

Global Generalized Net Model ff A Human Body: An Intuitionistic Fuzzy Approach

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1 Introduction

The idea for this model was generated some years ago, but there were many difficulties as well as discussions among the authors (until 2002 when he died, Joseph Sorsich was one of them) about the appropriate form of the Generalized Net (GN; see [1]) model. Finally a construction which contains possibilities for further developing future modifications by GN hierarchical operators was constructed and published in [2,3]. The applications of the GN theory in systems theory imply the necessity of such GN-models. Of course, the present GN-model is very simplified and relative, but it is at least a basis for further development. Extending [2,3], now elements fo intuitionistic fuzziness (see [4]) have been added.

2 A global GN-model of a human body

The basic systems of the human body are (see, e.g., [5]):

central neurologic system (regulation of all body functions),

cardiovascular system (provides blood supply),

respiratory system (gas exchange),

gastrointestinal system (digestion and processing of food),

endocrine system (humoral regulation),

hematopoetic system (production and maturation of blood cels),

musculo-skeletal system (posture and locomotion),

renal and urologic system (excretion of soluble substances maintains homeostasis),

reproductive organs (reproduction).

We shall represent each of these by a transition within the GN-model (see Fig. 1). These transitions have maximal simple form: one input, one output and one input-output place. The latest one symbolises the interior process of the respective organ/system and

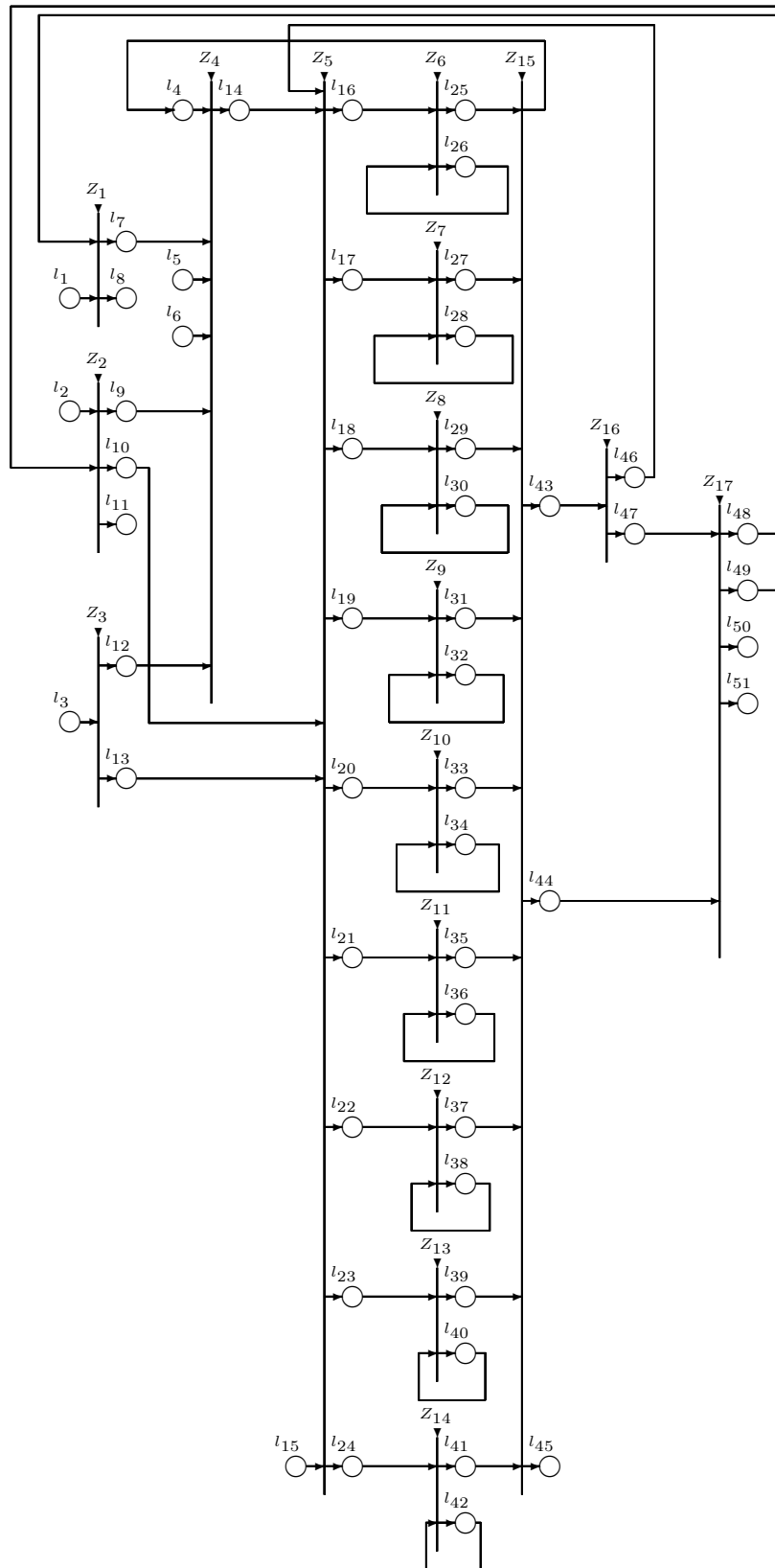


Fig. 1: GN-model

it contains a token (let these nine tokens be $\omega_1, \omega_2, \dots, \omega_9$) which will has as its current characteristic the status of the corresponding organ/system.

