tests analysing the human family and image by Karen Machover are mostly used. The test is based on the figure of a subject, so the children's creativity can be analysed with it. More symmetry is used in this test as it is a mirror, transportability, mathematical order, linguistic order, etc. [23]. The question is, when you can use these tests. German authors [26] say that the best age of a child to take the test is 4–5 years. It allows testing by the above mentioned types of psychological experiments as the child has already got some sort of sense besides colour vision.

Weyl considers to study the symmetry with poems and works of art [7]. He emphasises that beauty is defined by automorphisms. DNA structure and symmetry of knowledge are similar (see Section 3). On the contrary, the discovery of Hilbert allows explaining the structure of DNA, to express it more precisely. Therefore, symmetry defines a new feeling, known from Homer times. This is the sense of beauty.

Psychologists have found acceptable brain solutions to awareness of beauty in the recent studies [27, 28]. Such mechanism may be a comparison table of automorphisms within a man and the symmetry of the surrounding space. It can be much different from the space table regarding the age and human actions, to be harmonious or to have a dissociation with it. The appointment of a recently discovered gene can be regarded as an indirect confirmation of the hypothesis [29]. Physiological studies are lengthy, so the mechanism and the sensoric system are not known exactly. We can unambiguously confirm the fact that the human recognition mechanism depends not only on the vision.

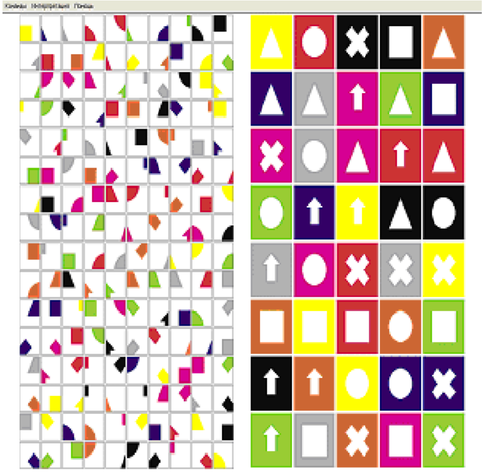

Figure 7. The combination of tests by Luscher and Dillinger

The symmetries table and DNA have the same structure and mechanism and the human touch can be present in every living cell of the human body. Based on that we have developed the hypothesis in terms of computer science saying that a man should not be seen as a central processor with peripheral equipment but as the cloud structure. The same principle can be incorporated in the pattern of recognition systems and robotics. Again we are faced with a contradiction between relational algebra and automata theory. The duality of the sensor systems is used in robots for a long time, for example, echolocation and thermal imager combined in one device. Man does not have the duality of the vision as it was previously thought. Hypotheses used in the framework of modern architecture of computing devices are possible only for software purposes.

7 SELECTING IMAGE FEATURE POINTS

Search for the image characteristics is an important task of a computer vision. Feature points can effectively accomplish the following tasks: stitching panoramas and aerial photographs (image stitching); 3D reconstruction search and identification of objects, fingerprints verification [30], etc. A large number of works in this direction [31, 32, 33] testifies indirectly the relevance of the problem of finding image feature points. Unfortunately, at present there is hardly any universal algorithm for generating an acceptable solution to the problem in different subject areas. The reason is all sorts of distortions of recorded images such as affine and projective transformations associated with the movement of the camera or objects in the scene, scene change illumination, occlusion and shadowing objects in the scene, etc. In this work, the task of finding the image feature points image has attempted to be solved in the context of a comparison of the current photograph area, made on board of the aircraft, with the search field composed of aerial photographs or satellite images. Such comparisons will enable to position the aircraft.

Every object in the nature has its specific symmetries. Points of the device orientation, in contrast to other points, have a pronounced symmetry linguistic order. However, most objects are characterised by a simple mirror symmetry. A test added for the manifestation of symmetry allows to increase the reliability of solutions of known algorithms.

The successful positioning of the aircraft needs detected feature points belonging to the objects that will be called stable area reference objects. Not all objects in the current image area can be classified as stable reference objects. In these images some moving or variable objects are often present. People and vehicles should be classified in the class of moving objects. The objects, which are easily subject to changes, such as single trees, paths, small single buildings, etc., are considered to be variable objects. The presence of these objects in the image makes it difficult to find a stable reference object. Figure 8 shows original image areas. There are roads, buildings and clusters of trees as stable reference objects. Cars, trails, single trees and bushes, hedges are changeable.

Figure 8. The source image of terrain

To reduce the number of moving and changing objects in an image we use the median image filtering with the $N \times N$ pixel aperture, which allows preserving the boundaries of the major objects in an image [34].

The value of the aperture should be selected with the following considerations. The maximum aperture size of the median filter is dependent on the minimum width of the road. The minimum size of the median filter aperture is calculated from the condition of suppression of moving objects such as buses, passenger cars and trucks. Depending on the scale and resolution of the shooting aperture value typically ranges from 3 to 9 pixels.

Median filtering suppressed all vehicles, narrow dirt roads, small elements of vegetation and small buildings. In addition, the image preserved road network, large buildings and groups of trees. It is necessary to emphasise the preservation of boundaries among the objects which remained on the image.

