PROBABLE-STATISTICAL ANALYSIS AND DECISION-MAKING IN THE INDISTINCT ENVIRONMENT

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In all branches and political system directions there is a necessity for the decision of numerous problems of numerical estimations, the analysis and decision-making. It is possible to carry problems to number of analyzed problems both operative, and strategic character of various appointments (management, forecasting, approximation, diagnosing, a logic conclusion, synthesis of structures, etc.) . The decision of the overwhelming majority of such problems is automated now with use of modern control devices, information and computer technology and methods. However in some cases there are no means, ways of reception of the necessary information on some indicators or (and) effective methods for decision-making. In such cases quite often use intellectual systems. As is known, base elements of such systems are experts who at a presentation of the relations to the concrete facts often use linguistic indistinct expressions (variables) with enough big uncertainty. Since ancient times people used such expressions and at concrete application they defined their numerical characteristics. As such numerical characteristics depending on semantics of indistinct expressions the determined numbers, intervals, relations etc. on a numerical axis in a certain scale have been used. Certainly, the person at definition of numerical characteristics of indistinct expressions (IE) has wider representations about them, for example, in the form of some function. Proceeding from it it is possible to conclude, that the numerical characteristics HB traditionally defined by the person grow out of the implicit analysis and generalisation of its representations. For example: 1)I read *much* every day 2) The weather will be *warm* tomorrow; 3) Student Mamedov studies *better*, than Hasanov.

On semantics numerical characteristics IE it is "much" and "warm" can be expressed as in the form of numbers, and intervals, and IE it is "better"- in the form of the binary relation. Certainly, that the person using these expressions has the certain numerical information on them. In particular in the form of fragments about volume of the read material in the first, quantity of the collected apples in the second example in certain days; knowledge of answers of the students specified in the third example, in several test checks. The person mentally generalising this information defines corresponding numerical characteristics. It is possible the person can have more general concepts about семантиках IE, generated in a mode of training and generalisation for long time of its activity.

Occurrence to the public in the sixtieth years of the last century of work of L.Zadeh [1] under the theory of indistinct sets (TIS) has opened ample opportunities of more adequate display of representations of experts about IE and acceptances of qualitative decisions. It is possible at the expense of use of substantive provisions TIS and entered in it to multiple-valued characteristic function (MCF) - accessory functions (AF) for display of representations of experts about семантиках IE and decision-making.

Issue TIS has interested many scientific world and works in this direction have roughly begun. And the number of such works continuously increased. In these works the important results have been received. However, there were also such works in which attempts to use TIS outside the limits of its primary application became, in particular, there where there were means or ways of measurement of sizes, indicators and (or) effective methods of decision-making.

Proceeding from the analysis of the published works devoted to theoretical and applied aspects TIS it is important to note the following:

1. At known means, ways and (or) methods of an estimation of sizes, indicators, processes and decision-making, use with that end in view TIS is ineffective, hence is inexpedient.

2. In the majority of the published works though the question of the analysis of indistinct multidimensional problems with many (vector) indistinct (linguistic) variables is considered, but their actual analysis, it is possible to tell, it is spent on separate scalar variables. Thus communications between variables are not considered, that often leads non realisation or a bad realisation of the received results.

3. At the analysis of indistinct problems are under construction and used MCF kind AF IE and the decision is accepted, as a rule, on the basis of a pessimistic rule and a kind composition «crossing of sets». In that case found decision has small degree of an accessory that leads to another technical and economic losses to which do not pay attention.

4. Indistinct problems of optimum control and synthesis are is infinite-dimensional, and indistinct characteristics of linguistic variables do not suppose data of such problems to конечномерным. Therefore the analysis of such problems within the limits of indistinct sets appears difficult enough, and use of various principles of generalisation for the decision of such problems are ineffective. Proceeding from told, such problems often enough are unreasonably represented and analyzed as a problem of an indistinct logic conclusion.

In the report for definition of numerical estimations IE, the analysis of problems and decision-making in the indistinct environment as alternative variant TIS is offered theory of probability and the mathematical statistics (TPMS) [3] which in certain degree consider above told remarks. It is shown, that because of sufficient work and clear advantage TPMS before TIS offered ways and methods are represented by more effective. It first of all is connected with properties CF - distribution functions (DF) random variables which replace linguistic variables.

Fundamental properties DF of each random variable is equality of its integral to unit within change of this size. This property allows on the one hand, statistical problems бесконечномерного optimum programming, management, synthesis, forecasting, etc., being the most difficult, especially in TIS with use of the theorem of Kelly it is easy to approximate final measure and for their decision to use fulfilled enough methods of mathematical programming, and on the other hand - the aprioristic information on fundamental property DF allows experts with use TPMS more adequately to define numerical characteristics IE in the form of DF. Thus unlike TIS also it is possible to check up various hypotheses, to define confidential intervals, etc. numerical estimations and the accepted decisions.

In the report possibilities of use of the offered ways and methods in the decision of typical problems THM are shown. We will more low result some of them.

1. An estimation of numerical characteristics IE.

For simplicity instead of DF, also as AF, approximation is used its triangular or трапецеидальная. At use of triangular approximation DF, proceeding from its fundamental property for its construction expert by it is enough to estimate numerical values of two of three characteristic points triangular CF IE, at the same time for construction MCF - AF the triangular form its all three characteristic points are estimated.

