SEMANTIC ARCHITECTURE OF THE BIT . THE TOPOLOGICAL RELATIVIST CONFIGURATION OF BITS IN THE INFORMATION AS A MEASURE OF THE TRI-MATRICIALITY OF THE DIACHRONIC SYLLOGISTIC STRUCTURES IN HYPER-CARTESIAN SPACES

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Abstract

Norbert Wiener and Claude Shannon argued that the signal (communication) and the perturbations can be described only in terms of probability 's theory as elements of some determined ensembles. The theory of information analyses all events from the point of view of the probability of their happening. Events can be in different states and each state can appear with a certain probability. The author has designate as structural-diachronic cell the minimal tri-objectual, tri-relational, quadri propertitional ensemble expressed mathematically as a set of three minimal sets. The BIT representing the elementary unit of measure of the information, we will associate it as a measure of the structural-diachronic cell. The non-Shannon phenomenological analysis of the measure unit of the information, in a Aristotelic-Liebnitzian demonstrates that the bit has by excellence a relational character, respectively a semantic architecture. Two examples are given in order to presenting the method, one for form recognition and the second for the problem of the urn with 8 balls of different colours. By an innovative approach of the concept of information, the conception of inferential engines to be used in the knowledge basis of an UNIVERSAL EXPERT SYSTEM.

Keywords expert system, information, bit, semantic, inferential engines

1 Fundamental Problems of the Theory of Information

Norbert Wiener and Claude Shannon argued that the signal (communication) and the perturbations can be described only in terms of probability 's theory as elements of some determined ensembles.

The theory of information analyses all events from the point of view of the probability of their happening. Events can be in different states and each state can appear with a certain probability.

1.1 Certain events and impossible events

Events and processes in their evolution can have different results, depending on different conditions that are unknown or cannot be taken totally into account, having a stochastic character. In order to compare the events by their probability, they must being measured with a certain number so called the probability of the event, on base of a certain comparison criterion.

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As a reference element, the CERTAIN event's probabilities were adopting; such an event takes place undoubtedly as a result of an experiment. The certain event is considering to having the probability equal to the unit, p(A)=1, in which p is the probability and A the event.

If a certain event's probability is equal to the unit, then any other possible but not certain event's probability will be less than the unit.

The IMPOSSIBLE event is opposite with the CERTAIN event, because it is the event that cannot take place in a done circumstance; its probability is equal to zero. p(A)=0.

Generally speaking, the probability, p of an event is a quantity that can take values among 0 and 1; $0 \le p(A) \le 1$.

1.2. Measurement of the information

In order to became a scientific branch, the information's theory would be necessary to establish the appropriate unit of measure for the quantity of information. The quantitative analysis is based on the abstractisation of the concept of information, beyond the real or semantic meaning of the transmitted information.

Any event can be selected from a limited number of possible events. A measure for the quantity of information must be related to the process of choice of a situation from many other possible situations.

1.2.1. Shannon has established the criterion to compare the quantity of information of different signals and in this way to measure the information. The information can be carried only by an unexpected event selected in a random manner from an assemble of possible events.

The concept of information must be related to the probability that an event could have a result or another without a certain knowledge.

The main feature of the random events consists in the undetermination of their happening. the information obtained by the appearance of one of the possible states of the event eliminates the undetermination, and as result the quantity of information is equal to the undetermination contained by an event.

The undetermination which characterise the event X is the average value of all the undeterminatiions of the event's situations:

$$H(X) = -\sum_{i=1}^{n} p_i \cdot \log p_i$$

where H(X) - is the measure of the global undetermination of the event X, called by Shannon entropy.

The quantity of information is equal to the entropy, so the quantity of information is given by the equation:

$$I = -\sum_{i=1}^{n} p_i \cdot \log p_i$$

Were p_i is the probability of the state x_i of the event X.

If all the states of the given system are equiprobables, the proper information obtained by any state is equal to the average information:

$$I = -\log p_i = \log n$$

As information unit the BINARY INFORMATION UNIT, BIT was adopted. It represents the quantity of information obtained as a result of a single choice from two equiprobable possibilities.

The quantity of information obtained as a result of the determination of one of 2 equiprobable results, is equal to the information unit.

The quantity of information obtained as a result of the determination of one of 4 equiprobable results, is equal to two information units.

