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Incorrect Problems of Risk Assessment in Fuzzy Initial Information

Muhamediyeva D.T.

Tashkent University of Information Technologies named after Muhammad al-Khwarizmi, Amir Temur street, 108, 100200, Tashkent, Uzbekistan

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Abstract:
The development of algorithmic and software for solving incorrect problems that are formalized in the process of constructing a model for assessing and predicting risk for fuzzy systems is considered. An analysis is made of methods for solving ill-posed problems, formalized in the process of constructing a model for assessing and predicting risk for fuzzy systems.

Keywords:*Theory of fuzzy sets, incorrect problem, risk, optimization, model, algorithm..*

I. INTRODUCTION

For complicated procedures distinguished by doubt (imperfection, incompleteness, vagueness) from the initial information and scenarios in internal and external surroundings, there's generally no sufficient chance to develop mathematical models that are simple. Information regarding the parameters of such procedures is conveyed by specialists in a way of words and sentences, ie in linguistic form. In such cases it is wise to employ a modeling structure, decision-making and management, using instruments of soft computing methods (Soft Computing) [1,2].

With the growing complication of this system there seems problem related to deciding the suitable set of rules and membership functions to report the behavior of this system sufficiently. Fuzzy systems have problems from disadvantage of extracting extra information on the outcomes of the test and correcting downy principles to enhance the standard of the system. In analyzing different choices on threat assessment under undetermined the issue of building fuzzy designs based on fuzzy conclusion principles happens. However, a generic procedure building fuzzy evaluation versions do not exist. The benefit of fuzzy logic would be that the capability to utilize expert understanding of the thing in the kind of "if" inputs", the "outputs". Throughout the progression of the fuzzy version of risk evaluation depending on the results of fuzzy rules, researchers frequently face the issue of identifying estimated solutions of ill-posed issues. It needs to be mentioned that the processes, employed for resolving ill-posed issues of systems aiding decision making, have been exclusively for few special scenarios, models (eg, models based on classical logic). On the other hand, the overall method of solving the issues of fuzzy logic for arbitrary fuzzy systems doesn't exist.

Therefore, analysis of the tasks of threat assessment in fuzzy conditions, in addition to modeling and algorithmic assistance of ill-posed difficulties, legalized at the practice of the investigation are applicable for latest support systems of determination.

Difficulties in decision making under risk assessment, which caused the aspect of natural, technological and environmental calamities have been studied in works of V.I.NorkinaY.M.Yermoleva and [3], and also

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V.S.MihalevichaP.S.Knopova, I.V . V.M.YanenkoSergienko and [4]. Emergence of danger in economic conditions has been believed in AO Nedosekina [5]. Management issues connected with risk precaution steps are studied in works of Y.M. Yermoleva [3].

Examination of current techniques for resolving issues of threat evaluation has indicated that they are relied on inadequacy of technical abilities and the shortage of information regarding the conditions of the issue. Thus, in these situations it's a good idea to employ fuzzy mathematical techniques [7-11].

II. STATEMENT OF THE PROBLEM.

Given a sample fuzzy experimental data (X_r, y_r), $r=\overline{1,M}$, here - $X_r=(x_{r,1},x_{r,2},...,x_{r,n})$ the input n-dimensional vector and $-y_r$ corresponding output vector.

On the basis of fuzzy inference rules, it is needed to develop a model of soil fertility reduction risk in the below mentioned way:

If $(z=a_{11}^1 \vee z_1=a_{12}^1 \vee z_2=a_{13}^1 \vee z_3=a_{14}^1)\wedge$

. . . .

$(z=a_{11}^{m_1} \vee z_1=a_{12}^{m_1} \vee z_2=a_{13}^{m_1} \vee z_3=a_{14}^{m_1})$

then

$$z=\frac{\sum_{i=1}^n \mu_{k_{0i}}k_{0i}}{\sum_{i=1}^n \mu_{k_{0i}}}+\frac{\sum_{i=1}^n \mu_{k_{1i}}k_{1i}}{\sum_{i=1}^n \mu_{k_{1i}}}x_1+\frac{\sum_{i=1}^n \mu_{k_{2i}}k_{2i}}{\sum_{i=1}^n \mu_{k_{2i}}}x_2+...+\frac{\sum_{i=1}^n \mu_{k_{7i}}k_{7i}}{\sum_{i=1}^n \mu_{k_{7i}}}x_7+\frac{\sum_{i=1}^n \mu_{k_{8i}}k_{8i}}{\sum_{i=1}^n \mu_{k_{8i}}}x_8$$

If

$(x_{11}=a_{31}^1 \vee x_{12}=a_{32}^1 \vee x_{13}=a_{33}^1 \vee ... \vee x_{17}=a_{37}^1 \vee z=a_{38}^1)\wedge$

. . . .