For construction DF of the triangular form expert by one of characteristic points is defined from balance

$$S_1 + S_2 = 1 \quad \text{or} \quad h(\ell_1 + \ell_2) = 1, \tag{1}$$

Where S_1, S_2 are the areas of the direct triangles located at the left and to the right of base value IE, i.e. from a point with the maximum probability - $p = h$; ℓ_1, ℓ_2 - the bases of the left and right direct triangles.

Thus, for piece-linear approximation IE of any form, fairly following statement:

The theorem. Number of the characteristic points estimated expert by for DF on one less, than for AF.

2. Operations over CF, random numbers, sets, relations, etc. do not differ from corresponding operations over MCF. Difference only in definitions.

3. The statistical analogue of generalisation of L.Zadeh basically does not differ from its indistinct relation. However the offered conditional generalisation (at restrictions on the bottom

limits of probabilities of an accessory of numerical values IE to the given set) can be considered generalisation, somewhat, development of generalisation of L.Zadeh.

4. Statistical - logic statements and conclusions.

With one conclusion of a kind: if $P(u_j \in G_j) \geq \gamma_j$ then $P\left(x \begin{pmatrix} \leq \\ \geq \end{pmatrix} \bar{x} \right) \geq \gamma$, i.e. a kind: if

$$P(u_1 \in G_1) \geq \gamma_1,\ P(u_2 \in G_2) \geq \gamma_2,\ \ldots,\ P(u_m \in G_m) \geq \gamma_m,\ P\left(x \begin{pmatrix} \leq \\ \geq \end{pmatrix} \bar{x} \right) \geq \gamma \quad (2)$$

With many conclusions of a kind: if $P(u_j \in G_j) \geq \gamma_j$, $P\left(x_i \begin{pmatrix} \leq \\ \geq \end{pmatrix} \bar{x}_i \right) \geq \gamma_i$, i.e. a kind: if

$$P(u_1 \in G_1) \geq \gamma_1,\ P(u_2 \in G_2) \geq \gamma_2,\ \ldots,\ P(u_m \in G_m) \geq \gamma_m,\ P\left(x_1 \begin{pmatrix} \leq \\ \geq \end{pmatrix} \bar{x}_1 \right) \geq \gamma_1,$$

$$P\left(x_2 \begin{pmatrix} \leq \\ \geq \end{pmatrix} \bar{x}_2 \right) \geq \gamma_2,\ \ldots,\ P\left(x_n \begin{pmatrix} \leq \\ \geq \end{pmatrix} \bar{x}_n \right) \geq \gamma_n \quad (3)$$

Certainly, that the number of models of a kind (2), (3) is enough for display of practically possible situations.

In expressions *P* - a probability symbol; γ - reliability of performance of a corresponding condition; ΔG_j - elementary sets of the general set of change $u_j - G = \bigcap G_j$, m - number of conclusions.

Having made replacement $P(u_j \in G_j) \geq \gamma_j$ and $P\left(x_i \begin{pmatrix} \leq \\ \geq \end{pmatrix} \bar{x}_i \right) \geq \gamma_i$ in (2), (3) accordingly on $M[u_j] \in G_j$, $M[x_i] \begin{pmatrix} \leq \\ \geq \end{pmatrix} \bar{x}_i$ we will receive these expressions on the average, where M - a population mean symbol. Also other variants of models (2), (3) are possible.

5. A problem of stochastic programming and its linear approximation.

The problem generally is represented so:

$$Q = f(u, a_0) \to \max_{u \in G} \quad (4)$$

Under conditions

$$G = \left\{ u \middle| M[\underline{u \leq u \leq \bar{u}}],\ M[f_i(u, a_i) \leq b_i,\ i = \overline{1, m}\ ] \right\}, \quad (5)$$

Where *G* - set of change of a vector of management u; $f_i(\cdot)$, $i = \overline{0, m}$ - functions of the purpose and restrictions; a_i - a vector of parametres f_i.

The decision of a problem (4), (5) it is possible to carry out both in pure, and in the mixed strategy. For most general variant optimum control is searched in the form of linear function of certain number of points on a set surface at camber of the last, on a surface of convex cover *G* at it non convex and the number of such points is defined proceeding from Kelly's theorem. By such approximation the initial nonlinear problem is reduced to linear for which decision it is possible to use standard programs of linear programming. The analogue of such approach is not available in TIS [2,3].

The following conclusion follows from the report:

1. The offered procedures and methods of definition of numerical characteristics, analysis IE and decision-making in the indistinct environment, based on TPMS, being worthy analogue of corresponding procedures and methods TIS, in some cases has clear advantages in comparison with this theory. In particular, allow to carry out the statistical analysis of the received results, it is rather easy to consider restrictions on values MCF, to solve

multidimensional problems of optimisation, even on not convex set of restrictions on management etc. Besides many of the offered ways and methods of the analysis and decision-making in the indistinct environment are most effective remedies of the analysis and decision-making outside the limits of primary application TIS, i.e. in the environment of real numerical measurements.

References

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