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A GENERALIZED NET MODEL OF INFORMATION FLOW WITHIN A SCHOOL

Anthony Shannon[1], Boriana Miteva[2], Evdokia Sotirova[2], Krassimir Atanassov[2,3], Taekyun Kim[4]

[1] Honorary Fellow,
Warrane College, The University of New South Wales, Kensington NSW, 2033, Australia
t.shannon@warrane.unsw.edu.au
[2] Laboratory of Intelligent Systems, University "Prof. Dr. Assen Zlatarov"
"Prof. Yakimov" Blvd. 1, Burgas 8010, Bulgaria
e-mail: esotirova@btu.bg, boryana_e@abv.bg
[3] Department of Bioinformatics and Mathematical Modelling Institute
of Biophysics and Biomedical Engineering,
Bulgarian Academy of Sciences,
Acad. G. Bonchev Str., Bl. 105, Sofia-1113, Bulgaria
e-mail: krat@bas.bg
[4] Department of Mathematics,
Kwangwoon University, Seoul 139-704, Korea
e-mails: tkkim@kw.ac.kr, taekyun64@hotmail.com

Abstract
A generalized net is used to construct a model which describes the organization of the processes for information exchange among the different units within a school. The model can be applied for both the analysis and the optimization of the flow of information.
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1 Introduction

In a series of research papers, the authors have studied some of the most important models of contemporary universities [3, 4, 5, 6, 7, 8, 9, 10]. In this research, we discuss a model, developed using the apparatus of the Generalized nets (GN, see [1, 2]), which describes the information flow within a school. The principal, vice-principal and the students exchange information. The school also sends data to external institutions and organizations, such as government and other statutory authorities. These information processes run in parallel in time.

The exchange of information among the different units of a school and the interaction with external bodies can be a long, difficult and tedious process, but it is important for the accuracy of the functioning of the systems. The processing and distribution of information takes time and resources. The absence or delay of transactions among the units can be a reason for the poor quality functioning of a school.

Furthermore, it is necessary for the tasks of processing the received and transmitted information to specify different priorities. This leads to changes in the order of receipt and performance. It has to be kept in mind that the objects which achieve these processes have finite information capacity and this can demand the restructuring of existing units or the development of new units in the structure. Therefore, the management and organization of the information flows and processes are a condition for increasing the quality of work and flexibility of the school management.

2 GN-Model

The GN-model constructed for the information processes is shown in Figure 1. The transitions represent the activities of:

- The principal (transitions Z_1 and Z_2),
- The vice-principals (p in number; transitions $Z_3,\ldots, Z_{p+2}, Z_{p+3}$),
- The teachers (q in number; transitions $Z_{p+4},\ldots, Z_{p+q+3}, Z_{p+q+4}$) and
- The students (transition Z_{p+q+4}).

The GN contains interior and exterior tokens. The first ones are related to

- The principal (α-tokens),
- The vice-principal (β_1-,…, β_p- tokens),
- The teachers (γ_1-,…, γ_q-tokens) and
- The students (σ-tokens).

The exterior tokens (ε-tokens) represent the information that enters the net (from the government, the public, etc.) and the information that is generated in the school and is returned to the exterior contacts.

Initially, there is one α-token that is located in place r_2 with an initial characteristic "principal's information archives". In the next time-moments this token is split into two or more. One of them, let it be the original α-token, will continue to stay in place r_2, while the other α-tokens will move to transitions Z_3, …Z_{p+3}, Z_{p+q+4}, passing through transition Z_2.

In the first time-moment, there is one β_i-token (i =1, 2,…, p) that is located in place $v_{i,6}$ with an initial characteristic "i-th vice-principal's information archives". In the next time-moments this token is split into two or more. One of them, let it be the original β_i-token, will continue to stay in place $v_{i,6}$, while the other β_i-tokens will move to transitions Z_1, Z_2, Z_{p+3}, Z_{p+q+4}.

Also initially, there is one γ_j-token (j = 1, 2,…, q) that is located in place $t_{j,6}$ with an initial characteristic "j-th (class) teacher's information archives". In the next time-moments this token is split into two or more. One of them, let it be the original γ_j-token, will continue to stay in place $t_{j,6}$, while the other γ_j-tokens will move to transitions Z_1, Z_2, Z_{p+3}, Z_{p+q+4}.