$(x_{21}=a_{41}^{m_4} \vee x_{22}=a_{42}^{m_4} \vee x_{23}=a_{43}^{m_4} \vee ... \vee x_{27}=a_{47}^{m_4})$

then

$$z_2=\frac{\sum_{i=1}^n \mu_{c_{0i}}c_{0i}}{\sum_{i=1}^n \mu_{c_{0i}}}+\frac{\sum_{i=1}^n \mu_{c_{1i}}c_{1i}}{\sum_{i=1}^n \mu_{c_{1i}}}x_{21}+\frac{\sum_{i=1}^n \mu_{c_{2i}}c_{2i}}{\sum_{i=1}^n \mu_{c_{2i}}}x_{22}+...+\frac{\sum_{i=1}^n \mu_{c_{7i}}c_{7i}}{\sum_{i=1}^n \mu_{c_{7i}}}x_{27}$$

If

$(x_{31}=a_{51}^1 \vee x_{32}=a_{52}^1 \vee x_{33}=a_{53}^1 \vee ... \vee x_{37}=a_{57}^1 \vee z_2=a_{58}^1)\wedge$

. . . .

$(x_{31}=a_{51}^{m_5} \vee x_{32}=a_{52}^{m_5} \vee x_{33}=a_{53}^{m_5} \vee ... \vee x_{37}=a_{57}^{m_5} \vee z_2=a_{58}^{m_5})\wedge$

then

$$z_3=\frac{\sum_{i=1}^n \mu_{d_{0i}}d_{0i}}{\sum_{i=1}^n \mu_{d_{0i}}}+\frac{\sum_{i=1}^n \mu_{d_{1i}}d_{1i}}{\sum_{i=1}^n \mu_{d_{1i}}}x_{31}+\frac{\sum_{i=1}^n \mu_{d_{2i}}d_{2i}}{\sum_{i=1}^n \mu_{d_{2i}}}x_{32}+...+\frac{\sum_{i=1}^n \mu_{d_{7i}}d_{7i}}{\sum_{i=1}^n \mu_{d_{7i}}}x_{37}+\frac{\sum_{i=1}^n \mu_{d_{8i}}d_{8i}}{\sum_{i=1}^n \mu_{d_{8i}}}z_2$$

In common, it is needed to build a model depend on fuzzy inference rules:

$$\bigcup_{p=1}^{k_j}\left(\bigcap_{i=1}^{n} x_i=a_{i,jp} - \text{с весом} \, w_{jp}\right)\rightarrow y_j=b_{m_0}+b_{m_1}x_1^j+...+b_{m_n}x_n^j.$$

In the procedure of developing such models it is needed to find the coefficients of the rules $B=(b_{ij}), i=\overline{1,n},\ j=\overline{1,m}$, from the minimum of the following expression achieved:

$$\sum_{r=\overline{1,M}}\left(y_r-y_r^f\right)\rightarrow \min \quad ,\{1)$$

where y_r^f - (X_r) outcome of fuzzy inference rules with parameter Bin r- line.

To the input vector $X_r=(x_{r,1},x_{r,2},...,x_{r,n})$ correlates the following outcome of fuzzy inference:

$$y_r^f=\frac{\sum_{j=\overline{1,m}}\mu_{d_j}(X_r)\cdot d_j}{\sum_{j=\overline{1,m}}\mu_{d_j}(X_r)} \text{ or}$$

$$y_r^f=\frac{\int \mu_{d_j}(X_r)\cdot d_j dd_j}{\int \mu_{d_j}(X_r)dd_j}, \qquad (2)$$

here $d_j=b_{j0}+b_{j1}x_{11}+b_{j2}x_{12}+......+b_{jn}x_{1n}$ - output j- rules; $\mu_{d_j}(x_r)$ - membership function correlating to each of the investigational information:

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$$\mu_{d_j}(X_r)=\mu_{j1}(x_{r1})\cdot\mu_{j1}(x_{r2})\cdot\mu_{j1}(x_{r3})\cdot.......\cdot\mu_{j1}(x_{rn})\vee$$
$$\vee\,\mu_{j2}(x_{r1})\cdot\mu_{j2}(x_{r2})\cdot\mu_{j2}(x_{r3})\cdot.......\cdot\mu_{j2}(x_{rn})\vee$$
$$.........\;.........\;.........\;.........\;.........\;.........$$
$$\vee\,\mu_{jm}(x_{r1})\cdot\mu_{jm}(x_{r2})\cdot\mu_{jm}(x_{r3})\cdot.......\cdot\mu_{jm}(x_{rn});$$

$$\beta_{jr}=\frac{\mu_{d_j}(X_r)\cdot d_j}{\sum_{j=1,m}\mu_{d_j}(X_r)}\text{ or }\beta_{jr}=\frac{\mu_{d_j}(X_r)\cdot d_j}{\int\mu_{d_j}(X_r)dd_j}.$$

Thenwe will rewrite (2) in the following form:

$$y_r^f=\sum_{j=1,m}\beta_{r,j}\cdot d_j=\sum_{j=1,m}\left(\beta_{r,j}\cdot b_{j,0}+\beta_{r,j}\cdot b_{j,1}\cdot x_{r,1}+\beta_{r,j}\cdot b_{j,2}\cdot x_{r,2}+...+\beta_{r,j}\cdot b_{j,n}\cdot x_{r,n}\right)$$

Let's enter following notations:

$$Y^f=\left(y_1^f,y_2^f,...,y_M^f\right)^T;$$
$$Y=\left(y_1,y_2,...,y_M\right)^T;$$
$$A=\begin{bmatrix}\beta_{1,1},...,\beta_{1,m}, & x_{1,1}\cdot\beta_{1,1},...,x_{1,1}.\beta_{1,m}, & ..., & x_{1,n}\cdot\beta_{1,1},...,x_{1,n}\cdot\beta_{1,m}\\ \vdots & & & \\ \beta_{M,1},...,\beta_{M,m}, & x_{M,1}\cdot\beta_{1,1},...,x_{M,1}\cdot\beta_{1,m}, & ...,x_{M,n}\cdot\beta_{M,1},...,x_{M,n}\cdot\beta_{M,m} & \end{bmatrix}$$

Then the problem (1) can be redraft in the succeeding matrix form: find such vector Bto satisfy the condition

$$E=(Y-Y^f)^T\cdot(Y-Y^f)\rightarrow\min. \quad (3)$$

Result of (3) correlates to the outcome of below equation:

$$Y=A\cdot B. \quad (4)$$

During an development of fuzzy risk evaluation designs depends on fuzzy inference rules, in scenarios when difficulty (4) do not meet the conditions of accurate, frequently face the issue of discovering an estimated result for ill-posed difficulties.

III. THE SOLUTION TO THE PROBLEM.

The outcomes of the following mathematical exploration mostly rely on how sufficiently utilized information regarding the study topic in modeling, ie what is sufficiency level of this model. In this regard, the principal tasks of modeling of weakly planned procedures are:

- evaluation of the compact and non-compact accurate courses. Pointing that the probability of acquiring fuzzy and fuzzy-sustainable answers to ill-posed difficulties, authorized in the method of building a model of risk evaluation with distinct membership functions;
- development of algorithms to figure out unreliable difficulties, authorized at the practice of building the model evaluation and risk forecast depend on fuzzy sets.

Fuzzy solution of the equations $Az=u$ is the primary information, expressed using fuzzy set $\bigcup_\alpha \alpha A_\alpha$ and has the below properties:

* Given operator A and reference data z;

* $\forall\alpha\in(0,1],\ A_\alpha=\{z:\mu_A(z)\geq\alpha\}$;

$\exists\varepsilon(\alpha)>0,\ \sup_{z\in A_\alpha}\rho_z\left(A(z),A_\alpha\right)<\varepsilon(\alpha)<\infty.$

Here ρ_z –is interval between sets $A(z)$and A_α.