For completeness of the model we shall add input and output places which represent separate organs related to the inputs and outputs of the human body. Let tokens $\beta_{1,j_1}, \beta_{2,j_2}, \dots, \beta_{5,j_5}$ enter respective places l_1 (derma), l_2 (nose), l_3 (mouth and tongue), l_5 (eyes), l_6 (ears), where $j_1, j_2, \dots, j_5 \geq 1$ correspond to the current number of exterior effects, with initial characteristics, corresponding to the type of the efect and its parameters (power, continuity, volume, and so on).

Place l_{15} exists only in GN-model of the female body, while place l_{45} exists only in GN-model of the male body, since these represent their reproductive functions.

Place l_{43} represents simultaneously the blood and lymph systems. In the future more detailed GN-models, of course, these two systems will be represented by separate subnets.

Places l_{50} and l_{51} represent, respectively, defecation and urine excretion.

Transition Z_4 represents the peripheral neurologic system.

The GN-transitions have the following forms.

$$Z_1 = \langle \{l_1, l_{48}\}, \{l_7, l_8\}, \begin{array}{c|cc} & l_7 & l_8 \\ l_1 & true & false \\ l_{48} & false & true \end{array} \rangle .$$

The tokens which enter place l_1 have initial characteristic: “dermatological irritations; their quantity and quality; and so on”.

The tokens do not obtain any characteristic in place l_7 and they have the characteristic “sweat, etc.; quantity and quality; and so on” in place l_8 .

$$Z_2 = \langle \{l_2, l_{49}\}, \{l_9, l_{10}, l_{11}\}, \begin{array}{c|ccc} & l_9 & l_{10} & l_{11} \\ l_2 & W_{2,9} & true & false \\ l_{49} & false & false & true \end{array} \rangle ,$$

where

$W_{2,9}$ = “there is odor irritation”.

The tokens which enter place l_2 have initial characteristic: “inhaled air, etc.; quantity and quality; and so on”.

The tokens do not have any characteristic in places l_9 and l_{10} , and they have the characteristic “exhaled air, etc.; quantity and quality; and so on” in place l_{11} .

$$Z_3 = \langle \{l_3\}, \{l_{12}, l_{13}\}, \begin{array}{c|cc} & l_{12} & l_{13} \\ l_3 & W_{3,12} & W_{3,13} \end{array} \rangle ,$$

where

$W_{3,12}$ = “there are stimuli acting in the mouth, on the tongue and musole membranes”,

$W_{3,13}$ = “there is food, fluids, etc.”.

The tokens which enter place l_3 have initial characteristic: “air, food, etc.; quantity and quality”.

The tokens do not have any characteristic in places l_{12} and l_{13} .

$$Z_4 = \langle \{l_4, l_5, l_6, l_7, l_9, l_{12}, \}, \{l_{14}\}, \begin{array}{c|c} & l_{14} \\ \hline l_4 & true \\ l_5 & true \\ l_6 & true \\ l_7 & true \\ l_9 & true \\ l_{12} & true \end{array} \rangle .$$

The tokens which enter place l_5 have initial characteristic: “visual stimuli, eye irritation; quantity and quality; etc.” and those which enter place l_6 have initial characteristic: “sound and equilibrium stimuli; quantity and quality”.

Each sensory organ has a specific modality (visual, auditory, tactile, taste and olfactory) and reacts to specific external stimuli in a definite range limited by minimal and maximal thresholds. Eyes, for example see light with wave length between 350 and 800 mm, ears detect auditory vibrations with frequencies between 20 and 16 000 Hz, etc.