Again, initially, there is one σ-token that is located in place s_4 with an initial characteristic "students' information archives". In the next time-moments this token is split into two or more. One of them, let it be the original σ-token, will continue to stay in place s_4, while the other σ-tokens will move to transitions Z_1, Z_2, Z_{p+3}.

All tokens that enter transitions Z_1, Z_3, …, Z_{p+2}, Z_{p+4}, Z_{p+q+3} and Z_{p+q+4} will unite with the corresponding original token; that is, it will enter the respective archive. All

information generated by the respective subject (principal, vice-principal, and so on) will be put as an initial characteristic of a token, generated by the respective original token.

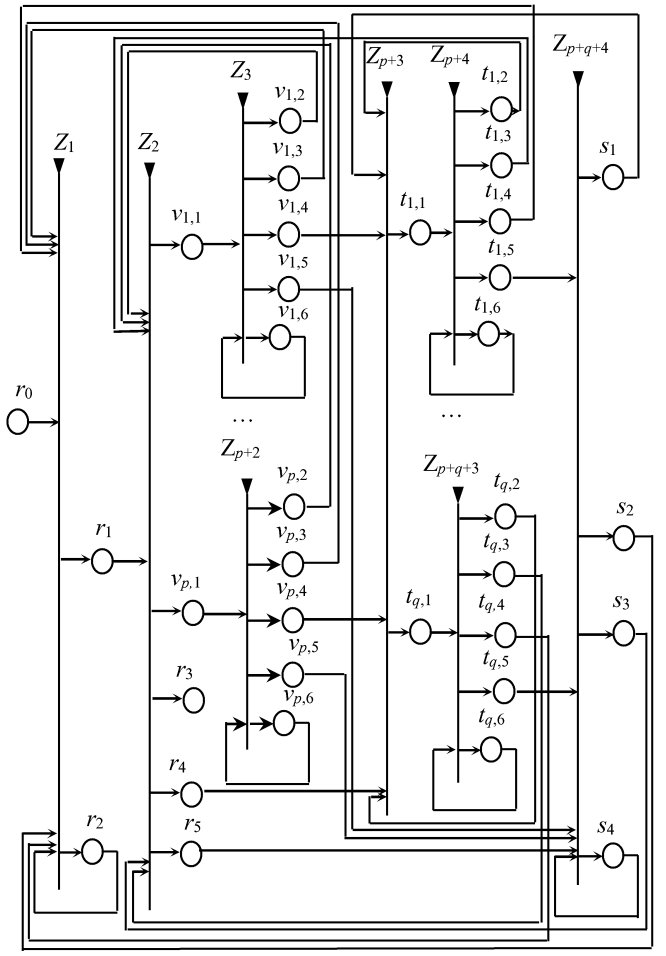

Figure 1. GN model of the information processes in a school

Tokens ε will enter the net via place r_0 in some time-moments. These moments will be determined stochastically when the model is simulated, or they will correspond to real events, when the GN is used for observation of real processes. These tokens have an initial characteristic "information (usually, it is addressed to the principal) from exterior sources (government, public, etc.)".

In the current GN-model all transition types will be of disjunctive forms. For this reason, they will be omitted here.

The GN transitions have the following forms.

$$Z_1=<\{r_0, r_2, v_{1,3}, \ldots, v_{p,3}, t_{1,4}, \ldots., t_{q,4}, s_2\}, \{r_1, r_2\}, R_1>,$$

where:

$$R_1 = \begin{array}{c|cc} & r_1 & r_2 \\ \hline r_0 & false & true \\ r_2 & w_{2,1} & true \\ v_{1,3} & false & true \\ \ldots & \ldots & \ldots \\ v_{p,3} & false & true \\ t_{1,4} & false & true \\ \ldots & \ldots & \ldots \\ t_{q,4} & false & true \\ s_2 & false & true \end{array},$$

and

$w_{2,1}$ = "there is information (commands, questions, etc.) from the principal to the other model participants (vice-principals, teachers, students)".