Finding solutions to the equation

$$Az=u$$

reduces to difficulty of locating the fuzzy result to this equation.

Suppose that in a linear regression model $y=a_0+a_1x_1+a_2x_2+....+a_nx_n$ - a_i – coefficient of assessment a_i and the input data x_i given in the form of fuzzy.

Let us find the model parameters, membership function which is given in the form of Gauss. a_i - Gauss fuzzy number in fuzzy linear regression model, specified with the parameter $(\tilde{a}_i,c_i)$ .Here $\tilde{a}_i$ - center of fuzzy number, c_i - breadth of interval, $c_i>0$.

Let us assume that x_i - input data, which are Gauss fuzzy numbers. Let the membership functions of the input data are shown as the succeeding way:

$$\mu(x)=\begin{cases}e^{-\frac{1}{2}\frac{(x-\tilde{a})^2}{c_1^2}}, & x\leq a,\\ e^{-\frac{1}{2}\frac{(x-\tilde{a})^2}{c_2^2}}, & x>a.\end{cases}$$

Then these fuzzy numbers are elucidated by three parameters: $(c_1,\ \tilde{a},\ c_2)$; here $\tilde{a}_i$ - center of fuzzy number; c_1 - breadth of left interval; c_2 - breadth of right interval.

In such scenario, the issue is generated as mentioned: discover such parameters $(\tilde{a}_i,\ c_i)$ of coefficients a_i , to satisfy the following conditions:

a) let y_k in the equation correlates to the found interim with a level of not lower than α, $0<\alpha<1$;

б) the degree of breadth of interval αis minimal.

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Interval of evaluation with a degree αis as follows :

$$d_\alpha = y_2 - y_1 .$$

$y_1$andy_2 can be found outfrom system

$$\begin{cases} \alpha = \exp\left(-\dfrac{1}{2}\dfrac{(y_2 - \tilde{a})^2}{c_2^2} \right), \\ \alpha = \exp\left(-\dfrac{1}{2}\dfrac{(y_1 - \tilde{a})^2}{c_1^2} \right). \end{cases}$$

From here $y_2 = c_2\sqrt{-2\ln\alpha} + \tilde{a}$, $y_1 = c_1\sqrt{-2\ln\alpha} + \tilde{a}$, $d_\alpha = -2\ln\alpha(c_2 + c_1)$.

Condition a) will be written as follows

$$\mu(y_k) \geq \alpha \Rightarrow \begin{cases} y_k \leq \tilde{a}_k + c_{2k}\sqrt{-2\ln\alpha}, \\ y_k \geq \tilde{a}_k - c_{1k}\sqrt{-2\ln\alpha}. \end{cases}$$

The task uses the mentioned format:

$$\min\sum_{k=1}^{m} d_\alpha^k = \min\sum_{k=1}^{m}(c_{2k} + c_{1k})\sqrt{-2\ln\alpha},$$

$$\begin{cases} y_k \leq \tilde{a}_k + c_{2k}\sqrt{-2\ln\alpha}, \\ y_k \geq \tilde{a}_k - c_{1k}\sqrt{-2\ln\alpha}. \end{cases}$$

To locate the parameters of the model, which membership function is bell shaped, it is needed to resolve the succeeding linear programming issue:

$$\begin{cases} \sum_{k=1}^{m}(c_{1k} + c_{2k})\sqrt{\dfrac{1-\alpha}{\alpha}} \to \min, \\ y_k \leq \tilde{a}_k + c_{2k}\sqrt{\dfrac{1-\alpha}{\alpha}}, \\ y_k \geq \tilde{a}_k + c_{1k}\sqrt{\dfrac{1-\alpha}{\alpha}}. \end{cases}$$

After locating the parameters $\tilde{a}_k$, c_{1k}, c_{2k} the type of a given fuzzy model is decided.

The optimization difficultyof poorly formalizedprocesses hasovercome having based on fuzzy-set approach. Problem solving of assessment optimization and risk prediction are acquired and examined.

The job of predicting the hazard of reduction of soil fertility has overcome in accordance of the fuzzy model.

Soil fertility is distinguished by commonlyused components of fertility, as a reserve humidity, amount of humus, nitrogen, phosphorus.