However, even if the boundary of the object area is close to the ideal, after sampling it becomes unsharp and dim which makes it more complicated to highlight the contours of objects. To restore the boundaries an extreme filter is used [34]. When the extreme filter is used it calculates the distance between the current brightness of the input image pixel brightness and extreme values in the neighborhood of $(x,y)\begin{cases} d_{\min}(x,y) = \left|b_1(x,y) - e^N_{\min}(x,y)\right| \\ d_{\max}(x,y) = \left|b_1(x,y) - e^N_{\max}(x,y)\right| \end{cases}$, where $e^N_{\min}(x,y)$ and $e^N_{\max}(x,y)$ are the minimum and maximum extreme values of brightness in the $N \times N$ pixel vicinity of the current image.

The value of the extreme (maximum or minimum), closest to the brightness of the central pixel, is assigned to the current pixel of the output image $b_2(x,y) = \min\left(d_{\min}(x,y); d_{\max}(x,y)\right)$.

As a result, the boundary gets aggravated and actually becomes a step one, which highly facilitates the construction of the circuit stable area landmarks. Extreme filter aperture size is set to the minimum value of 3×3. However, it has been found by experiments that slightly better results can be obtained by increasing the filter extreme aperture to median filter aperture size while significantly increasing the cost of computational complexity. Further, any available contour detector builds the contours of objects. In this paper, we used Canny detector [35].

In addition, the curvature function for each circuit is calculated [36]. The choice of the curvature function as a basis for feature points is due to its invariance to the shift, rotation and lighting conditions. If we do not use the information about the value of curvature at the point of its extreme for the further comparison, and will only fix the coordinates of extreme points, the proposed method will have an invariance and scale changes.

Curvature function is one-dimensional and requires unbranched circuit, but the description of complex objects may call for contour branching. In this case, the branching point becomes the anchor point, and the outline of a complex object becomes an integral of multiple curvature functions. Positive and negative curvature function extremes exceed a predetermined threshold, the markers are marked on the original image. It results in an image of the current location frame marked up with feature points. If the number of feature points is not enough to match the current frame with the search area image or the comparison is made with a low reliability, the extreme threshold of curvature function is adaptively reduced and the extreme search is repeated. A large number of isolated feature points can significantly slow down the process of further comparison. In this case, raising the extreme search threshold is provided. Checks revealing points on the above symmetry are carried out at the end of the process.

Figure 9 shows the original image, and areas marked thereon are the singular points found as described above. Figure 9 shows that all the major junctions and bends of the roads are marked by feature points. The rest of the feature points are located at the corners of buildings and in the bends of the outlines of large clusters of trees. At the same time, cars, small buildings, light fencing, single trees and bushes remained untagged. Modification methods described apparatus can also speed up the algorithm.

Figure 9. The source image labeled by feature points

We looked at several actual tasks of informatics on the basis of mathematical linguistics. It would be logical to turn to the analysis of a natural language texts.

8 AUTOMORPHISMS AND UNIVERSALS

We started from linguistics, and finished there as well. Let us consider how natural language texts will meet the proposed table automorphisms. By the linguistic research we understand not only the semiotic analysis of texts, but natural languages and linguistics in general.

Formation of semiotics as a science is associated with the name of C. S. Pierce [37], the son of an eminent mathematician who obtained mathematical education. Erlangen program and similarity method had a great influence on the development of language linguistics, too [38]. However, unfortunately, the modern principle of humanitarian knowledge representation does not allow to apply precisely the results of linguistics in solving mathematical problems. Different natural languages have different study structures [4]. Common mechanism of abstraction [39] developed in the 30's, 40's is rarely used.

Regarding linguistics in general, regarding any language, many terms are invariant, such as a "synonym", "homonym" and "antonym". This category is called linguistic universals [39]. The binary nature of structural analysis in the interpretation of Zvegintsev allowed for the past forty years to apply his theory in information technology, and proposed a binary linguistic principle long ago [39].

We begin our consideration with universals from antonyms. Antonyms are the words where one word has an opposite meaning [39, p. 36]. Antonym is the ratio of lexical units having the opposite meaning, for example "cold" and "hot". Let A be the set of words that have antonyms and C be a lot of antonyms from A. Antonyms describe the attitude $f_{An} : a_i \to c_j$. Let shelf ratio f_{An} twice: $f_{An} : a_i \to c_j$, $f_{An} : c_j \to a_i$. Therefore, it is a symmetry (automorphism) in a limited definition [7]. Of course, due to the presence of considered table automorphisms [14, 17] in the latter case may be $f_{An} : c_j \to a_i$ or $f_{An} : c_j \to a_k$, when $k \neq i$. This process is random. If we continue the transformation, then in Markov process of random variables, we always get $f_{An} : c_j \to a_i$. That is the symmetry determined by M. Born [9]. This type of automorphism is comparable with mirror symmetry of the Euclidean plane and defined by the sign n and $-n$.

