The Logic Process Formalism of the Informational Domain

Ion BURLACU
SC "Informational Technology and Systems", Chişinău, Moldova

The performance of present-day informational technologies has two main properties: the universality of the structures used and the flexibility of the final user's interfaces. The first determines the potential cover area of the informational domain. The second determines the diversity and efficiency of processing methods of the proceedings being automated.
The mentioned aspects are of great importance in agriculture and ecology because there are complex processes and considerable volumes of used information. For example, the meteorological processes are a part of the ecological one like habitats' existential conditions and are known as a complex prognostic problem. The latter needs considerable computational resources to solve the appropriate equations. Likewise, agriculture as a controlled activity under strong impact from natural conditions has the same high requirements for diverse structures and flexibility of information processing.
Keywords: *informational technology, flexibility, universality, cybernetic model, informational domain*

1 Basic principles

The structure universality and interfaces flexibility, which are at the base of intelligent systems, can be examined from the point of view of the structural-functional diversity. This brings up the strong connection between them and permits to use them following common principles. So, the functional structure becomes abstract - equivalent with the structured function.
On the one hand, the functional structure is assured using simplified application of the same function (concrete control or production activities of business enterprise: planning, bookkeeping, control etc.) to different structural components (enterprise, subdivision, department etc.). In other words, a function is simpler and easier to apply to a typified and universal structure than to several separate and stray structures.
OTOH, the structured function permits to obtain the desired result using several functions organized in a hierarchical structure for the same structural component. In this case several typed functions are used for one concrete structure.
The intelligent systems use typical and universal data structures to obtain informational frames and knowledge bases and typical and universal function structures to organize heuristic procedures, evolutionary computation, and other intelligent methods of processing and operating structured information. The close interaction between the functional and the structural aspects is obvious and mutually conditioned. The processing procedure implies specific structured informational components (as function arguments) by default. The same way, the informational structure implies special processing dependent on information features and nature.

2. The main structures of the logic process

2.1. The area of examination
The search for existing informational structures to use in automated logic processes is very important for mutual connection and utilization of informational structures, integration in efficient common technologies, for designing effective informational applications. The mentioned principles were applied in the automation process in agriculture and ecology (in Republic of Moldova). The logic of some important informational components was examined and used in the process of designing and operating informational systems from the point of view of ***"Graph AND/OR"*** type structure. Its structures, such as: economic table, natural language text document, cybernetic command (control, management etc.) model – CCM and database type structures, exist in diverse economic, social-

politic and other types of activity. The first two represent real process information sources. The last two represent automation features components.

2.2. Economic table type structures.

The economic table document is one of the most common systematized information forms. In this structure we can separate three main parts: the title part (title - T), the table part (the table columns - C) and the left part (the table lines - L) of the document. Each part can include several main elements.

The mutual logic connection between the main elements of the lines (separate) and of the columns (separate) is disjunctive ("OR" logic relation type). The internal connection between the components of the main elements is very diverse, constitutes a sophisticated hierarchy and can be operated by any logic type: "AND", "OR", "NOT" etc. depending on the real situation of the described process (mixed logic connections).

Whatever internal connection, on the column level (or line level) the components of different main elements have a disjunctive ("OR") logic mutual connection (as components of the main elements) just like the main elements. The components of the main elements have the same mixed mutual connection on the title part (T).

In the case of mixed logic connections of title part's elements the structure represents a cumulative homogeneous table multitude equivalent to the one created by the disjunctive connection between the components of the main elements. But on the main elements level in the title part unlike the case of lines and columns the connections are conjunctive ("AND" logic connection type). The components of different main elements of the title part have a conjunctive ("AND") logic mutual connection just like the main elements.

A stricter and a more stable logic connection takes place between the title, the lines and the columns (see figure 1.). Its structures have identical conjunctive connections that imply the same connection type for each to each between any two main elements of these parts. This way the presented table information (in economic aspect) has the following logic properties. Each element of the table part (column - C) with the numbers (table data of real process) represented by this element constitutes a conjunctive vector of vertical orientation ("AND" logic connection type). Each element of the left part (line - L) with the table numbers represented by this element constitutes the similar conjunctive vector but of horizontal orientation.

The main logic connections in the economic type table can be seen in Fig. 1.

2.3. Natural language text document type structures.

Obviously this kind of information has a very large spreading and indicates its evident importance too. Its specific features are mentioned by some authors, [1], [2]. The sentence is the main form of natural language text information expression. A special approach to the sentence (based on cybernetic principles) was developed in conjunction with the necessity of automation of processes (both economic and technological) in agriculture and ecology, [3], [4] etc. The flexible and universal methods in these domains are very important.