A numerical expression of the reliance of risk reduction of soil fertility from its components is prepared based on the experimental data:

$$y = \frac{\sum_{i=1}^{n}\mu_{a_{0i}}a_{0i}}{\sum_{i=1}^{n}\mu_{a_{0i}}} + \frac{\sum_{i=1}^{n}\mu_{a_{1i}}a_{1i}}{\sum_{i=1}^{n}\mu_{a_{1i}}}x_1 + \frac{\sum_{i=1}^{n}\mu_{a_{2i}}a_{2i}}{\sum_{i=1}^{n}\mu_{a_{2i}}}x_2 + \ldots + \quad .(5)$$

The model parameters are elucidated as fuzzy subsets, ie they are explained by the membership function corresponding subsets:

$$a_i = \left(\mu_{a_i}, (a_i', a_i'')\right),$$

here

$\mu_{a_0} = e^{25\cdot 10^2 (x+0.93)^2}$, $a_0 \in [-0,95;-0,91]$;

$\mu_{a_1} = e^{25\cdot 10^2 (x+0.25)^2}$, $a_1 \in [-0,27;-0,23]$;

$\mu_{a_2} = e^{25\cdot 10^8 (x+0.002)^2}$, $a_2 \in [-0,0022;-0,0018]$;

$\mu_{a_3} = e^{25\cdot 10^8 (x-0.004)^2}$, $a_3 \in [0,0038;0,0042]$;

$\mu_{a_4} = e^{25\cdot 10^6 (x-0.004)^2}$, $a_4 \in [0,0028;0,0032]$;

$\mu_{a_5} = e^{25\cdot 10^2 (x+0.49)^2}$, $a_5 \in [-0,51;-0,47]$;

$\mu_{a_6} = e^{25\cdot 10^2 (x-0.13)^2}$, $a_6 \in [0,11;0,15]$;

$\mu_{a_7} = e^{25\cdot 10^4 (x+0.05)^2}$, $a_7 \in [-0,052;-0,048]$;

$\mu_{a_7} = e^{25\cdot 10^4 (x+0.04)^2}$, $a_8 \in [0,038;0,042]$.

Function of the state system performs mass fraction of humus in the soil as a percentage, x_1 - bulk mass of soil, x_2 - plowing depth, x_3 - input proportion of phosphorus, x_4 - input proportion of potassium, x_5 - proportion of nitrogen in the soil, x_6 - proportion of organic carbon in the soil, x_7 - average temperature per day, x_8 - soil moisture.

As stated in the equation (5) to multiply the proportion of organic carbon in the soil comprising soil moisture, norms of phosphorus and potassium, and the quantity of humus increased on average by [0,11;0,15]; [0,038;0,042]; [0,0038;0,0042]; [0,028;0,032] respectively. Growing bulk density of soil, the quantity of nitrogen in it and plowing depth per unit, reduce the humus proportion in soil on average by [0,23;0,27]; [0,47;0,51] и [0,0018;0,0022] respectively.

Fuzzy modelpermits to depend on any prior information and get fuzzy result for a provideddegree of correctness of initial data.

The algorithm and software were developed to construct a design of risk assessment under fuzzy information considering the solutions of unstable linear algebraic

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equations, which are formalized in the process. To illustrate the solution of a system of unstable linear algebraic and integral equations, method of Tikhonov was chosen.

In the theoretical part, it was shown that it is appropriate to use the following form of regularizing operator: $(\alpha E + A^T A)z^{\alpha} = A^T u_{\delta}$, where E – identity matrix, $z^{\tilde{\alpha}}$ - fuzzy normal solution, A^T –transposed original matrix, $\tilde{\alpha}$ - regularization parameter, u_{δ} - right side, which is defined in indeterminate form. This problem can be solved using standard methods with preliminary task of function $\alpha = \alpha(\delta)$, satisfying the conditions of Tikhonov theory [6]. Further we will solve the regularized problem with accuracy ε=0.0001, consistently changing the values α.

