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GENERALIZED NET MODELS IN NEUROLOGY (INTRODUCTION)

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One of the important components of the scientific area called "artificial intelligence" is "Decision Making" (DM). The DM methods are heterogeneous - logical, statistical, combinatorial etc. One of the characteristic feature of the existing methods is that they are sequencial ones.

Four years ago it was introduced the idea for Generalized Net (GN) description of the different components of the artificial intelligence (see [1,2]). One of the aims was to describe the procedures of the DM by the means of the GNs. In general, this problem is open to the moment, but in a series of papers the authors plan to show the way for GN-modelling of the DM schemes in neurology. They will use the DM schemes described in [3]. These schemes will be described by separate GNs. Practically, the GN-models will correspond to the models from [3]. In some places the authors (using their knowledge) will do some minor corrections with which they will extend or modify the schemes from [3]). The basic difference between both approaches (the binary graph approach from [3] and the GN-approach) is the following. The first approach reflects the statical structure of the process of the DM, i.e., the sequencial activities which the specialist (doctor) has to do in the diagnostic process for a given patient. The logic of this process and the activities which the specialist must do are represented by the texts in the graph vertices; the sequencial steps which the specialist must follow - by the arcs of the graph. In the general case, from the vertices go out one or two arcs (thus the graph is a binary one). Therefore, the transfer on this graph is related to the YES/NO-answers of the specialist. In real practice, there are a lot of cases, when the answer cannot be "YES" or "NO". There are situations, in which the answer can be, e.g., 40% YES and 60% NO; or, the most interesting case - 35% YES, 40% NO and 25% - indeterminate. In this case the transfer on one path in the graph is not the best solution. The process of DM must be based on parallel transfers on different paths on the graph. This is not possible by means of the graph theory only. The elements of other mathematical means are necessary. On the other hand, the graph way for representing of the DM process cannot describe the temporal elements of the diagnostic process. The solution of this problem is related to the use of Petri net tools. The GNs are these extensions of the Petri nets, which give the possibility to describe the time-parameters, the logical conditions, the capacities of the separate components, the history of the modelled processes.

Shortly, the GNs [1,4] are abstract mathematical objects for modelling, simulation, optimization and control of real processes. These nets include as particular cases the ordinary Petri Nets (PNs) and other extensions and modifications as E-nets, Time PNs, PRO-nets, Coloured PNs, Self-modifying nets, Predicative/transition nets, Super nets, Generalized modified PNs, M-nets and others, and different types of the neural networks. All models, described by means of another type of nets can be described by GNs, too. On the other hand the GNs give a possibility for more detailed descriptions of the real processes because:

1. They have temporal components as E-nets, PRO-nets and Time PNs, but they can be non-invariant about time.
2. Their tokens have characteristics, but they can contain all necessary information in contrast to the colours in Coloured PNs and the symbols in Predicative/transition nets.
3. They contain predicates which determine the token's transfer from i-th input to j-th output transition places in contrast to the unique predicate in the Predicative/transition nets.
4. The algorithms for tokens' transfer are more detailed than the algorithms for the other nets (in particular, the algorithms for the functioning of the different types of neural networks).
5. All events generated in the time of the functioning of the GNs are registered and they can be used for calculation of the truth-values of the predicates and of the token's characteristic functions.
6. GNs can be self-modifying, but in contrast to the Self-modifying nets, they can change their structure, tokens, characteristic and other functions and algorithms for tokens' transfer.
7. They have different tools for analysis of the final and intermediate results.
8. Different operations, relations and operators can be applied over GNs and which had not been defined for the other nets yet. The operators are global, local, hierarchical, reducing, extending and dynamical.

In [5] (using previous results) the GN-models of diagnostic approach to different signs and symptoms in nephrology were described. First, we construct GN-models which function in similar way, i.e., GNs (without temporal components, places capacities and other auxiliary components) that describe the logical relations between the different steps of the diagnostic process. In next research, we shall add these other components, too. Still, this is not accomplished for the GN-models from [5].

Here we discuss some elements of the researches in [3] on DM in (adult) neurology. Separate DM schemes are described there, but the connections between these schemes are not discussed. These connections are the following, where the following notation is used: the numbers $\frac{m}{n}$ denote that the m-th DM scheme is on page n;