According to this feature the cybernetic control model (CCM) structure is synonym to sentence structure (SS), [3], [4]. The relation between the respective components of the simplest form of their structure can be as follows: CCM ~ SS, where

$$CCM = (S_c, F_c, O_c);\ SS = (S_s, P_s, O_s);\ S_c \sim S_s;\ F_c \sim P_s;\ O_c \sim O_s;$$

"~" – equivalency sign; S_c – control subject (subsystem); F_c – control function; O_c – control object (informational domain); S_s – sentence subject; P_s – sentence predicate; O_s – sentence object.

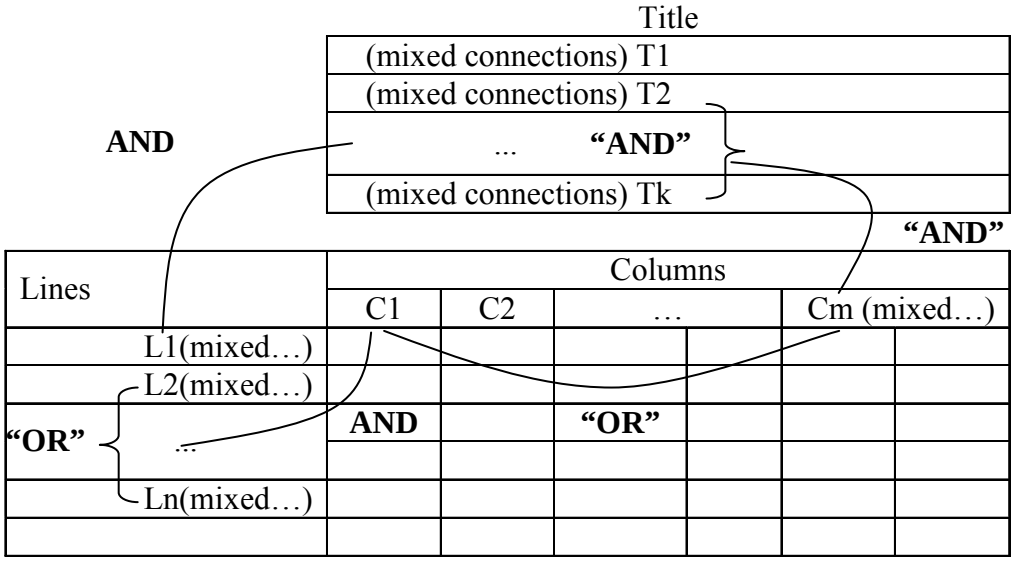

Fig.1. The main logic connections in the economic type table

The logic analysis of the sentence from the point of view of the ***"Graph AND/OR"*** type structure gives the following results:

a) The sentence words are related through the **AND** mutual connection type;

b) The **OR** logic expression has to be included in the respective place of the sentence to represent the **OR** connection type;

c) To avoid non unique representation of the **AND**, **OR** connections in a sophisticated sentence the respective logic expression has to be included explicitly;

d) The **AND**, **OR** connection type can be represented by any other punctuation signs such as bracket, comma, hyphen etc.;

e) The texts of different sentences represent the **OR** mutual connection type and are divided by full stop. The latter emphasizes the end of the expressed thought.

f) Usually, several sentences may be used to express complex thoughts. In this case special words such as "simultaneous", "therewith", "in this time" etc. are to be used at the beginning of the following sentences.

2.4. Cybernetic control model type structures (CCM)

The CCM represents a fundamental template used when applying the formalism of cybernetic principles to an automated process. Unfortunately, the investigations on CCM structures and its properties exist today next to nothing. It is a pity, because CCM can become a strong methodological resource. For an economical process the CCM structure can be represented the following way:

$$CCM = \{S, O, F, C(T, R, L)\},$$

Where S – is the subject (control subsystem); O - the control object; F –control functions; C – activity conditions; T – control targets (goal); R – internal conditions (orders, dispositions, rules etc.); L – external conditions (laws, contracts, competition etc.).

The following aspects can be estimated in this case. The decomposition methods usually represent the vertical hierarchical structure components as an **AND** connection type structure. The control process in the CCM is possible if the components on the same level constitute a closed circuit. So the components on this hierarchical level of CCM represent the **AND** connection type structure too.

The consecutive processes connecting the control contour operations in a closed circuit represent the control time type phases and are related through an **AND** mutual connection type. Consequently, formally a general control model from the logic point of view can be described by the logical expression: MCC = S•O•F•T•R•L, where "•" signifies the logical **AND**.

The parallel processes in the control contour usually have the **OR** logic type. Therefore, the simultaneous events and processes lo-

cated in any place of the control contour are always parallel (**OR** logic type).