The quantity of information obtained as a result of the determination of one of 8 equiprobable results, is equal to three information units.

In the case of non equiprobable events the number of information units is given by the equation:

$$I = -\tfrac{1}{N}\sum_{i=1}^{n} n_i \cdot \log \tfrac{n_i}{N}$$

1.3.The non-von Neuman approach of devices and programs

The concept of non-von Neuman computer is based on structures derived from large generality formal instruments such as the theory of categories and the theory of toposes.

The von Neuman computers are syntactic machines which if an alphabet representable in internal computer codes is given, then all the symbols of the freely generated monoid on the given alphabet are accepted, with the limitness conditions given length constraint.

The semantic aspects of the information processing impose some constraints on the generative process, which permit the discrimination of some classes with disjunct semantic properties in order to avoid the generation of absurd symbolic combinations.

A semantic error is the interpretation of the symbolic configuration, which represent an operand (object) as symbolic configuration that represents a statement, regardless that a constraint rejects as absurd the transfer of an acceptable configuration from a semantic class to another disjunct class.

In the von Neuman systems the concepts of memory, memorised program and sequential control do not exclude the generation of absurd objects.

1. The concept of memory - a sorted ensemble of significanceless locations, accessible in non-natural modes on the basis of theirs fixed position onto the memory and not on the base of an identifiable name or a role that the memorised information is playing on in a certain process.

2.The concept of memorised program - the programs memorised as data are different from data only by a non-specified information in the program, associated to them by an external intervention which must correctly initiate the interpretation process and the possibility of alteration by the program of its content, without the possibility of being controlled by hardware or a dedicated operating system like software.

3. The concept of sequential control - the supposition that at the next location, in a physical sequence determined by a logical interpretation of the program the next statement being executed is find, cannot being certified by an automatic control procedure by the lack of the explicit information which specify that the given location contain an executable statement that is the logical successor of the previous one.

In order to avoid such potential inconvenience, the concept of non-von Neuman computer infers:

•a semantic kind of constraint over the memory, which permits to define on hardware support of some categories having ensembles as objects;

•an implicit association of the semantic by means relational symbols;

•inferential mechanisms of deductive and inductive kind operating over the memory;

•an unique representation formalism of the knowledge, regardless to its nature, objects, actions or their interpretations, in structural terms;

•an organising system of the knowledge basis in categories on the support of objects having the same degree of complexity like the afferent morphisms.

1.4. Abstract models

The abstract models reflect the invariant relations, which can explain the architecture and the dynamics of systems.

The systems being structured, we cannot start on their explanation nether from the entire toward the parts nether vice-versa but only from the network of relations that characterises them.

The concept of structure designs the network of necessary relations between the elements of a system, relations that are invariant and independent by rapport of the elements and in conclusion formalisables, leading to a topological and relational approach.

1.5.The axiom of syllogistic inference

"All that we can say about all the objects belonging to a class can be stated also about each individual element of that class. All that must be nied about all the objects belonging to a class must be nied about each object belonging to that class".

The priciple "dictum de omni et nullo , a sentence about "all and nothing" is respected when sylogistic figures are constructed. (Aristotel)

The theory about the relations between the objects and classes of objects can be derived from the general relations between the classes that goes farer then the theory of syllogism.

The modern sciences have as object of research the relations between objects.

1.6.The priciple of simplicity

The methodological principles of the science contain the principle of simplicity also, formulated by Newton : " To say us that each species of things is doted with an occult specific quality by which it acts and produces evident effects means to do not say us noting ; but to derive two or three general principles about the movement from phenomena and to say later how the properties and actions of all corporal things results from those evident principles, that should be a great step in the philosophy, even the causes of those principles are not yet discovered " (Isaac Newton, Optics)

1.7. About the information's definition

The information is a scientific concept, which is considered in philosophy as having a universal character in the existence. The information is related to meaning, meaning infers a phenomenological process.

The information has not defined rigurosselly, saying "Information is any new that contain the trace of an event, fact or process, information is the communication, the message, which gives news about facts, events, objects, processes."

The concept of information infers the concept of order, and the concept of order infers the rationality of a system, how rationally organised the system's elements are and what kind of rationale functionality they do inside the order that defines the system.