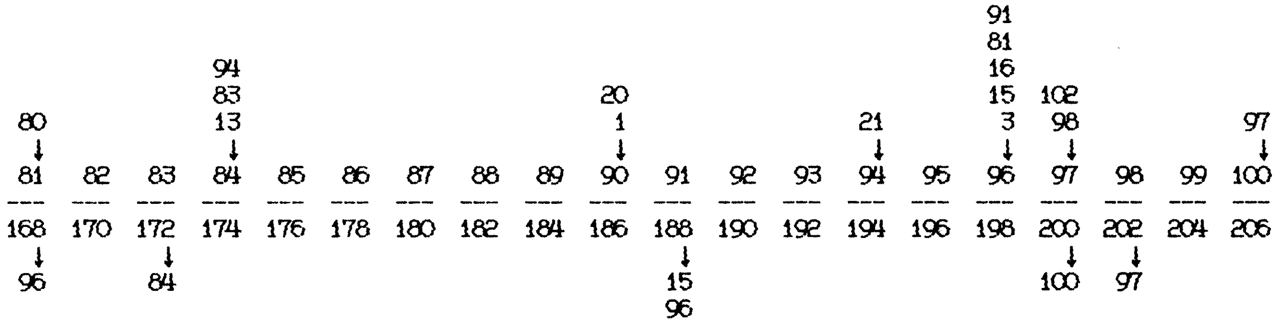
$\begin{array}{c}k\\\downarrow\\m\\\hline n\end{array}$ denotes that there is a call to m-th scheme in the frames of k-th DM scheme and $\begin{array}{c}m\\\hline n\\\downarrow\\p\end{array}$ denotes that there is a call to p-th scheme in the frames of m-th DM scheme:

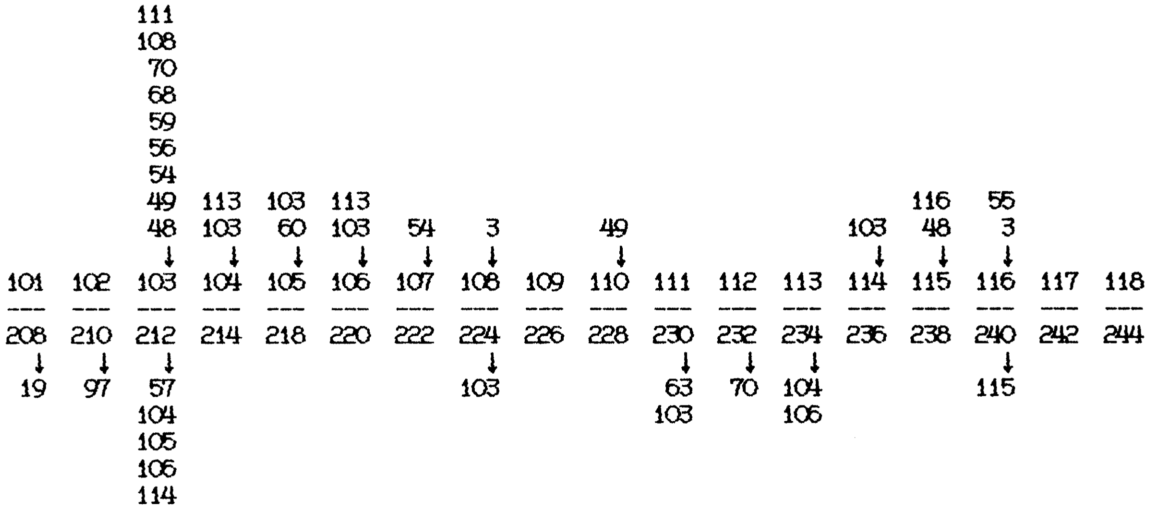
$\begin{array}{c}1\\\hline 2\\\downarrow\\90\end{array}$ $\begin{array}{c}2\\\hline 4\\\downarrow\\4\\11\\26\\51\\62\\64\\67\end{array}$ $\begin{array}{c}3\\\hline 6\\\downarrow\\96\\103\\116\end{array}$ $\begin{array}{c}64\\59\\49\\2\\\downarrow\\4\\\hline 8\\\downarrow\\5\end{array}$ $\begin{array}{c}73\\4\\\downarrow\\5\\\hline 10\end{array}$ $\begin{array}{c}6\\\hline 12\end{array}$ $\begin{array}{c}49\\\downarrow\\7\\\hline 14\end{array}$ $\begin{array}{c}8\\\hline 16\end{array}$ $\begin{array}{c}9\\\hline 18\end{array}$ $\begin{array}{c}10\\\hline 20\end{array}$ $\begin{array}{c}2\\\downarrow\\11\\\hline 22\end{array}$ $\begin{array}{c}12\\\hline 24\end{array}$ $\begin{array}{c}13\\\hline 26\\\downarrow\\16\\84\end{array}$ $\begin{array}{c}14\\\hline 28\end{array}$ $\begin{array}{c}91\\\downarrow\\15\\\hline 30\\\downarrow\\96\end{array}$ $\begin{array}{c}13\\\downarrow\\16\\\hline 32\\\downarrow\\96\end{array}$ $\begin{array}{c}17\\\hline 34\end{array}$ $\begin{array}{c}18\\\hline 36\end{array}$ $\begin{array}{c}101\\\downarrow\\19\\\hline 38\end{array}$ $\begin{array}{c}20\\\hline 40\\\downarrow\\90\end{array}$