2.5. Database type structure.
Databases are another example of the **"Graph AND/OR"** type structure. The first represents an important component of informational system designing. A simple analysis of database structures permits to trace the following properties:
a) The fields of each database table have the **AND** mutual connections type;
b) The records of each database table have the **OR** mutual connections type;
c) The database tables as well as different databases have the **OR** mutual connections type;
d) The connections other than the above mentioned, are usually realized using programming language methods. They represent complex expressions describing the real economic process using database information.

3. Algorithmic procedure for logic structures presentation

The performed analysis permitted to obtain two logic structure types: a) real process structures (economic tables and natural language texts); b) structures necessary for informational systems automation (cybernetic control model and databases).
The first type represents the main expressing form of the automation domain. The latter one is an essential automation feature. The interchangeable, mutual identification of the structure type above represents an important problem of informational systems designing process. This is one of the initial automation stages.
For example, the cybernetic control model (CCM) is directly used mainly at the initial stages of informational system designing. Its main destination is to correctly identify the structural and functional components of the automating process. Then the components are represented in databases, which form the systems' informational space.
The possibility of designing a centralized type database equivalent to the CCM structure was demonstrated and described for ecological and economical (agriculture) informational systems [5], [6], [7].
The analysis of the above statements permits the following affirmations: a) real processes consist of **"Graph AND/OR"** type structures; b) from the logical point of view, real processes can be expressed by any of the above-indicated methods (table or text description, database identification, cybernetic modeling).
Therefore, the above descriptions represent equivalent possibilities. In view of the previously mentioned, the determination of switching procedures between different presentation forms or their mixed utilization becomes an important problem. Because designing informational systems means formalizing real processes, the main importance belongs to switching procedures from real process structures to automation resource structures. Thus the determination of the switching procedure from the table or text form to database form signifies obtaining the identification algorithm of the real process information in the database. In fact, this is the main part of the automation process.
Let us see the possibilities of designing its procedures. A more careful analysis of the database (of one of its tables) logic structure brings up two homogeneous logic components: the table fields in conjunctive (**"AND"**) mutual connections and the records in disjunctive (**"OR"**) mutual connections.
The registration of the economic table complex structure and natural language sentence in the database table is possible in case of decomposition in sequences of homogeneous logical chains. The elements of a chain would be in conjunctive mutual connections. They would form a database table record. The chains would be in disjunctive mutual connections. The chains would represent different records of a database table.
Thus let's mark the conjunctive logical operation (**"AND"**) by the multiplication sign "•" and the disjunctive one (**"OR"**) – by the addition sign ($\sum$ or "+"). Then the logical structure of an economic table or a natural language sentence (S_t) can be generally expressed in the following way:

$$S_t = X_i \bullet X_j \bullet (\sum_k X_k) \bullet X_l \bullet ... \bullet (\sum_m X_m) \bullet X_n \bullet ... \bullet X_p,$$

Where: $X_i \bullet X_j$, X_k , X_l ,..., X_m , X_n ,..., X_p represent structural – logical components of the respective table or text.

In this case S_t can be decomposed in a multitude of conjunctive homogeneous chains as follows:

$$X_i \bullet X_j \bullet (\sum_k X_k) \bullet X_l \bullet ... \bullet (\sum_m X_m) \bullet X_n \bullet ... \bullet X_p =$$
$$= \sum_k \sum_m (X_i \bullet X_j \bullet X_k \bullet X_l \bullet ... \bullet X_m \bullet X_n \bullet ... \bullet X_p) = \sum_k \sum_m (L_{km}),$$

Where L_{km} represent conjunctive homogeneous chains.

As a matter of fact the fields in a database table constitute chains just like these. So, we can note the following rapport:

$$L_{km} = R_q;$$
$$\text{and } S_t = \sum_q (R_q),$$

Where R_q represents the DBF table record, q = 1, 2, ..., k*m.

As a result we can see that the analytic expressions indicated above represent the identification algorithms of real process structures (economic table or natural language sentence) in the database of an informational system.

For the ecological and agricultural domains the scheme of the presentation algorithm for the economic table form in a database has been shown anterior [5], [6], [7] and can be seen in Figure 2.

