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Some aspects of computer diagnostic analysis of the management systems

by

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The method of analysis and the attempt of its computer realization for typical management system is presented. The advantage of this method is a relatively low cost and laboriousness which was confirmed during tests on particular object. Given method may be also the convenient preliminary stage to the works on implementing the computer applications to management.

1. Introduction

Some years lasting investigations in the field of the complex management system algorithmization [1, 2] have led to design of the hipothetic mathematical model for the typical management system [3, 4]. Methods of quantificator logic [5] and the classic sentence calculus [6] were used with that. The method of diagnostic analysis of management systems [7] with regard to its computer realization is connected with this model. Some problems concerning the computer diagnostic analysis are considered below.

2. System of computer diagnostic analysis

The scheme of the system is presented in Fig. 1. The system consists of blocks containing the replaceable sets of programs. Such structure ensures the flexibility of the system either in utilization domain or in its further improvement.

The essence of computer diagnostic analysis system lies in identification of the "illness symptoms" i.e. in identification of the indisposition symptoms of investigated object (block 3) and in defining its "illness units" i.e. the very indispositions (block 6) on the basis of identification.

Obtained on particular (consecutive) stages of analysis the intermediate results are gathered in block 4 and then utilized during diagnosis process (block 6). Block 7 ensures in the exit of desired kinds of results of the diagnostic analysis.

The assumption was made that most of the needed for analysis data is obtained from the questionnaires prepared in such a way that the data is easily acceptable as the computer input through the block 2. The additional data that reflect the specific properties of object under investigation are inserted through block 5.

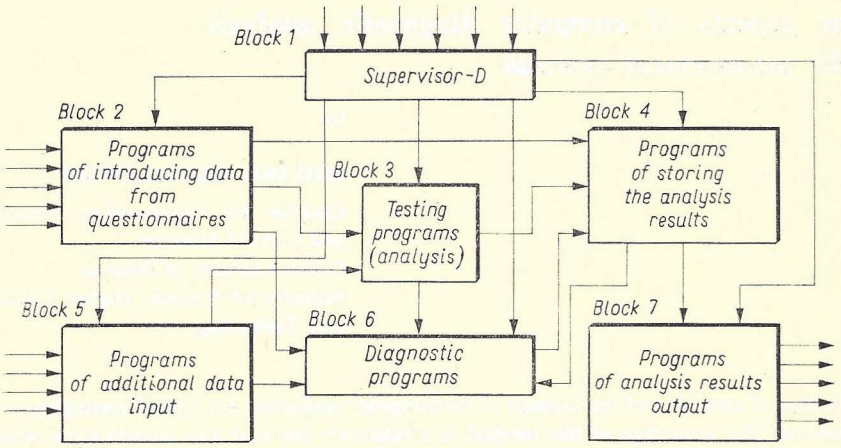

Fig. 1.

The programm called SUPERVISOR-D (block 1) administers work of all mentioned blocks. According to kinds of objects and to the analysis scope it qualifies the order of programms execution, manages the information input and output, performs the essential control functions and so on. At present only the assumptions concerning this block are elaborated. It follows, among the others, from the preparatory character of works on the utilization of the diagnosis results in the therapy of investigated object. Studies towards the computer synthesis of so called Managers Information System, treated as the casual therapeutic medium are more advanced.

There is no doubt however, that block 1 should also provide the suitable cooperation with appropriately developed future system of computer synthesis for improved, free of indispositions object of investigations, utilizing the results of diagnostic analysis in global and efficient therapy.

On the other hand, the studies over other more essential parts of the computer diagnostic analysis systems, i.e. over the testing (block 3) and diagnostic programms (3) are considerably advanced. They are described below.

3. Process of computer diagnostic analysis

The process of diagnostic analysis may be divided into following stages.

(a) Recognition and preparation of investigated object.

On this stage the object is divided into the functional cells. Furthermore, some cells are choosen for further inquiry. The set of basic tasks performed by these

cells, with the division into subtasks and operations is also designated. These data are coded to form some kind of thezaurus, which is obligatory for all persons filling in the questionnaires. Its form and an example are presented in the table I.

Table I

Name of cell	Name of task, subtask and the executive operation	Cell	Task	Subtask	Operation
		LL	CC	CC	CC
	Example				
Division of production planning and material provision	Elaboration of the production plan for year	HZ	01	00	00
	Fixing the predicted execution of planning tasks production	HZ	01	01	00
	Information about the raw material provision for the next month	HZ	06	12	08

(b) Object identification.

On this stage the inquiry of choosen cells is performed and then the data gathered from the questionnaires and the additional data are fed to the computer.