1.8. The relational approach of the concepts

Aristotle considers that the time has a relational character., being not something independently existent by itself, but represents only the " rhythm of progress ", and wrote: "It is evident that does not exists time without movement and change, the time is the measure of the movement, the time is the number of the movement" (Physica, IV)

Newton has an absolute substantialistic vision, considering the location in space of an object as a determined property of that object, which suppose the acceptance of an absolute space.

Leibnitz, contrarily considered the spatial relations as locational relations between two objects, as poliadical relations.

2. Semantic Architecture of the Bit

2.1. The structural-diachronic cell

We will designate as structural-diachronic cell the minimal tri-objectual, tri-relational, quadri propertitional ensemble expressed mathematically as an ensemble of three minimal ensembles:

$$\{\{O_{i-1\,k}, O_{ik}, O_{i\,k+1}\}, \{P_{i-1\,k}, P_{i\,k}, P_{i+1\,k}, P_{i+1\,k+1}\}, \{\Re_{i\,k\,i-1\,k}, R_{i\,k+1}, \Re_{i\,k\,i\,k+1}\}\}$$

The graphical representation of the structural-diachronic cell is given in fig. 1. in which N_i are the diachronic levels, i, k are the indexes of levels and respectively of the objects on each level.

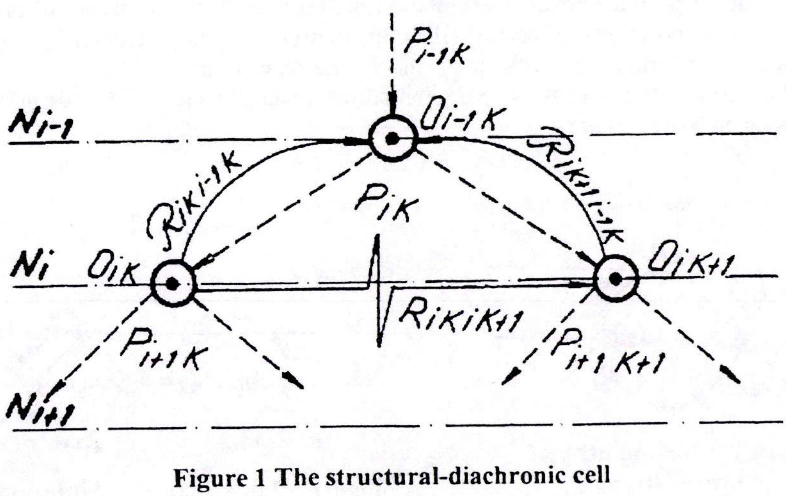

Figure 1 The structural-diachronic cell

The structural-diachronic cell can be modelled mathematically by three elementary matrixes:

$$\begin{vmatrix} O_{i-1\,k} & \\ O_{ik} & O_{ik+1} \end{vmatrix} \qquad \begin{vmatrix} P_{i-1\,k} & \\ P_{ik} & \\ P_{i+1\,k} & P_{i+1\,k+1} \end{vmatrix} \qquad \begin{vmatrix} [\Re_{i\,k\,i-1\,k} & \Re_{i\,k+1\,i-1\,k}] \\ [R_{ikik+1}] & \end{vmatrix}$$

2.2. The quadri-dimmensional interpretation of the bit

The BIT representing the elementary unit of measure of the information, we will associate it as a measure of the structural-diachronic cell.

The non-Shannon phenomenological analysis of the measure unit of the information, in a Aristotelic-Liebnitzian demonstrates that the bit has by excellence a relational character, respectively a semantic architecture.

Associating the bit to the structural-diachronic cell, we observe that the semantic architecture of the bit implies a configuration of three objects: $\mathbf{O_{i-1\,k}}$ -precursor, O_{ik} O_{ik+1} successors, between that exists two diachronic relations: $\Re_{i\,k\,i-1\,k}$, $\Re_{i\,k+1\,i-1\,k}$ and a synchronic contradictory relation $R_{i\,k\,i\,k+1}$;
the objects having the properties: $P_{i-1\,k}$, -aprioric, P_{ik} - in act and $P_{i+1\,k}$, $P_{i+1\,k+1}$ - potentials.

The configuration of three objects suppose the existence of 3 levels in the diachronic space: N_{i-1}. N_i and N_{i+1} (precursor, actual and successor).

