ALGORITHMS FOR SOLVING ONE-DIMENSIONAL BOUNDARY VALUE PROBLEMS AND VISUALIZATION OF THE RESULTS USING SOFTWARE TOOLS.

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Abstract. Using the numerical model, computational algorithms and software developed in this article, it is possible to conduct a number of studies on the main indicators of various physiological processes. The developed software is proposed to be used in design processes and research at enterprises related to the industry. The results are analyzed through numerical and visual graphs and visualized in 2D graph.

Keywords: Model, visual, 2D graphics, design.

АЛГОРИТМЫ РЕШЕНИЯ ОДНОМЕРНЫХ КРАЕВЫХ ЗАДАЧ И ВИЗУАЛИЗАЦИЯ РЕЗУЛЬТАТОВ С ПОМОЩЬЮ ПРОГРАММНЫХ СРЕДСТВ.

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Аннотация. Используя разработанную в данной статье численную модель, вычислительные алгоритмы и программное обеспечение, можно провести ряд исследований ключевых показателей различных физиологических процессов. Разработанное программное обеспечение предлагается использовать в процессах проектирования и научных исследований на предприятиях смежных отраслей. Анализировал с помощью графиков в числовой и визуальной форме и визуализировал полученные результаты в 2D графиках.

Ключевые слова. Модель, визуал, 2D графика, дизайн.

BIR O'LCHOVLI CHEGARAVIY MASALALARNI YECHISH ALGORITMLARI VA DASTURIY VOSITALAR YORDAMIDA NATIJALARNI VIZUALLASHTIRISH

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Annotatsiya. Ushbu maqolada ishlab chiqilgan sonli model, hisoblash algoritmlaridan va dasturiy ta’minotdan foydalangan holda turli fizik jarayonining asosiy ko‘rsatgichlari bo‘yicha qator tadqiqotlarni o‘tkazish mumkin. Ishlab chiqilgan dasturiy ta’minotdan sohaga tegishli korxonalarda loyihalashtirish jarayonlarida va tatqiqotlar o‘tkazishda foydalanish taklif etiladi. Sonli va vizual formadagi grafiklar orqali tahlil qilingan va olingan natijalarni 2D grafiklarda vizuallashtirilgan.

Kalit so‘zlar. Model, vizual, 2D grafiklar, loyihalash.

Let us consider the following boundary value problem for the one-dimensional linear differential equation to be solved numerically. For simplicity, let us consider the domain considered in the boundary value problem as follows. Then we can write the mathematical model of the boundary value problem as follows.

$$\frac{\partial P}{\partial t} = \frac{\partial^2 P}{\partial x^2} + 3e^{3xt}(x - 3t^2) \tag{1}$$

$$P(x,t) = \phi(x), \qquad t = 0; \tag{2}$$

$$\begin{cases} \left.\dfrac{-?\,P}{?\,x}\right|_{x=0} = ?\left(P_A - P\right), & x=0; \\ \left.\dfrac{?\,P}{?\,x}\right|_{x=1} = ?\left(P_B - P\right), & x=1; \end{cases} \tag{3}$$

Here

P – function that calculates the desired value;

P_A, P_B - P The limit value of a function;

In order to verify the correctness of the obtained results and the adequacy of the mathematical model, we obtain the analytical solution of the boundary value problem as follows.

$$P(x,t) = e^{-3xt}.$$

Then the boundary and initial conditions are as follows:

$$\begin{cases} P(x,0) = 1, \\ P(0,t) = 1, \\ P(1,t) = e^{3t}, \end{cases} \tag{4}$$

$$f(x,t) = 3e^{3xt}(\mathrm{x} - 3t^2) \tag{5}$$

To solve the boundary value problem numerically, we replace the domain with the following discrete domain. To do this, we add the following mesh.

$$\Omega_{h\tau} = \{x = ih, \ \ i = 0,1,\dots,N, \ h = \frac{1}{N}, \ t_j = j\tau, \ \ j = 0,1,\dots,N_0, \ \tau = \frac{1}{N_0}\}$$