For example, if in equation (4) m=1, M=3, n=2, $\beta_{11} = \frac{0{,}19}{0{,}20}$, $x_{11} = -\frac{4}{19}$, $x_{12} = -\frac{12}{19}$, $\beta_{21} = 1$, $x_{21} = -0{,}1$, $x_{22} = -0{,}5$, $\beta_{31} = 0{,}01$, $x_{31} = 0$, $x_{32} = -0{,}5$, $y_1 = -1$, $y_2 = -1$, $y_3 = -1$, then its matrix notation takes the following form:

$$\begin{pmatrix} -0{,}95 & 0{,}2 & 0{,}6 \\ -1 & 0{,}05 & 0{,}5 \\ -0{,}01 & 0 & 0{,}005 \end{pmatrix} \begin{pmatrix} z_1 \\ z_2 \\ z_3 \end{pmatrix} = \begin{pmatrix} 1 \\ 1 \\ 1 \end{pmatrix}.$$

Determinant of the matrix coefficients of this system is close to zero and is equal to 0.000125. We solve this system using the Gauss method. We obtain the following results:

$$z_1=316, z_2=-990, z_3=832.$$

Now suppose that the right side is given in the form of fuzzy with an error 0.1. We change the third element of a column vector from 1 to 1.1.

We will try to solve a new system using the inverse operator. We obtain the following results:

$$z_1=348, z_2=-1090, z_3=916.$$

As you can see, small changes in the right side of the equation correspond to large changes in solutions. This system is unstable and finding a solution which is close to exact, using the inverse operator cannot be accomplished.

A program to overcome this difficultywas developed and the final values of the outcome of the difficulty were given.

Value of the regularization parameter: 2.619344741106O3E-0010.

Based on the proposed method the approximate model of evaluation and risk prediction in fuzzy conditions with test on stability of solutions were established nonregistering (fig. 1,2). Prediction error for the initial design was 0,05-3,5% , for the second - 5,5 - 50,33%.

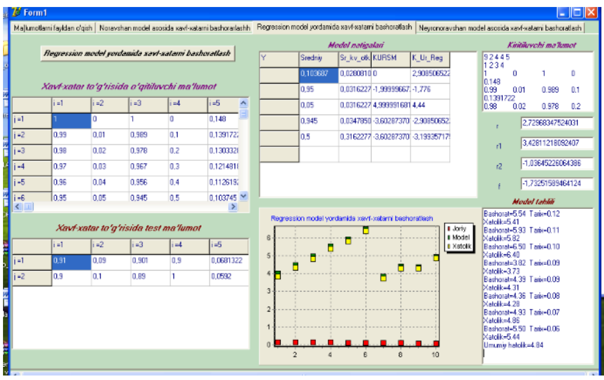

Fig.1. Program for solving the problem of risk assessment without verification on the stability

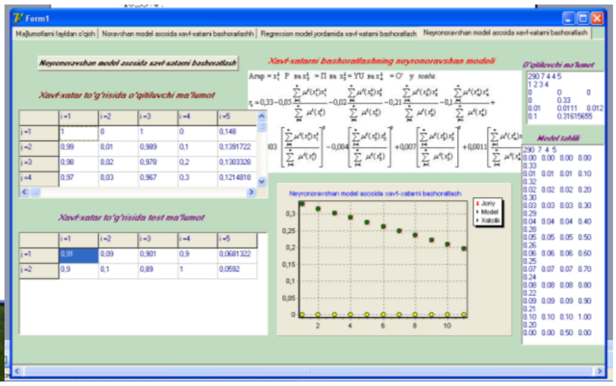

Fig. 2.Program for solving the problem of risk assessment with verification on the stability

An algorithm for overcoming the issue of parametric programming relied on fuzzy present information was discovered.

To overcome the issues of assessing, risk prediction and decision-making in poorly validated systems a program was developed (Fig. 3) and the outcomes of the problem of multiobjective optimization was obtained.

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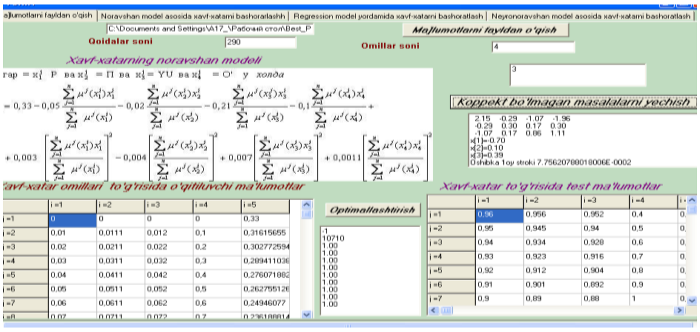

Fig.3. Program for solving multiobjective optimization

Optimization difficulties of poorly formalized processes solved based on fuzzy-set approach. Obtained and analyzed solution of optimization problems of risk assessment and prediction.