Synonym is a word of the same part of speech, with fully or partially identical meaning/values [39, p. 447], for example "buy" and "purchase". Let A be a lot of words – synonyms of one concept. Dual-use relationship of synonymy also leads to the original state of the text, either directly or by a Markov process. The mathematical operation of a set theory to describe the relationship of synonymy is $a_i \leftrightarrow a_k$, when $k \neq i$. Consequently, synonymy reflects the permutation symmetry. Other set with automorphism of the domain forms the Markov process. Markov process mechanism for the conservation of automorphisms is possible.

Homonym is a word which matches different linguistic units values of which are not related to each other [39, p. 344]. For example, mouse is an animal and mouse is a device. This is the most complex form of language universals. The Euclidean dimensional space described by Cartesian product $\mathbf{R}_1 \times \mathbf{R}_2 \times \ldots \times \mathbf{R}_n$, with the description in the literature can be $\mathbf{R} \times \mathbf{R} \times \ldots \times \mathbf{R}$. The unique name of the coordinates is lost, but the property of uniqueness of each coordinate axis is preserved. Consequently, homonym reflects the symmetry of a linguistic order.

Thus, the three from four low automorphisms of the Euclidean plane are used in linguistics. The four is only an automorphism defined by a mathematical order sets $\mathbf{Z}$, $\mathbf{R}$, $\mathbf{C}$, etc. Let us recall that most alphabets have a strict order of the characters. Ideographic and logographic systems display the language [39, p. 29] transmitting the knowledge of the sign system used in a particular order as well. The learning process is always built from a simple level to a complex one. Moreover, the basis of the phoneme alphabet and their number varies in different languages from 10 to 80 [39, p. 291]. Each phoneme has its own frequency sound vibrations. Therefore, they are arranged in a natural way. Cardinality of the set should not confuse us. The screen display is not more than 2 000 pixels along a single axis. Nevertheless, we can receive complex geometric images, watch videos, watch sports in real time, etc. However, this type of automorphism can be regarded as a manifestation of the second linguistic order.

Referring to senior automorphisms. chief automorphism of the existence of not empty set (Zermelo) for the language is correct. The second most important is the existence of relations as well. Without symmetry universal set-theoretic assertions semiotics is not possible. Symmetry of universal algebraic relation differs from the consumed in the Euclidean plane. Any grammar contains the rules of inference $A \to B$, where A, B are any (terminal or nonterminal in formal languages terms) symbol.

Euler's formula $e^{i\pi} = -1$ was replaced by implication. Number of phonemes transmitting sound statement is constant as stated above. Let us consider all the world's languages and to make a general interlingual phonemic dictionary. The number of phonemes in this dictionary is limited. Thus symmetry conservation of cardinality of the set is performed. Let us consider the rules of making the grammar. Let us recall that all the characters are divided into terminal and nonterminal ones. Symmetry degenerates to preserve the exact order equaling two. This type corresponds to Klein's symmetry. Thus, most of the relevant automorphisms exist on the sets of texts.

9 CONCLUSIONS

Similarity method is one of the oldest tools of science. It has been almost forgotten now. The similarity method allowed to explore electricity on the basis of mechanics, that is, it laid the foundations of modern civilisation. The concept of an invariant by Klein entered almost inside all the fields of science. We propose to consider the method of similarity on a new level with the use of mathematical linguistics.

Methods of mathematical linguistics allow identifying a new type of symmetry, the symmetry of knowledge. Its manifestation in mathematics has been known for a long time, but it has never been considered as a major one. The relational algebra and symmetry of knowledge are brought together in the theory of symmetry by Dieudonne and Weyl, who formulated a new method of linear transformations of the plane. One result of this method is the modified concept of singular transformations.

Binary relations are used in geometry and natural language linguistics – why was it possible it is not known. The modified binarity hypothesis by De Saussure and Bachmann has been put forward on the basis of singular transformations. The space must be considered primarily as the object of information technology. Symmetries in the table should be the number of sixteen by extended hypothesis. The middle floors can encounter a semantic burden in this case. Klein's theory is mentioned briefly in the article, so that the reader's attention is not taken away from the subject matter.

The development of the person's vision system was analysed from the standpoint of the proposed theory. The authors are not specialists in the field of medicine, biology, psychology, etc., so the research is based on information technology and mathematics. We propose to consider a new understanding of a man as a computer system. This is a cloud structure, not a computer with peripheral equipment. This principle can be incorporated into the design of mechatronic systems and CAD, both on hardware and on software levels. The work is based on the principle of people-cloud, it has been applied to solve the problems with images recognition. Precision solutions can thus be increased by 7 %.

Symmetries exist in any natural language as it has been shown. This principle can be useful for scientists dealing with the problems of artificial intelligence in natural languages.

Russian researchers have developed this problem for a long time in an interdisciplinary field. The terminology of the works combines classical geometry, information technology, and some natural and human sciences. Therefore, it is necessary to appreciate the approach of Slovak scientists who understood the materials, supplemented and edited it. The most important is that they brought the theory to specific new technologies, and therefore without their participation, this article would not be written.

The article has the character of problem formulation. Specific solutions are for scientists in the field of informatics for production only, but the submitted hypothesis may be the key for other relevant sections of computer science.

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