The quadridimmensional interpretation of the BIT implies:

1) The vector of diachronic levels (I.1);

2) The matrix of properties (I.3);

3) The matrix of objects (I.4);

4) The matrix of relations: diachronic and synchronic (I.5)

The triple arborescence of properties, objects and relations are asserted by the arborescence of truth (modelled by the truth matrix (I.2) and is represented by a hypergraph).

In the figure 2 the hypergraph corresponding to the quantity of information of 1 BIT.

The representation of the hypergraph corresponding to the quantity of information of 2 BITS is given by the figure 3.

The quadridimmensional interpretation of the quantity of information of 2 BITS is given by the diachronic level's vector (II.1), the matrixes of properties (II.3), objects (II.4), diachronic and synchronic relations (II.5) and the matrix of truth (II.2).

The representation of the hypergraph corresponding to the quantity of information of 3 BITS is given by the figure 4.

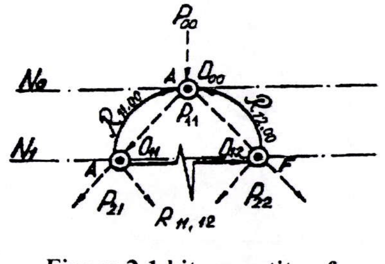

Figure 2 1 bit quantity of information

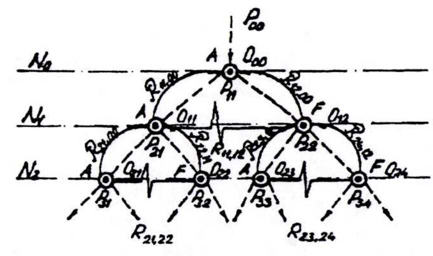

Figure 3 2 bits quantity of information

Vector of diacronic levels

$$\begin{vmatrix} N_0 \\ N_1 \end{vmatrix} \qquad\qquad \begin{vmatrix} N_0 \\ N_1 \\ N_2 \end{vmatrix} \qquad (II.1)$$

Matrix of truth

$$\begin{vmatrix} A & \\ A & F \end{vmatrix} \quad (I.2) \qquad \begin{vmatrix} A \\ A\ F \\ A\ F\ \ A\ F \end{vmatrix} \quad (II.2)$$

Matrix of properties

$$\begin{vmatrix} P_{00} \\ P_{11} \\ P_{21} \\ P_{22} \end{vmatrix} \quad (I.3) \qquad \begin{vmatrix} P_{00} \\ P_{11} \\ P_{21}\ P_{22} \\ \\ P_{31}\ P_{32}\ P_{33}\ P_{34} \end{vmatrix} \quad (II.3)$$

Matrix of objects

$$\begin{vmatrix} O_{00} \\ O_{11} \\ O_{21} \\ O_{22} \end{vmatrix} \quad (I.4) \qquad \begin{vmatrix} O_{00} \\ O_{11}\ O_{12} \\ O_{21}\ O_{22}\ O_{23}\ O_{12} \end{vmatrix} \quad (II.4)$$

Matrix of relations

$$\begin{vmatrix} [\mathfrak{R}_{11,00} & \mathfrak{R}_{12,00}] \\ [R_{11,12}\ ] & \end{vmatrix} \quad (I.5) \qquad \begin{vmatrix} [\mathfrak{R}_{11,00} & \mathfrak{R}_{12,00} & &] \\ [\mathfrak{R}_{21,11} & \mathfrak{R}_{22,11} & \mathfrak{R}_{23,12} & \mathfrak{R}_{24,12}\ ] \\ [\mathfrak{R}_{11,12} &] & & \\ [\mathfrak{R}_{21,22} & \mathfrak{R}_{23,24}] & & \end{vmatrix} \quad (II.5)$$

$$\begin{vmatrix} N_0 \\ N_1 \\ N_2 \\ N_3 \end{vmatrix} \quad \begin{vmatrix} A \\ AF \\ AF\ AF \\ AF\ AF\ AF\ AF \end{vmatrix} \quad \begin{vmatrix} P_{00} \\ P_{11} \\ P_{21}\ P_{22} \\ P_{31}\ P_{32}\ P_{33}\ P_{34} \\ \\ P_{41}\ P_{42}\ P_{43}\ P_{44}\ P_{45}\ P_{46}\ P_{47}\ P_{48} \end{vmatrix} \quad \begin{vmatrix} O_{00} \\ O_{11}\ O_{12} \\ O_{21}\ O_{22}\ O_{23}\ O_{24} \\ O_{31}\ O_{32}\ O_{33}\ O_{34}\ O_{35} \\ O_{36}\ O_{37}\ O_{38} \end{vmatrix}$$