The tokens which enter place l_{15} have initial characteristic: “sperm; quantity and quality”.

$$Z_5 = \langle \{l_{10}, l_{13}, l_{14}, l_{15}, l_{46}\}, \{l_{16}, l_{17}, l_{18}, l_{19}, l_{20}, l_{21}, l_{22}, l_{23}, l_{24}, \},$$

	l_{16}	l_{17}	l_{18}	l_{19}	l_{20}	l_{21}	l_{22}	l_{23}	l_{24}	
l_{10}	<i>false</i>	<i>false</i>	<i>true</i>	<i>false</i>	<i>false</i>	<i>false</i>	<i>false</i>	<i>false</i>	<i>false</i>	
l_{13}	<i>false</i>	<i>false</i>	<i>true</i>	<i>false</i>	<i>false</i>	<i>false</i>	<i>false</i>	<i>false</i>	<i>false</i>	
l_{14}	$W_{14,16}$	$W_{14,17}$	$W_{14,18}$	$W_{14,19}$	$W_{14,20}$	$W_{14,21}$	$W_{14,22}$	$W_{14,23}$	$W_{14,24}$	>
l_{15}	<i>false</i>	<i>false</i>	<i>false</i>	<i>false</i>	<i>false</i>	<i>false</i>	<i>false</i>	<i>false</i>	<i>true</i>	
l_{46}	<i>true</i>	<i>true</i>	<i>true</i>	<i>true</i>	<i>true</i>	<i>true</i>	<i>true</i>	<i>true</i>	<i>true</i>	

where

$W_{14,16}$ = “there is an afferent nerve-signal to the central neurologic system”,

$W_{14,17}$ = “there is an afferent nerve-signal to the cardiovascular system”,

$W_{14,18}$ = “there is an afferent nerve-signal to the respiratory system”,

$W_{14,19}$ = “there is an afferent nerve-signal to the gastrointestinal system”,

$W_{14,20}$ = “there is an afferent nerve-signal to the endocrine system”,

$W_{14,21}$ = “there is an afferent nerve-signal to the hematopoetic system”,

$W_{14,22}$ = “there is an afferent nerve-signal to the musculo-skeletal system”,

$W_{14,23}$ = “there is an afferent nerve-signal to the renal and urologic system”,

$W_{14,24}$ = “there is an afferent nerve-signal to the reproductive organs”.

In every one of the output places the token has the characteristic “quantity of the nerve-signal”.

$$Z_6 = \langle \{l_{16}, l_{26}\}, \{l_{25}, l_{26}\}, \begin{array}{c|cc} & l_{25} & l_{26} \\ \hline l_{16} & true & false \\ l_{26} & false & true \end{array} \rangle .$$

The tokens have the characteristic “afferent signal; quantity and quality” in place l_{25} and “current status of neurological system” in place l_{26} .

$$Z_7 = \langle \{l_{17}, l_{28}\}, \{l_{27}, l_{28}\}, \begin{array}{c|cc} & l_{27} & l_{28} \\ \hline l_{17} & true & false \\ l_{28} & false & true \end{array} \rangle .$$

The tokens have the characteristic “afferent neuron signals, blood, etc; quantity and quality” in place l_{27} and “current status of cardiovascular system; quantity and quality” in place l_{28} .

$$Z_8 = \langle \{l_{18}, l_{30}\}, \{l_{29}, l_{30}\}, \begin{array}{c|cc} & l_{29} & l_{30} \\ \hline l_{18} & true & false \\ l_{30} & false & true \end{array} \rangle .$$

The tokens have the characteristic “exhaled air; quantity and quality” in place l_{29} and “current status of respiratory system; quantity and quality” in place l_{30} .

$$Z_9 = \langle \{l_{19}, l_{32}\}, \{l_{31}, l_{32}\}, \begin{array}{c|cc} & l_{31} & l_{32} \\ \hline l_{19} & true & false \\ l_{32} & false & true \end{array} \rangle .$$

The tokens have the characteristic “excreted substances; quantity and quality” in place l_{31} and “current status of gastrointestinal system; digestion and its components; quantity and quality” in place l_{32} .

$$Z_{10} = \langle \{l_{20}, l_{34}\}, \{l_{33}, l_{34}\}, \begin{array}{c|cc} & l_{33} & l_{34} \\ \hline l_{20} & true & false \\ l_{34} & false & true \end{array} \rangle .$$

The tokens have the characteristic “hormones and related substances” in place l_{33} and “current status of endocrine system; quantity and quality” in place l_{34} .

$$Z_{11} = \langle \{l_{21}, l_{36}\}, \{l_{35}, l_{36}\}, \begin{array}{c|cc} & l_{35} & l_{36} \\ \hline l_{21} & true & false \\ l_{36} & false & true \end{array} \rangle .$$

The tokens have the characteristic “haematopoiesis, lymphopoiesis, etc; quantity and quality” in place l_{35} and “current status of hematopoietic system; quantity and quality” in place l_{36} .

$$Z_{12} = \langle \{l_{22}, l_{38}\}, \{l_{37}, l_{38}\}, \begin{array}{c|cc} & l_{37} & l_{38} \\ \hline l_{22} & true & false \\ l_{38} & false & true \end{array} \rangle .$$