For mathematical programming of the following formulation computational experiment was performed.

Given an optimization model of placement of investments in areas of risky agriculture with fuzzy initial information:

to maximize $x=\{x_i\}$ function

$$f(x)=\sum_i \theta_j x_i \to \max$$

in limits

$$\sum_i m_{ij}\theta_i x_i - r\mu_j \sum_i \theta_i x_i \subset K_j^1, \quad j=1,\dots,m;$$

$$\sum_i l_{ij} x_i - r\lambda_j \sum_i x_i \subset K_j^2, \quad j=1,\dots,m;$$

$$\sum_i c_i x_i - I \subset K_j^3; \quad 0\le x_i \le b_i, \quad i=1,\dots,n.$$

Here: x_i – sown area in the region i; c_i – cost of cultivation per unit area in the region i; θ_i – productivity of culture in the region i under normal conditions; l_{ij} – expertly determined factor of loss of sown areas in the region in catastrophic scenario j; m_{ij} – experimental coefficient of productivity loss in the region i in catastrophic scenario j; b_j – maximal sown areas in the region i; λ_j – allowable losses in shares of sown areas for scenario j; μ_j – allowable losses in shares of the total crop for scenario j; r – risk coefficient; I – total investment. If the coefficients and their estimates take fuzzy values "Low", "Medium", "High", then the problem takes the following form when m=2, n=2.

Let the objective function

$$f(x)=\frac{\sum_{j=1}^{J}\mu_{c_1}(c_1)c_1^j}{\sum_{j=1}^{J}\mu_{c_2}(c_2)}x_1+\frac{\sum_{j=1}^{J}\mu_{c_2}(c_2)c_2^j}{\sum_{j=1}^{J}\mu_{c_2}(c_2)}x_2 \to \max, \tag{6}$$

maximized in the set $D\subseteq X$, determined by the system of constraints

$$\begin{cases} -\dfrac{\sum_{j=1}^{J}\mu_{a_{11}}(a_{11})a_{11}^j}{\sum_{j=1}^{J}\mu_{a_{11}}(a_{11})}x_1+\dfrac{\sum_{j=1}^{J}\mu_{a_{12}}(a_{12})a_{12}^j}{\sum_{j=1}^{J}\mu_{a_{12}}(a_{12})}x_2 \subset K_1, \\ \dfrac{\sum_{j=1}^{J}\mu_{a_{21}}(a_{21})a_{21}^j}{\sum_{j=1}^{J}\mu_{a_{21}}(a_{21})}x_1-\dfrac{\sum_{j=1}^{J}\mu_{a_{22}}(a_{22})a_{22}^j}{\sum_{j=1}^{J}\mu_{a_{22}}(a_{22})}x_2 \subset K_2. \end{cases} \tag{7}$$

To solve this problem we use the system of possibilistic constraints. We turn to the fuzzy formulation of the problem of maximizing the objective function (6), defined in the set $D\subseteq X$ through the following system:

$$\begin{cases} \mu\{a_{11}(\gamma)x_1+a_{12}(\gamma)x_2=0\}\ge\alpha, \\ \mu\{a_{21}(\gamma)x_1+a_{22}(\gamma)x_2=0\}\ge\alpha, \end{cases}$$

where a_{12}, a_{21} = $N(1, b)$, a_{11}, a_{22} = $N(-1, b)$, α and b - parameters of fuzziness. Let us consider relationship $f_i(x,\gamma)=a_{i1}(\gamma)x_1+a_{i2}(\gamma)x_2$, u=1,2.

Here $f_1(x,\gamma)=N(-x_1+x_2,\ b(x_1+x_2))$,

$f_2(x,\gamma)=N(x_1-x_2, b(x_1+x_2))$.