III.1 III.2 III.3 III.4

$$\begin{vmatrix} \begin{vmatrix} \mathfrak{R}_{11,00} & \mathfrak{R}_{12,00} & & & & & & \\ \mathfrak{R}_{21,11} & \mathfrak{R}_{22,11} & \mathfrak{R}_{23,12} & \mathfrak{R}_{24,12} & & & & \\ \mathfrak{R}_{31,21} & \mathfrak{R}_{32,21} & \mathfrak{R}_{33,22} & \mathfrak{R}_{34,22} & \mathfrak{R}_{35,23} & \mathfrak{R}_{36,23} & \mathfrak{R}_{37,24} & \mathfrak{R}_{38,24} \end{vmatrix} \\ \\ \begin{vmatrix} R_{11.22} & & & \\ R_{11.22} & R_{11.22} & & \\ R_{11.22} & R_{11.22} & R_{11.22} & R_{11.22} \end{vmatrix} \end{vmatrix}$$

III.5

The quadridimmensional interpretation of the quantity of information of 3 BITS is given by the diachronic level's vector (III.1), the matrixes of properties (III.3), objects (III.4), diachronic and synchronic relations (III.5) and the matrix of truth (III.2).

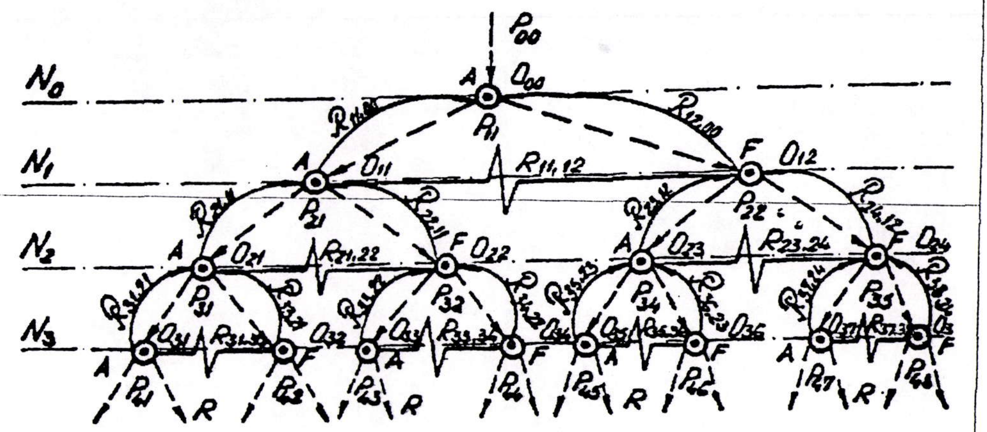

Figure 4 3 bits quantity of information

3.The Topological Relativistic configuration of BIT in the information, a measure of the trimatriciality of the syllogistic diachronic structures in hypercartezian spaces

Applying the concept of the Aristotle's and Leibnitz's relational theory the topological relativist configuration of the BIT in the information is relieved

The structural diachronic cell associated to 1 BIT information quantity represents the elementary structure of a diachronic syllogistic-inferential structure.

The complex diachronic sylogistic structures implies the existence of a pyramidal configuration of structural-diachronic cells on multiple diachronic levels represented by hyper-graphs and modelled mathematically by the objectual matrixes and by the matrixes of properties and diachronic-synchronic relations.

The information can be defined as a measure of the tri-matriciality of the sylogistic-diachronic structures in hyper - Cartesian spaces.

A certain quantity of information is corresponding to each sylogistic structure as a function of the complexity degree.

Analysing the three figures we can observe that the number of structural diachronic cells increases with the number of bits, each cell occupying a certain diachronic level and having a certain position inside the level.

From the figure 2 we observe that in comparison with the base level (N_1) the diachronic cell implies a precursor level $\log_2 2 = 1$ bit , (2 being the number of objects on the base level).

From the figure 3 we observe that in comparison with the base level N_2 where they are 4 objects, the diachronic structure corresponding to the quantity of information of 2 bits implies two precursor diachronic levels (N_1 and N_0), ($\log_2 4 = 2$ bits) .