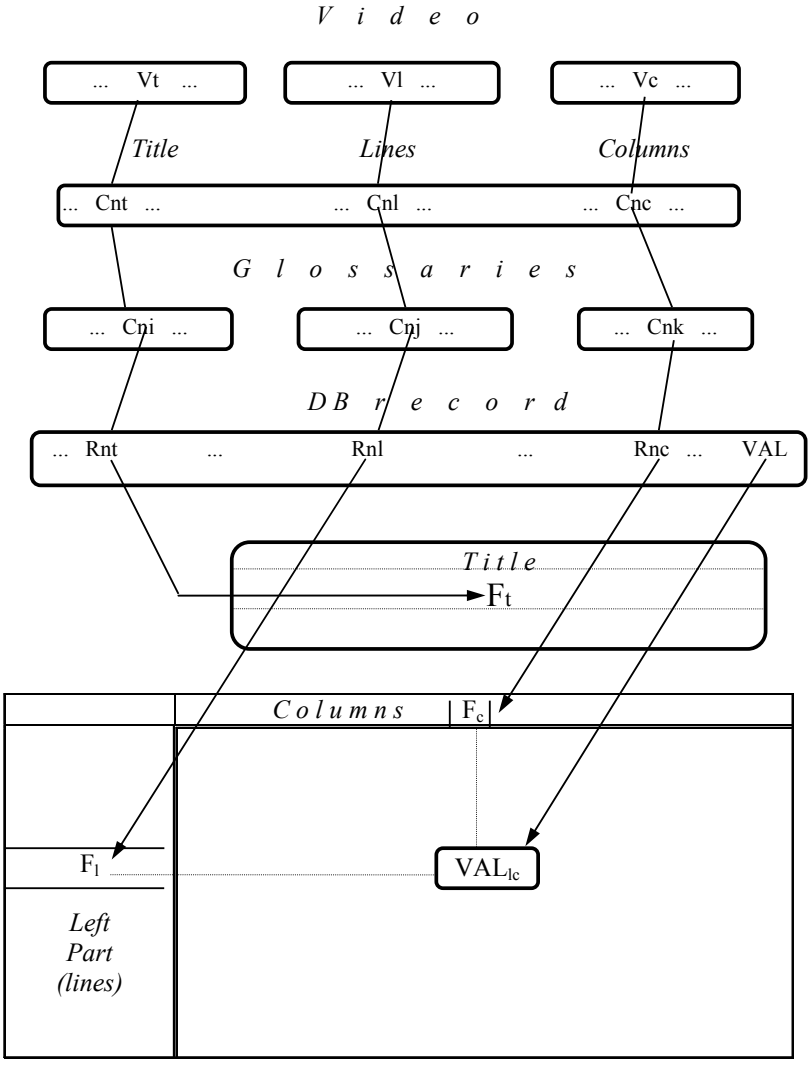

Fig.2. The main interpretation schema of an unregulated interpellation

4. Informational space of the automation domain

The cybernetic control system of a real automation domain includes the whole diversity of the necessary logic operations to describe the domain. So, the informational diversity of a domain identified in a database expresses the full diversity of the process and transforms the respective control space in a Boolean topology space.

A generalization of the above about the informational space of the automation domain permits to conclude the following. Because the fields of a database table represent the **AND** conjunctive type mutual connection, the same as mutual connections between Boolean topology space dimensions, a record of the database is equivalent to an informational space point.

For example, each natural language text sentence describes several records. And these represent a multitude of points that can form something like a curve in the space. Evidently a table economic document represents a group of curves in space (may be a figure or some volume – generally an object). The latter assumes already concrete economical sense.

5. Conclusions

The interpretation of the economical sense of the above figures described by multitudes of points in the informational space permits to obtain a universal type procedure for the automated informational management. This procedure being integrated in user's interface by means of simple operations on a sufficiently general level becomes an effective way of data handling. The procedure represents an unregulated type of interpellation, which doesn't require additional software engineering.

The functional schema of such an interpellation was described in earlier articles ([7] etc.) and presented in figure 2. The procedures realized this way become a processing mode for any activity like in an automated informational system.

The above ideas and ways of solving the automation problems were realized at SC "Informational Technologies and Systems"(Chisinau, Republic of Moldova) and used for designing complex informational systems in ecology and agriculture. The applied methods demonstrated their efficiency and permitted to obtain important performances.

References

1. Costaş I., Cocârţă P., Burlacu I. Designing of data banks in ecology and environment protection // Ecology and environment protection in Republic of Moldova, Chisinau, "Science", 1992, p.p. 105-107;

2. Costaş V., Costaş I., Burlacu I. The user linguistics interface in informational systems // The national cybernetic conference, the 6th edition, Bucharest, 1994, p.p. 81-82.

3. Burlacu I. The control aspects of semantic structures of the communicational language // Scientific symposium of scientist-didactical staff, ASEM, Chisinau, 1994. P.p. 141-143;

4. Burlacu I. Utilization of Some Features of the Communication Language in the Creation of the Database Frame in the Field of Ecology and Agriculture // The 2nd International Symposium of Economic Informatics, Bucharest, 1995, p. 293;

5. Costaş I., Burlacu I. Presentation of information in ecological data banks // The transitional economy and economical development // Scientist symposium, ASE, Bucharest, 1993, p. 72;

6. Costaş I., Burlacu I. The methods of informational technology designing in ecology // Ecological management and durable development // Theses, Chisinau, 1996, p. 58;

7. Costaş I., Burlacu I. Informational technologies in agriculture and environment protection // Acta Academia, Chisinau, AII, 1999, p.p. 253-269.