The tokens have the characteristic “muscle contractions; quantity and quality” in place l_{37} and “current status of musculoskeletal system; quantity and quality” in place l_{38} .

$$Z_{13} = \langle \{l_{23}, l_{40}\}, \{l_{39}, l_{40}\}, \begin{array}{c|cc} & l_{39} & l_{40} \\ \hline l_{23} & true & false \\ l_{40} & false & true \end{array} \rangle .$$

The tokens have the characteristic “uropoiesis and elimination; quantity and quality” in place l_{39} and “current status of renal and urologic system; quantity and quality” in place l_{40} .

$$Z_{14} = \langle \{l_{24}, l_{42}\}, \{l_{41}, l_{42}\}, \frac{l_{41} \quad l_{42}}{l_{24} \left| \begin{array}{cc} true & false \\ false & true \end{array} \right.} \rangle .$$

The tokens have the characteristic “ovulation and gestations; spermatopoesis; quantity and quality” in place l_{41} and “current status of reproductive organs; quantity and quality” in place l_{42} .

$$Z_{15} = \langle \{l_{25}, l_{27}, l_{29}, l_{31}, l_{33}, l_{35}, l_{37}, l_{39}, l_{41}\}, \{l_4, l_{43}, l_{44}, l_{45}\},$$

	l_4	l_{43}	l_{44}	l_{45}	
l_{25}	$W_{25,4}$	$W_{25,43}$	<i>false</i>	<i>false</i>	
l_{27}	$W_{27,4}$	$W_{27,43}$	<i>false</i>	<i>false</i>	
l_{29}	$W_{29,4}$	$W_{29,43}$	$W_{29,44}$	<i>false</i>	
l_{31}	$W_{31,4}$	$W_{31,43}$	$W_{31,44}$	<i>false</i>	$\rangle ,$
l_{33}	$W_{33,4}$	$W_{33,43}$	<i>false</i>	<i>false</i>	
l_{35}	<i>false</i>	$W_{35,43}$	<i>false</i>	<i>false</i>	
l_{37}	$W_{37,4}$	$W_{37,43}$	<i>false</i>	<i>false</i>	
l_{39}	$W_{39,4}$	$W_{39,43}$	$W_{39,44}$	<i>false</i>	
l_{41}	$W_{41,4}$	$W_{41,43}$	<i>false</i>	$W_{41,45}$	

where

$W_{25+2i,4}$ = “there is signal(s) toward the neurous system”,

$W_{25+2i,43}$ = “there is signal(s) toward the cardiovascular system”,

$W_{25+2i,44}$ = “there are substances for elimination”,

$W_{41,45}$ = “there are the ovulation, menstruation, copulation, birth, etc.”

($i = 0, 1, \dots, 8$).

The tokens obtain the characteristic “afferent impulse(s); quantity and quality” in place l_4 , “entry, circulation and transport of substances; quantity and quality” in place l_{43} , “excrements; quantity and quality” in place l_{44} , “ovulation, menstruation, copulation, birth, etc.; quantity and quality” in place l_{45} .

$$Z_{16} = \langle \{l_{43}\}, \{l_{46}, l_{47}\}, \frac{l_{46} \quad l_{47}}{l_{43} \left| \begin{array}{cc} true & true \end{array} \right.} \rangle .$$

The tokens do not have any characteristic in place l_{46} and they obtain the characteristic “elimination substance(s); quantity and quality” in place l_{47} .

Transition Z_{17} interprete the excretion functions of the human body. Its form is

$$Z_{17} = \langle \{l_{44}, l_{47}\}, \{l_{48}, l_{49}, l_{50}, l_{51}\}, \frac{l_{48} \quad l_{49} \quad l_{50} \quad l_{51}}{l_{44} \left| \begin{array}{cccc} W_{44,48} & W_{44,49} & W_{44,50} & W_{44,51} \\ W_{47,48} & W_{47,49} & W_{47,50} & W_{47,51} \end{array} \right.} \rangle ,$$

where

$W_{44,48} = W_{47,48}$ = “There are substances to be eliminated by the skin”,

$W_{44,49} = W_{47,49}$ = “There are substances to be eliminated by the nose”,

$W_{44,50} = W_{47,50}$ = “There are substances to be eliminated by defecation”,

$W_{44,51} = W_{47,51}$ = “There are substances to be eliminated by the urine”.

The tokens do not have any characteristic in places l_{48} and l_{49} , and they have the characteristics “results of defecation; quantity and quality” in place l_{50} and “eliminated urine; quantity and quality” in place l_{51} .

3 Conclusion

In future related studies, GN-models of the separate human body systems will be constructed. The places of these nets will correspond to the different organs of the respective human body systems. This will be the second GN-model level. The, after that, the third GN-model level will contain nets to represent the functioning and the results of the work of the separate organs.

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