The token characteristic of the original α-token is mentioned above, while a new α-token (if transition condition predicate $w_{2,1}$ is valid) that enters place r_1 obtains a characteristic "recipient (vice-principal, teachers, students) of information (commands, questions, etc)".

$$Z_2 = \langle \{r_1, v_{1,2}, \ldots, v_{p,2}, t_{1,3}, \ldots, t_{q,3}, s_3\}, \{r_3, v_{1,1}, \ldots, v_{p,1}, r_4, r_5\}, R_2 \rangle,$$

where:

$$R_2 = \begin{array}{c|cccccc} & r_3 & v_{1.1} & \ldots & v_{p,1} & r_4 & r_5 \\ \hline r_1 & w_{1,3} & w_{1,1,1} & \ldots & w_{1,p,1} & w_{1,4} & w_{1,5} \\ v_{1,2} & w_{1,v,3} & false & \ldots & w_{1,v,p,v} & false & false \\ \ldots & \ldots & \ldots & \ldots & \ldots & \ldots & \ldots \\ v_{p,2} & w_{p,v,3} & w_{p,v,1,v} & \ldots & false & false & false \\ t_{1,3} & w_{1,f,3} & w_{1,f,1,v} & \ldots & w_{1,f,p,v} & false & false \\ \ldots & \ldots & \ldots & \ldots & \ldots & \ldots & \ldots \\ t_{q,3} & w_{q,f,3} & w_{q,f,1,v} & \ldots & w_{q,f,p,v} & false & false \\ s_3 & false & w_{s,3,1,v} & \ldots & w_{s,3,p,v} & false & false \end{array},$$

where for each $i = 1, 2, ..., p$ and $j = 1, 2, ..., q$:

$w_{1,3}$ = "there is information from the principal to exterior contacts",

$w_{1,i,1}$ = "there is information from the principal to i-th vice-principal",

$w_{1,4}$ ="there is information from the principal to the classes",

$w_{1,5}$ ="there is information from the principal to the students",

$w_{1,v,3}$ ="there is information from i-th vice-principal to exterior instances",

$w_{i_1,v,i_2,v}$ ="there is information from i_1 vice-principal to i_2-th vice-principal" ($i_1 \neq i_2$),

$w_{j,t,3}$ ="there is information from j-th teacher to exterior instances",

$w_{j,v,i,v}$ ="there is information from j-th teacher to i-th vice-principal",

$w_{s,3,i,v}$ ="there is information from some/all student(s) to i-th vice-principal",

The tokens that enter places r_3, $v_{1,1}$, …, $v_{p,1}$, r_4 and r_5 do not obtain new characteristics.

For each $i = 1, 2,..., p$:

$$Z_{i+2}=\langle\{v_{i,1}, v_{i,6}\},\{v_{i,2}, v_{i,3}, v_{i,4}, v_{i,5}, v_{i,6}\}, R_{i+2}\rangle,$$

where:

$$R_{i+2} = \begin{array}{c|ccccc} & v_{i,2} & v_{i,3} & v_{i,4} & v_{i,5} & v_{i,6} \\ \hline v_{i,1} & false & false & false & false & true \\ v_{i,6} & w_{i,6,2} & w_{i,6,3} & w_{i,6,4} & w_{i,6,5} & true \end{array},$$

and:

$w_{i,6,2}$=”there is information (questions, etc.) from i-th vice-principal to (an)other vice-principal(s)”,

$w_{i,6,3}$=”there is information (questions, etc.) from i-th vice-principal to the principal”,

$w_{i,6,4}$=”there is information (commands, questions, etc.) from i-th vice-principal to some/all teacher(s)”,

$w_{i,6,5}$=” there is information (commands, questions, etc.) from i-th vice-principal to some/all student(s)”.

The token characteristic of the original β-token is mentioned above, while the new β-token (if the corresponding transition condition predicate $w_{i,6,k}$ is valid for some k, k=2,…,6), entering the respective output place, obtains a characteristic “recipient (principal, vice-principal(s), teachers, students) of information (commands, questions, etc)”.

For each $i = 1, 2,..., p$ and $j, m = 1, 2,..., q$:

$$Z_{p+3}=\langle\{r_4, v_{1,4},\ldots,v_{p,4}, t_{1,2},\ldots,t_{q,2}, s_1\},\{t_{1,1},\ldots,t_{q,1}\}, r_{p+3}\rangle,$$

where:

$$r_{p+3} = \begin{array}{c|ccc} & t_{1,1} & \ldots & t_{q,1} \\ \hline r_4 & w_{4,1,1} & \ldots & w_{4,q,1} \\ v_{1,4} & w_{1,v,t} & \ldots & w_{1,v,q,t} \\ \ldots & \ldots & \ldots & \ldots \\ v_{p,4} & w_{p,v,1,t} & \ldots & w_{p,v,q,t} \\ t_{1,2} & w_{1,t,1,t} & \ldots & w_{q,t,p,t} \\ \ldots & \ldots & \ldots & \ldots \\ t_{q,2} & w_{q,t,1,t} & \ldots & w_{q,t,p,t} \\ s_2 & w_{2,1,t} & \ldots & w_{2,q,t} \end{array},$$

and:

