Improvement and assessment of the effective therapy selection method

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Introduction. Within the framework of scientific work of Faculty of Computer Science and Information Technology of Riga Technical University various computer control systems have been created. One of the inquiry objects is foundation of intellectual medicine computer systems, which could be useful for medical attendants in decision making process. In this article authors present improved arterial hypertension therapy selection methodology that includes extended description model of pathogenesis and graph mathematical processing approach. At the beginning problem domain is discussed to define possible system structure, and then improvements are given. In the conclusion part usefulness of new method and further progress is described.

Development of intellectual medicine expert system. Social sphere investigations manifest that common demographics becomes worse, because society ages. Main reason of this situation is majority of elderly people [1]. One of the main cardiovascular diseases (e.g. arterial hypertension, heart ischemia and others) of elderly people (and not only) is widely spreaded arterial hypertension (AH). Authors have developed AH modeling and therapy efficacy assessment methodology [2] and the latest developed medicine system [3] incorporates the most effective therapy combination selection approach. Before the improvement is under discussion it is necessary to consider medicine expert system application field to point out structure of computer system.

At the end of the last century expert systems (ES) in many activity fields became widely exploited, because software distribution companies made investments in these systems. Expert system can be described as an artificial intelligence (AI) consultation system, which uses AI decision making techniques to represent expert (human) decision making process in specialized sphere [4]. In this case medical expert system is one of the ES applications. Medical ES can consist of three main parts, which are necessary to be observed before development of system [5]:

- Knowledge base. It is important to select most suitable knowledge representation, storage and processing method. Authors use topological model which represents knowledge in oriented graph form. Processing method allows directly investigate systems activity. Topological model includes all functional aspects of the systems which are under examination.
- Decision making uses knowledge base to form resolution. Main therapy modeling process and evaluation of results are based on perambulation of the topological model, which is based on graphs'

recalculation. In medicine system the side disease assessment based on production law logic is also included.

- User interface of computer system. This aspect includes medicine system visual appearance and functional elements.

Arterial hypertension topological model. Authors use topological model to perform arterial hypertension modeling process. Modeling tool is described in papers [2, 3]. AH topological model is knowledge (of pathogenesis) representation in orientated graph form. Nodes in graph represents: organism subsystem changed levels, therapies and therapies' side effects. Full initial graph model is represented in Fig. 1.

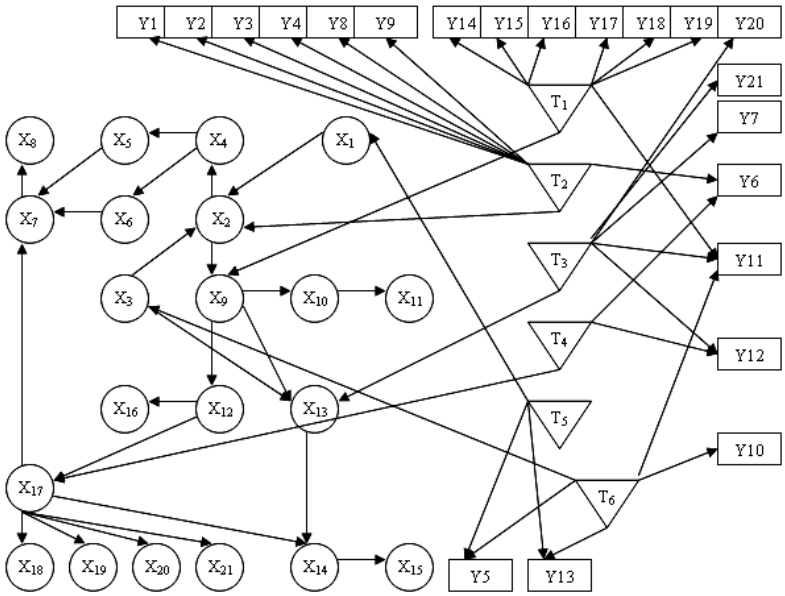

Fig. 1. Initial graph model of arterial hypertension

Modelling process of therapy is based on each node recalculation. Selected therapy makes an influence on some organism subsystem node and then algorithm perambulates further linked graph nodes. Resultant efficiency of therapy is based on summary change of all nodes.