(c) Illness symptoms testing.

The data concerning the objects gathered in the computer memory are consecutively tested according to specified procedure, by the set of testing algorithms. As a solution the information of existence or nonexistence of given indisposition symptom and its location and intensification is obtained.

Until the present moment, in the grounds of the literature data [8] 29 symptoms are singled out. For some of them the testing algorithms are made. For a symptom "overall or partial doubling of executive operations" the algorithm has a form:

$$\bigwedge_{r=1}^{k}\left(A_r \wedge \left(\bigvee_{r=1}^{k} A_{r+1}\right)\right),$$

where: A_r — the r-th executive operation; for symptom: — "lack of receiver of the task (subtask, operation) result" the algorithm is following:

$$\bigvee_{n=1}^{N}\bigvee_{m=1}^{M} W_{nm} \mp \bigvee_{n=1}^{N}\bigwedge_{m=1}^{M} Z_{(n+1)m},$$

where: W_{nm} — the m-th internal operation of the n-th cell, $Z_{(n+1)m}$ — the m-th external operation of the $(n+1)$-th cell.

The information about symptoms for which there are not testing algorithms, is taken from appropriate rubric of questionnaire (most often it is a subjective estimation).

Such example is the "limited activity efficiency".

Information about the symptom detection is sent to the estimation register. For each symptom an appropriate sensitivity threshold is fixed. It takes into consideration the number of detections depending on the specifies of object under consideration. Crossing the threshold implies designation of value 1 to appropriate component of the column vector of symptoms (so called measure vector).

(d) Diagnosis.

The diagnosis process based on the experience and on the identification of illness units consisting in the measuring vector investigation. On the grounds of the literature data [9] 15 units are singled out. These units all either of local character (for instance the "operation doubling", the "bottle-necking") or of the global one ("bad coordination", "excessive direction extension" and so on).

Each illness unit is described by a series (a vector) of symptoms. One of them is a dominant symptom, i.e. its existence is a necessary condition for occurrence of given illness unit. Some components of the symptom vectors may be identical for some illness.

The symptoms and illness units form the so called diagnosis matrix (consisting of zero—one elements), in which every one of 15 columns forms the description of one illness unit in class of symptoms (the existence of symptom — 1, its absence — 0), and 29 rows reflect the description of every symptom in class of illness units.

The problem of identification of an illness unit lies in attribution of measure vector to the "closest" column vectors from the diagnostic matrix.

For that purpose a set of diagnostic algorithms was prepared. The algorithm for checking if the necessary condition for illness unit existence fulfilled has the following form

$$\bigwedge_{j=i}^{15} \bigvee_{i-1}^{29} (x_j^i = x_j^*),$$

where x_j^i — the current value of the dominante symptom of the j-th illness unit measured on the measure vector; x_j^* — the patterns value of the dominante value of the j-th illness symptom (in given case x_j^* is always equal 1, it is however predicted that $x_j^*=0$ may be introduced when this symptom existence eliminates the given illness unit).

(e) Getting the results of the diagnostic analysis.

At this stage identified names of illness units are made available from the computer (most usually as a printed material). On special desire the additional data may be obtained (for instance the intensification, the surpassing of sensitivity threshold, or the number of particular symptoms occurrence, the position of symptoms and so on).

4. The attempt to computer diagnostic analysis realization

Some discussed above algorithms have been realized. The written and checked programs have been designed in the convenient way to constitute some integrity (so called system DIANA-2), which enables realizing the preliminary computer

diagnostic analysis of the concrete object. Such investigations have been performed on the example of Central Board of Union of Paints and Lacquers Industry. A little earlier the management system of one paints and lacquers factory was the object of investigations.

The first group of programs of DIANA-2 system serves to identify the information connections network and to check the dominant and associated symptoms of the illness unit — "CH2" — the "impasses". In this case the following information taken from the questionnaires of every functional cell is utilized:

Table II

1a	1b	2a	2b	3a
Code of cell-executive	Code of consecutive task (subtask operation)	Code of cell the information deliverer	Code of this task (subtask operation) whose the results are utilized by the all executor	Code of all receives

The assumption is made that the person who fields in the questionnaire is familiar with the tasks realized by the execution cell, with the cells from which the desired information is collected and which cell is the receiver results. This person, however, is unfamiliar with the way the results are utilized.

The codes are given in conformity with the thezaurus.

The information from the rubric 3a enables the computer to search for the particular task of the execution cell in the set of tasks of the receiver cell of particular task. In other words, one aims to add one rubric to table II:

3b
The code of task (subtask, operation) of the receiver cell in which the result of task (subtask, operation) of executor cell was utilized.