The membership function $f_j(x,\gamma)$ is defined as follows:

$$\mu_{f_i(x,\gamma)}(0)=\exp\left(-\frac{1}{b^2}\frac{(x_1-x_2)^2}{(x_1+x_2)^2}\right).$$

We specify the errors of current fuzzy parameters. Then, instead of (6) and (7) we obtain the optimization problem (6) in the set D^{ε}:

$$\begin{cases} \mu\{a_{11}(\gamma)x_1+a_{12}^{\varepsilon}(\gamma)x_2=0\}\ge\alpha, \\ \mu\{a_{21}^{\varepsilon}(\gamma)x_1+a_{22}(\gamma)x_2=0\}\ge\alpha, \end{cases} \tag{8}$$

where

$$a_{12}^{\varepsilon}, a_{21}^{\varepsilon}=N(1+\varepsilon,b),\ a_{11},a_{22}=N(-1,b).$$

In this case the probability distribution function of points $x\in X$ in the set of solutions D^{ε} has the following form:

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$$\mu_{D^\varepsilon}(x)=\min_i\{\mu_{f_i^\varepsilon(x,\gamma)}(0)\}=\exp\left(-\frac{((1+\varepsilon)\max\{x_1,x_2\}-\min\{x_1,x_2\})^2}{b^2(x_1+x_2)^2}\right)$$

.

Graphics of membership functions $\mu_{D^\varepsilon}(x)$, describing the action of each failing constraints are shown in Figure 4, 5 respectively, for the following values of parameters: b=0.5, ε=0.3 и b=0.5, ε=0.9. Increase in parameter errors of restrictions reduce the probability membership of points $x\in X$of setD^ε. When ε=0 result is $\Re^0$ = 2 reached in point (1,1) with possibility 1.

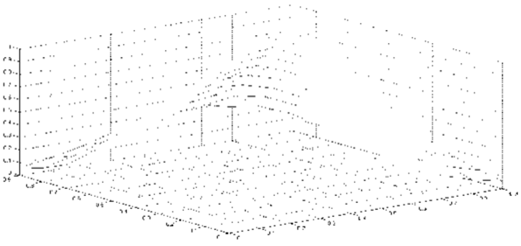

Fig.4. The membership function $\mu_{D^\varepsilon}(x)$ when b=0.5 $\varepsilon=0{,}3$

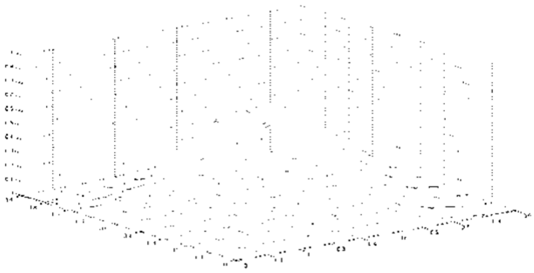

Fig.5. The membership function $\mu_{D^\varepsilon}(x)$ when b=0.5 $\varepsilon=0{,}9$

Modelrelied on a skillful determination of designs of nonlinear optimization difficulties in the kind of fuzzy quantities, permits the person, who makes decision, recognize the meaning of the objective function and limitations (semantics) of the optimization issue of poorly formalized processes.

IV. Conclusion.

According to the results of this study we can formulate following conclusions:

1. Systematically analyzed problems of constructing fuzzy risk assessment models and forecasting in poorly formalized systems and inaccurateissues, formalized in the procedure of developing these models were identified.

2. Algorithms for overcoming unbalanced difficulties, validated in the procedure of developing the assessment model and risk estimation relied on fuzzy sets were developed. It is shown that the difficulty of locating the parameters of fuzzy coefficients can be overcome by bringing it to the mathematical programming.

3.An algorithm for solving unstable multiobjective optimization with fuzzy information was developed. A program for overcoming unbalanceddifficulties in the procedure of building a risk assessment model depending on the theory of fuzzy sets was created.

4. Inaccordance to evaluate the efficacy of created software tools a computational test for overcomingunbalanced difficulties, validated in the procedure of developing a model of risk assessment and prediction in poorly formalized systems was carried out.

5.The problem of predicting the risk of decreasing soil fertility was solved. Fuzzy approach allows us to obtaina fuzzy decision for a given level of accuracy, and input data.

6. It is clear that the outcome of the optimization issue of poorly validated processes based on fuzzy-set approach allows obtaining optimal solutions of the risk assessment and prediction. Description objective functions and limitations of nonlinear optimization problems in the type of fuzzy set-expressions permit to elucidate the issue in the type of "soft" models and get successfulresults.

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