$\begin{array}{c}21\\\hline 42\\\downarrow\\94\end{array}$ $\begin{array}{c}22\\\hline 44\\\downarrow\\49\\78\end{array}$ $\begin{array}{c}48\\\downarrow\\23\\\hline 46\end{array}$ $\begin{array}{c}24\\\hline 48\\\downarrow\\34\end{array}$ $\begin{array}{c}25\\\hline 50\end{array}$ $\begin{array}{c}2\\\downarrow\\26\\\hline 52\end{array}$ $\begin{array}{c}47\\\downarrow\\27\\\hline 54\end{array}$ $\begin{array}{c}28\\\hline 56\end{array}$ $\begin{array}{c}29\\\hline 58\\\downarrow\\30\end{array}$ $\begin{array}{c}29\\\downarrow\\30\\\hline 60\end{array}$ $\begin{array}{c}31\\\hline 62\end{array}$ $\begin{array}{c}32\\\hline 64\end{array}$ $\begin{array}{c}33\\\hline 66\end{array}$ $\begin{array}{c}24\\\downarrow\\34\\\hline 68\end{array}$ $\begin{array}{c}35\\\hline 70\end{array}$ $\begin{array}{c}36\\\hline 72\end{array}$ $\begin{array}{c}37\\\hline 74\end{array}$ $\begin{array}{c}38\\\hline 76\end{array}$ $\begin{array}{c}39\\\hline 78\end{array}$ $\begin{array}{c}42\\\downarrow\\40\\\hline 80\end{array}$

$\begin{array}{c}41\\\hline 82\end{array}$ $\begin{array}{c}42\\\hline 84\\\downarrow\\40\end{array}$ $\begin{array}{c}43\\\hline 86\end{array}$ $\begin{array}{c}44\\\hline 88\end{array}$ $\begin{array}{c}45\\\hline 90\end{array}$ $\begin{array}{c}46\\\hline 92\end{array}$ $\begin{array}{c}47\\\hline 94\\\downarrow\\27\end{array}$ $\begin{array}{c}48\\\hline 96\\\downarrow\\23\\56\\103\\115\end{array}$ $\begin{array}{c}22\\\downarrow\\49\\\hline 98\\\downarrow\\4\\7\\57\\63\\77\\78\\103\\110\end{array}$ $\begin{array}{c}50\\\hline 100\end{array}$ $\begin{array}{c}2\\\downarrow\\51\\\hline 102\\\downarrow\\56\end{array}$ $\begin{array}{c}52\\\hline 104\end{array}$ $\begin{array}{c}53\\\hline 106\\\downarrow\\56\\64\end{array}$ $\begin{array}{c}54\\\hline 108\\\downarrow\\57\\58\\103\\107\end{array}$ $\begin{array}{c}55\\\hline 112\\\downarrow\\62\\116\end{array}$ $\begin{array}{c}68\\64\\53\\51\\48\\\downarrow\\56\\\hline 114\\\downarrow\\57\\103\end{array}$ $\begin{array}{c}103\\64\\56\\54\\49\\\downarrow\\57\\\hline 116\end{array}$ $\begin{array}{c}54\\\downarrow\\58\\\hline 118\end{array}$ $\begin{array}{c}59\\\hline 120\\\downarrow\\4\\103\end{array}$ $\begin{array}{c}60\\\hline 122\\\downarrow\\105\end{array}$

$\begin{array}{c}61\\\hline 124\end{array}$ $\begin{array}{c}55\\2\\\downarrow\\62\\\hline 126\end{array}$ $\begin{array}{c}111\\49\\\downarrow\\63\\\hline 128\end{array}$ $\begin{array}{c}65\\53\\2\\\downarrow\\64\\\hline 130\\\downarrow\\4\\56\\57\end{array}$ $\begin{array}{c}68\\\downarrow\\65\\\hline 132\\\downarrow\\64\end{array}$ $\begin{array}{c}66\\\hline 134\\\downarrow\\67\end{array}$ $\begin{array}{c}66\\2\\\downarrow\\67\\\hline 136\end{array}$ $\begin{array}{c}68\\\hline 138\\\downarrow\\56\\65\\73\\103\end{array}$ $\begin{array}{c}70\\\downarrow\\69\\\hline 140\end{array}$ $\begin{array}{c}112\\\downarrow\\70\\\hline 142\\\downarrow\\69\\103\end{array}$ $\begin{array}{c}71\\\hline 144\end{array}$ $\begin{array}{c}72\\\hline 146\end{array}$ $\begin{array}{c}68\\\downarrow\\73\\\hline 148\\\downarrow\\5\end{array}$ $\begin{array}{c}74\\\hline 150\end{array}$ $\begin{array}{c}75\\\hline 152\end{array}$ $\begin{array}{c}76\\\hline 154\\\downarrow\\78\\79\end{array}$ $\begin{array}{c}49\\\downarrow\\77\\\hline 158\end{array}$ $\begin{array}{c}76\\49\\22\\\downarrow\\78\\\hline 160\end{array}$ $\begin{array}{c}76\\\downarrow\\79\\\hline 164\end{array}$ $\begin{array}{c}80\\\hline 166\\\downarrow\\81\end{array}$





In future, for every scheme of a neurological disease diagnostic process, we shall construct a GN. These GNs we shall mark by "NGNk", where k is the number of the scheme and "NGN" is an abreviature of "GN in neurology".

The GN which will include as subnets all NGNs will be a part of the GN described in [6-8].

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