The discovered code of task of the receiver cell determines the next connection in the information net of object under in investigation. The negative result indicates the lack of receivers of realized task by the execution cell (the dominant symptom of impasse).

The consequent fulfillment of the programm for all tasks of inquired cells gives, as the solution, the description of informative connections net in which the execution cell and its task constitute the node and the providing and receiving cells the input and output of the net respectively. This description is utilized for further analysis to detect for instance some concomittant symptoms, i.e. the bottle-necks, the critical paths, and so on. It consists also the basis to the computer synthesis of the management system.

The result of realization of identification programm which identifies the information net and the impasses is printed in form presented in Fig. 2.

EZ	1			
		EF	2	EE
		TT	5	EK
		HO	10	EK
		IW	0	BP
				MR
				EZ
EZ	2			
		ZP	0	ZP
EZ	3			
		EF	6	EF
EZ	4			
		ZP	0	NE
EZ	5			
		EE	4	CF
		EF	2	ZP
		GF	2	IB
EZ	6			
		ZP	0	US
				MR
EZ	7			
		HP	12	US
		HZ	6	MR
		HO	1	
EZ	8			

Fig. 2.

Another group of DIANA-2 system programs realizes the diagnosis process. The result of programs realization — names of detected illness units, the sensitivity thresholds of their dominant symptoms, the tolerance coefficients (the admissible deviation) and the transformed matrix are printed in form showed in Fig. 3.

21	1	0	0	1	0	1	1	1	1	0	1	1	0	1	1	0
22	1	0	1	1	0	1	1	1	0	1	1	1	0	0	1	1
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	1	1	1	0	1	0	1	1	0	1	1	0	1	1*	1	1
27	1	1	0	0	1	1	0	1	0	1	1	0	0	1	1*	1
28	1	1	1	1	0	1	0	1	0	1	1	0	1	1	1	1
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E	16	9	7	10	5	11	7	10	9	11	16	12	7	7	12	11
MAX	29	12	11	17	11	15	15	16	19	16	22	21	15	15	24	21
%	40.0	41.4	37.9	58.6	37.9	51.7	51.7	55.2	65.5	55.2	75.9	72.4	51.7	51.7	82.8	72.4
%E	55.2	75.0	63.6	58.8	45.5	73.3	46.7	62.5	47.4	68.7	72.7	57.1	46.7	46.7	50.0	52.4
X		X				X		X	X					X	X	
CH		CH				CH										

K= 55.2/15 = 3.7 %

CH1 - operations doubling (more then P1.1)
P1.1 = 10% of all operations

CH5 - excessive management expansion (at least P8.5 cases)
P 8.5 - 1 case

Fig. 3.

5. Conclusions

The method of analysis and the attempt of its computer realization for typical management system is presented. The advantage of this method is a relatively low cost and laboriousness which was confirmed during tests on particular object. Given method may be also the convenient preliminary stage to the works on implementing the computer applications to management.

The next works should be continued in two directions.

First, one should search the further efficient ways of detecting and particularly "treating" the illness units, because the efficiency of using of the diagnosis results depends on solving the problems connected with the therapy.

Therefore, interdisciplinary approach to the problem seems to be indispensable.

Secondly, the applied mathematical methods should be expanded to take into consideration the need of suitable man-computer contact and not only to join in uniform way the diagnostic analysis and synthesis.

The attempts of adopting such existing specialized languages as ALGOL-68, AUTOSATE, SYSTEMATICS, ISDOS (PSL, SODA) and so on, has not given positive results as yet. Therefore the need of designing a special language oriented toward problems of computer diagnostic analysis and synthesis of management systems may appear in the future.

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Pewne aspekty maszynowej analizy diagnostycznej systemów zarządzania

Przedstawiono metodykę i próbę realizacji maszynowej analizy diagnostycznej typowego systemu zarządzania. Zaletą metody jest stosunkowo niski koszt i pracochłonność badań przy znacznej efektywności co potwierdziły próby na konkretnym obiekcie.

Podana metodyka może być również dogodnym etapem wstępnym przy pracach nad wdrażaniem elektronicznej techniki obliczeniowej w zarządzaniu.

Некоторые аспекты машинного диагностического анализа управленческих систем

Представлена методика и попытка реализации машинного диагностического анализа типичной управленческой системы. Преимуществом метода является относительно невысокая стоимость и трудоемкость исследований при ощутимой эффективности результатов, что подтверждается работами проводимыми на реальном объекте.

Данная методика может быть также полезной в качестве предварительного этапа при работах по внедрению вычислительной техники в управленческой области, в особенности при разработке АСУП и ОАСУ.