Materials of Conferences

MODEL AND ANALYSIS OF FACULTY STAFF AGE STRUCTURE DYNAMICS AT UNIVERSITIES

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Age dynamics of faculty staff at universities on the basis of cellular automata model was investigated. Quality analysis of number of professors according to their age was performed, the most active age groups were detected.

In the article the social system (faculty staff) is investigated with nonlinear dynamics methods. Research objective is to analyze and forecast the state of the system. Faculty staff current state and progress trends, as well as development of universities scientific potential is analyzed by applying mathematical modeling.

Let us consider mathematical model of the one-dimensional cellular automata class, which allows analyzing age structure dynamics of faculty staff. We are going to model each faculty staff age category of the same kind with one element of the cellular automata, value of which characterizes number in this category. Model, which was the basis for staff analysis, was designed for age groups with 10 years gap: 25–29 years, 30–39 years, …, above 60 years.

Transition from one age group to another takes one discrete time step corresponding to time interval $\Delta t = 1$ year. This transition goes with shift along the space of cellular automata. The element, whose age is at the boundary of the group 29, 39, 49, 59 years, should be transferred to the next age group.

The following factors were taking into account in modeling:

– ageing of each professor with the course of time (transition into next age group of each element of the model);

– retirement of professors who reached corresponding age;

– change of activity by ambitious employees;

– employment of newcomers recently graduated from the university;

– defense of Ph.D. and doctoral thesis with the succeeding professors' transition to the new category.

Let us describe these factors using cellular automata rule.

Cell dynamics (one year ageing of the employees in one group and of the same age) in each step at a time is computed using the following formula

$$X_j^{i+1} = X_{j-1}^{i} \quad (j = 2, \ldots, N-1), \tag{1}$$

with using at the boundary of the cellular automata space ($j = 0$) the boundary condition

$$X_0^{i+1} = X^0, \tag{2}$$

where the value X^0 characterizes the number of young employees annually joining the faculty staff.

Change of activity by ambitious employees is described by the formula

$$X_j^{i+1} = X_{j-1}^{i} - G(i,j) \quad (j = 2, \ldots, N-1). \tag{3}$$

In the simplest variant the function G is as follows

$$G(i,j) = kX_j^{i+1}, \tag{4}$$

where the coefficient $0 < k \leq 1$.

Equation corresponding to one-dimensional cellular automata is the equation of continuity – conservation law of staff number taking into account their leave of university system:

$$\frac{\partial x}{\partial v} + \frac{\partial x}{\partial t} - G(x,v) = 0, \tag{5}$$

where $x(v, t)$ is the university staff number aged v at a time t. G is the function of skilled workers drain, it is characterized by staff number aged v, who leave the university system for other activities. In the simplest variant the function G can be described by the linear relationship

$$G(x) = kx, \tag{6}$$

where $0 < k \leq 1$.

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UNIVERSITY OPERATION MODEL

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Findings obtained in the article prove the need of maintaining the high level of faculty staff activity at the universities.

The problem of loss of universities operating effect is associated with the level decline of scientific research conducted by the employees, and with decline of high skilled staff training quality through postgraduate and doctoral training systems.