To solve this problem numerically in the discrete domain, we use the finite difference method based on the direction scheme of the variables. In this method, the time layer is implemented stepwise. The finite difference equation can be written in the operator form, dropping the index i, as follows:

$$\frac{P^{l-1} - P^l}{\Delta\tau} = \Lambda P^{l-1} + f(x,t). \tag{6}$$

Then the system of finite difference equations in the l+l time layer will be as follows.

$$a_i P_{i-1} - b_i P_i + c_i P_{i-1} = -d_i, \tag{7}$$

Here:

$$a_i = \frac{1}{h^2}; \qquad b_i = \frac{2}{h^2} + \frac{1}{\Delta\tau}; \qquad c_i = \frac{1}{h^2}; \tag{8}$$

$$d_i = \frac{1}{\Delta\tau} P_i^l + 3e^{3xt}(x - 3t^2), \quad [9] \tag{9}$$

We use the run-in method to solve the finite difference system (in l+1 time layers). According to the run-in method, its numerical solution is:

$$P_i = A_i P_{i-1} + B_i \qquad (i = n-1, \ldots, 1) \tag{10}$$

determined from the formula.

Here A_i, B_i - are the running coefficients, which are determined by the following formulas:

$$A_i = \frac{c_i}{b_i + a_i A_{i-1}}; \qquad B_i = \frac{a_i B_{i-1} + d_i}{b_i + a_i A_{i-1}}; \tag{11}$$

The initial values of the run coefficients are determined from the boundary conditions. For the first boundary condition in general (3), it is as follows:

$$A_0 = \frac{b_1 - 4c_1}{a_1 - (3 - 2\Delta x)c_1}; \qquad B_0 = \frac{d_1}{a_1 - (3 - 2\Delta x)c_1}. \quad [10] \tag{12}$$

For the specific example used above, the value of function (4) is determined by the formula on the right boundary.

$$P_N^l = e^{3t}, \qquad A_0 = 0; \quad B_0 = 1. \tag{13}$$

Algorithm for numerical solution of the boundary value problem:

1. Start.

2. N, h, nt, x,k assigning values to variables.
3. P–Enter the initial value of the function.(i=1,2,…,N,)
4. $a_i, \; b_i, \; c_i, d_i$ Calculating the coefficients of a finite difference equation.