From the figure 4 we observe that in comparison with the base level N_3 where they are 8 objects, the diachronic structure corresponding to the quantity of information of 3 bits implies three precursor diachronic levels (N_2, N_1 and N_0), ($\log_2 8 = 3$ bits) .

So, by the equation of the quantity of information in case of equiprobable events ($I = \log_2 N$), N being the number of equiprobable events) we do not calculates only the number of bits but also the number of diachronic levels of the diachronic structure corresponding to the given quantity of information.

Associating 1 bit to each structural-diachronic cell of the structure, we observe that the relative cell's position inside the complex structure implies the topological relativistic structure of the BITS in the information.

4. Applications

4.1.Form recognition

Let determining the necessary quantity of information to identify and recognise a bidimmensional form using the principle of decomposition in successive diachronic levels.

The graphical solution of the problem represented in the figures 5..11 and show successively the metamorphosis of the searched form as a function of the quantity of information by:

1) The matrix of 0 Bits , level N_0;
2) The matrix of 1 Bit , level N_1;
3) The matrix of 2 Bits , level N_2;
4) The matrix of 3 Bits , level N_3;
5) The matrix of 4 Bits , level N_4;
6) The matrix of 5 Bits , level N_5;
7) The matrix of 6 Bits , level N_6;
8) The matrix of 7 Bits , level N_7.

It results that is enough 8 successive diachronic levels corresponding to the quantity of information of 8 bits, verifying the concept of sufficiency introduced by the Leibnitz's "sufficient meaning principle" respectively the principle of "sufficient divergence" introduced by the author (Mirita, 1994).

4.2. The example of the urn with 8 balls

Given an urn with 8 balls of different colours let establish the diachronic structure needed to identify of each ball.

The graphical solution applying the principle of decomposition on diachronic levels is given in fig. 12.

From the figure it results that in comparison with the base level (N_3) , the level of the 8 balls other 3 successive diachronic levels are necessary (N_2, N_1, N_0) , a diachronic structure corresponding to a quantity of information of 3 bits ($\log_2 8 = 3$ bits)

Conclusions

The phenomenological non-Shannon analysis of the unit of measure of the information , in an Aristotelian- leibnitzian manner demonstrates that the bit has by excellence a relational character, respectively a semantic architecture.

By an innovative approach of the concept of information, the conception of inferential engines to be used in the knowledge basis of an UNIVERSAL EXPERT SYSTEM.