$w_{4,j,1}$ = ”there is information (commands, questions, etc.) from the principal, to the j-th teacher”,

$w_{i,v,j,t}$ = ” there is information (commands, questions, etc.) from the i-th vice-principal, to the j-th teacher”,

$w_{j,t,m,t}$ = “there is information (questions, etc.) from the j_1-th teacher to the j_2-th teacher” ($j \neq m$),

$w_{2,j,t}$ = “there is information (questions, etc.) from some/all student(s) to the j-th teacher.

For each $j = 1, 2,..., q$:

$$Z_{p+j+3} = \langle \{t_1, t_{j,6}\}, \{t_{j,2}, t_{j,3}, t_{j,4}, t_{j,5}, t_{,6}\}, R_{p+j+3} \rangle,$$

where:

$$R_{p+j+3} = \begin{array}{c|ccccc} & t_{j,2} & t_{j,3} & t_{j,4} & t_{j,5} & t_{j,6} \\ \hline t_{j,1} & false & false & false & false & true \\ t_{j,6} & w_{j,6,2} & w_{j,6,3} & w_{j,6,4} & w_{j,6,5} & true \end{array},$$

and:

$w_{j,6,2}$ = "there is information (questions, etc.) from j-th teacher to (an)other teacher(s)",

$w_{j,6,3}$ = "there is information (questions, etc.) from j-th teacher to some/all vice-principal(s)",

$w_{j,6,4}$ ="there is information (questions, etc.) from j-th teacher to the principal",

$w_{j,6,5}$ ="there is information (commands, questions, etc.) from j-th teacher to some/all student(s)".

The token characteristic of the original γ-token is mentioned above, while the new γ-token (if the corresponding transition condition predicate $w_{j,6,k}$ is valid for some k, k =2,…,5), entering the respective output place, takes on a characteristic "recipient (principal, vice-principal(s), teachers, students) of information (commands, questions, answers, etc)".

For each i = 1, 2,..., p and j = 1, 2,..., q:

$$Z_{p+q+4} = \langle \{r_5, v_{1,5}, \ldots, v_{p,5}, t_{1,5}, \ldots, t_{q,5}, s_4\}, \{s_1, s_2, s_3, s_4\}, R_{p+q+4} \rangle,$$

where:

$$R_{p+q+4} = \begin{array}{c|cccc} & s_1 & s_2 & s_3 & s_4 \\ \hline r_5 & false & false & false & w_{1,5} \\ v_{1,5} & false & false & false & w_{1,5,4} \\ \ldots & \ldots & \ldots & \ldots & \ldots \\ v_{p,5} & false & false & false & w_{p,5,4} \\ t_{1,5} & false & false & false & w_{1,5,4} \\ \ldots & \ldots & \ldots & \ldots & \ldots \\ t_{q,5} & false & false & false & w_{q,5,4} \\ s_4 & w_{1,4} & w_{4,2} & w_{4,3} & true \end{array},$$

and:

$w_{i,5,4} = w_{i,6,5}$,

$w_{j,5,4} = w_{j,6,5}$,

$w_{4,1}$ ="there is information from the student(s) to some/all teacher(s)",

$w_{4,2}$ ="there is information from the student(s) to the principal",

$w_{4,3}$ ="there is information from the student(s) to some/all vice-principal(s)".

The token characteristic of the original σ-token is mentioned above, while the new σ-token (if the corresponding transition condition predicate $w_{4,k}$ is valid for some k, k = 1,…,3), entering the respective output place, has a characteristic "recipient (principal, vice-principal(s), teachers) of information (questions, answers)".

3 Conclusion

The purpose of the GN constructed in this work is to model the information flow and associated processes within a school and to aim for their optimisation. Since the modelled processes are very complex in any real school, the GN presented here has not been described in too much detail. Nevertheless, it has been provided with sufficient information to apply the model in practice.

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