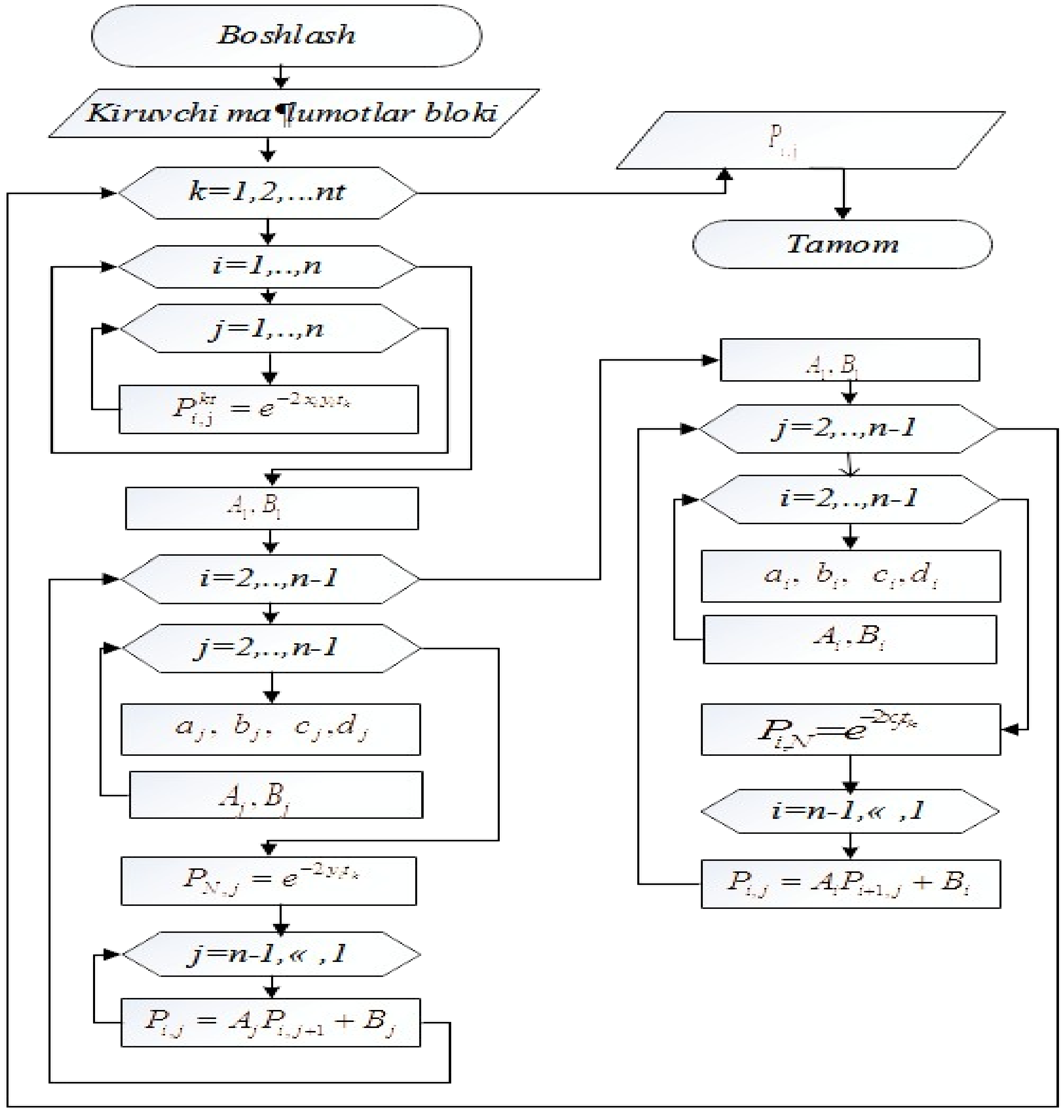
5. A_0, B_0 - giving from boundary conditions.

6. A_i, B_i - Calculating odds for a race.(i=2,…,N-1,)

7. P_n - Calculating the value of a function. (vaqt j=1,2,…,nt)

8. Output the result as a numerical solution and 2D graph

9. That's it.



A mathematical model and algorithm for this equation were developed. The results were obtained in the MathLab programming environment:

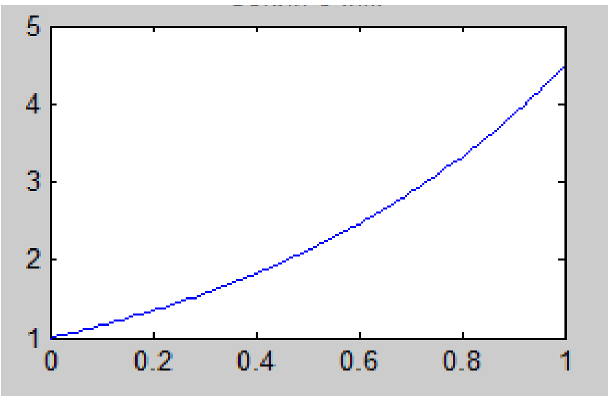


Figure 1.2. Numerical solution 2D graph

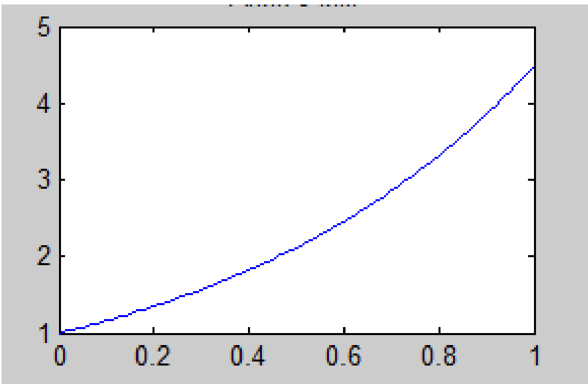


Figure 1.3. Exact solution 2D graph

As can be seen from these graphs, the larger the number of points, the smaller the error, meaning that the numerical solution approaches the exact solution. The created software presents numerical results and 2D graphs.

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