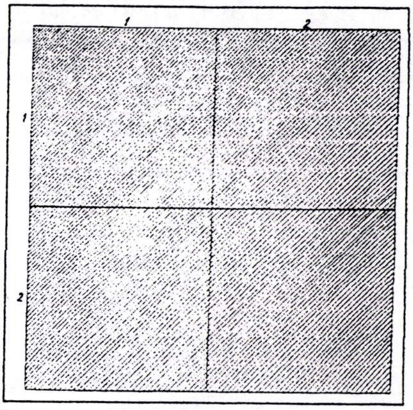
Fig.5 1 bit shape

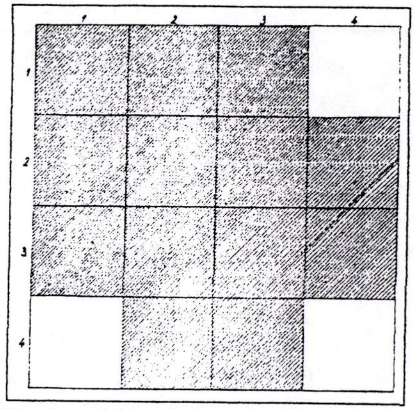
Fig.6 2 bits shape

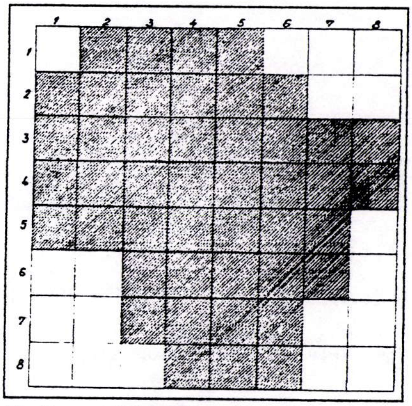
Fig.7 3 bits shape

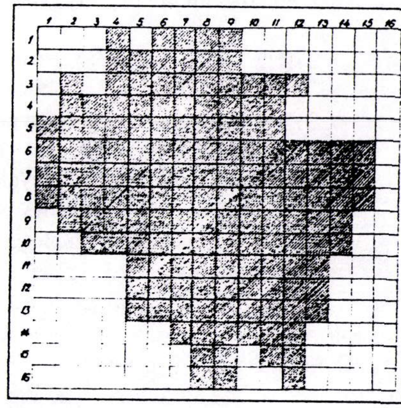
Fig. 8 4 bits shape

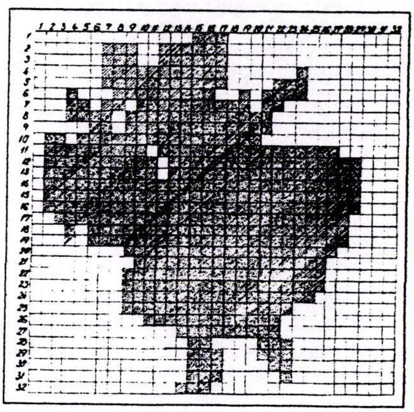
Fig.9 5 bits shape

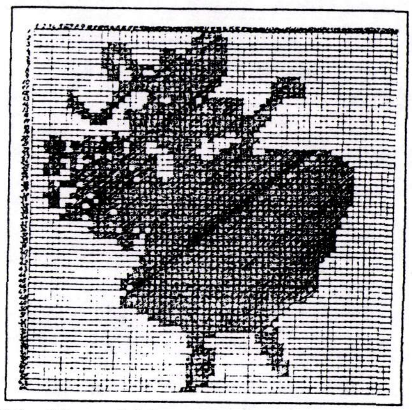
Fig.10 6 bits shape

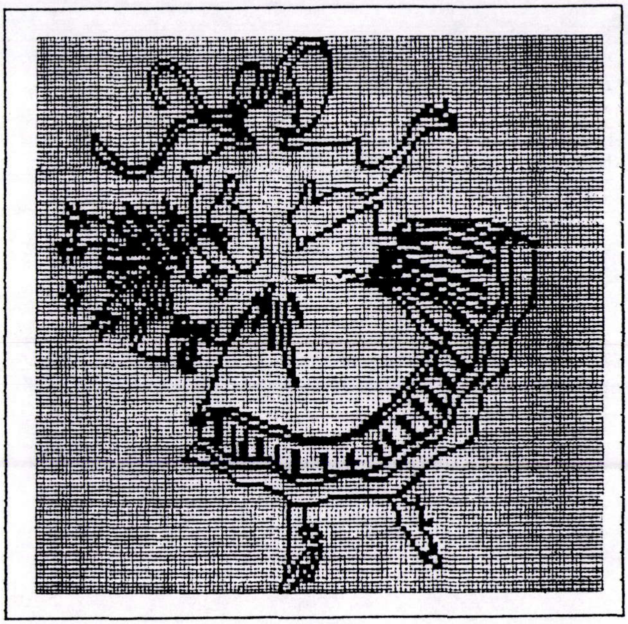

Fig.11 7 bits shape

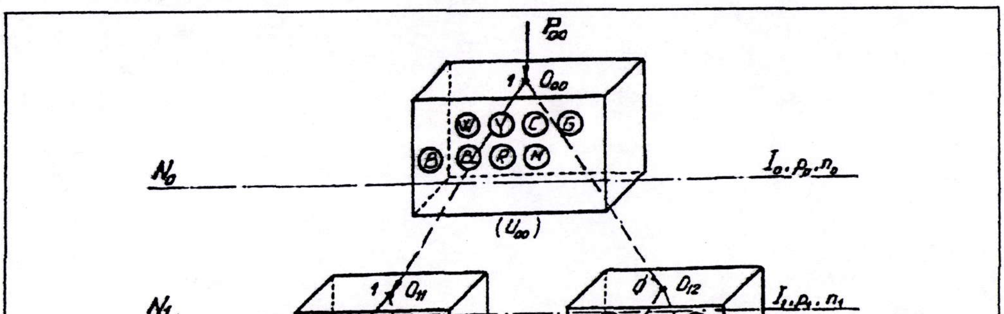

Fig 12 Example of the urn with 8 balls

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