Improvement and assessment of therapy selection method. The main goal of this paper and recent research is to create mathematical assessment complex that could reduce calculation of topological model. It is necessary to use graph techniques to relieve complexity of graph recalculation. Also these techniques are useful because further development includes expansion of pathogenesis topological model. Expansion includes:

- More precise definition of pathogenesis existing model. Contemporary medicine evolves, so it is useful to update knowledge about topological model of arterial hypertension.
- Addition of other pathogenesis to existing AH topological model. In this case in collaboration of medical experts, topological models of other diseases (heart ischemia, diabetes mellitus or other) have to be created. Then by using graph composition techniques, one common topological model will be created.

One of the solutions how to reduce complexity of calculation is to decrease topological model structure by cutting off less important nodes. It is possible to perform node ranging to select most informative nodes. This methodology will be much useful when common multi pathogenesis topological model will be created. Authors propose node assessment technique that can select cut off nodes. Algorithm is based on PageRank [6] method and it is implemented in intellectual medicine system. PageRank is an iterative algorithm and it is presented:

$$\Pr(A) = (1-d) + d\sum_{i=1}^{n}\frac{\Pr(T_i)}{C(T_i)}, \quad (1)$$

where *Pr()* – PageRank coefficient of node; *d* – Dumping coefficient; *n* – Input node count; C*()* – Output node count.

Dumping coefficient *d* is used to describe situation that perambulation in some node will stop with definite probability. It means that in some node the therapy influence will be so small, that it could stop at all. In Fig. 2 it is shown organism subsystem reduced graph model after methods execution (dashed nodes will not be examined in calculation process).

By using combinatorics it is possible to determinate therapy combination count. If we use 6 therapies then there are 36 012 942 possible therapy combinations (sum of one therapy all variants, 2 therapies all combinations and so on) and the reviewed node count is 1 566 562 455. After execution of PageRank algorithm modelling process will review 828 297 390 nodes. Calculation of all arterial hypertension therapy combinations will be 1,89 times faster.

Experimental results show that in most cases this reduction method does not affect on final therapy selection. In the further research authors will examine PageRank algorithm variations, like probability component and weighted node algorithm versions. Integration of other graph structure assessment methods (MITS, SALSA, TrustRank) will be included to create general graph structure analyze method.

Discussion. Medical care always is on of the governments and society priority. It is important to provide wholesome medical service and protection. Authors' research includes development of intellectual medicine systems. The most effective arterial hypertension therapy selection methodology has been created. In this paper authors introduce possibility to expand pathogenesis

topological model by upgrading existing arterial hypertension topological model and by adding models of other diseases. Also example of graph processing techniques, that could reduce processing complexity and execution time, are given. Further study will be based on graph structure analyze method survey and implementation in intellectual medicine system.

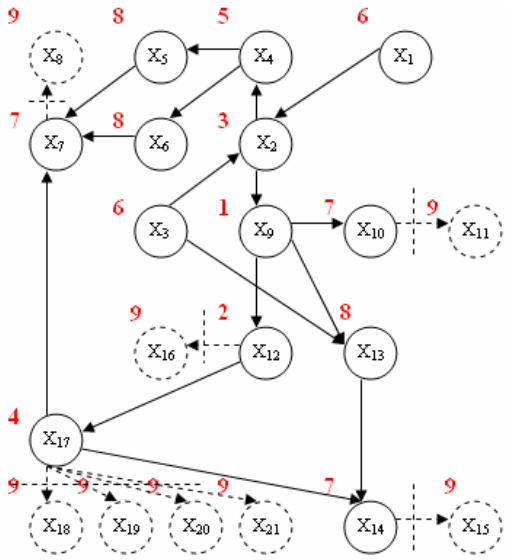

Fig. 2. Reduced topological model of organism subsystems

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In this article the most effective improved arterial hypertension therapy selection method is described. At the beginning of the article authors discuss similar systems, which are used in practice. Then possible solution range is defined. Solution includes therapy selection improvement – expansion of the pathogenesis topological model. Other diseases and existing arterial hypertension are taken into account. At the ending part authors consider usability of the new method. Further mathematical processing and topological model assessment approach is given.