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# METHODS OF INDISTINCT REGULATION IN MANAGEMENT PROBLEMS EDUCATIONAL PROCESS

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In management problems, educational process the big sets of alternatives appear at the decision of the subtasks connected with distribution. In work for them special methods are allocated: the method of generation of set of alternatives-distributions, and of an estimation of alternatives and a conclusion of the unique decision is developed the device of an indistinct regulator is adapted.
**Keywords:** decision-making, an indistinct regulator, generation of alternatives, fuzzification.

## Introduction

In management problems educational process methods of an expert estimation of alternatives we will apply when capacity of set of alternatives and restrictions is not great, otherwise it is difficult to expert to execute their estimation. The big capacities of set of alternatives appear at the decision of problems of distribution.

Let's use in this case for an estimation of alternatives methods of unsharp regulation which found reflection in the device of creation of an unsharp regulator. The mechanism of an indistinct logic conclusion is put in a basis of indistinct regulators.

The given methods, as a rule, are applied at the decision of problems of automatic control.

In work it is offered to adapt them for the decision of problems of organizational management. It is connected by that distribution problems at management of educational process always are accompanied by the indistinct entrance data and the decision of problems characterized by considerable influence of the person. It confirms validity of a choice of the given device. The indistinct regulator allows estimating set of alternatives of the big capacity, at ranging which (distribution) the set of restrictions is used. The basic means of maintenance of the given possibility are solving rules, which are intended in this case for reflexion of influence of the person on an estimation and a choice of alternatives. Thus, the choice of alternatives is carried out as a conclusion of the unique decision.

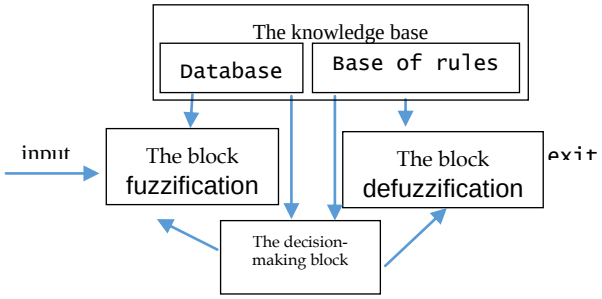
## 1. Introduction methods in an illegibility

Thus, for the purpose of the decision of questions of adaptation, we will consider structure of an indistinct regulator and we will describe methods, which are necessary for developing.

The indistinct regulator [1] consists of five functional blocks (drawing 1):

- The block fuzzification, reformative numerical entrance values in conformity degree to linguistic variables;
- The base of rules containing a set of indistinct rules of type "if";
- A database in which functions of an accessory of the indistinct sets used in indistinct rules are defined;
- The block of decision-making making operations of a conclusion on the basis of available rules;
- The block defuzzification, reformative results of a conclusion in numerical values.

Usually the base of rules and a database unite in the general block – the knowledge base.




Drawing 1 – Structure of an indistinct regulator

The procedure of an indistinct conclusion, which is carried out in an indistinct regulator, includes five following procedures:

- Formation of base of rules of system of an indistinct conclusion;
- Transformation entrance variable in values of functions of an accessory of elements of indistinct sets of entrance linguistic variables (fuzzification);
- Comparison among themselves values of functions of an accessory of various entrance variables for reception of weight of each rule (aggregation);
- Definition of target indistinct values in production (accumulation);
- Transformation of values of an accessory of target variables to target value (defuzzification).

For adaptation of the device of an indistinct regulator to problems of distribution of organizational management, it is necessary to consider methods and the algorithms underlying realization of first two procedures. These procedures are connected with preparation of the initial information and rules for an indistinct regulator, the others can be used without change.

Rules work with linguistic variables, which prepare in procedure fuzzification. Therefore, we will consider the methods realizing given procedure, and then – formation of base of rules of system of an indistinct conclusion.

Procedure fuzzification is realized on the basis of introduction methods in an illegibility and defined as follows.

Fuzzification is a procedure of transformation of the entrance functions of an accessory of elements of indistinct sets of the entrance linguistic variables described by a train given in values.

For performance of the given procedure it is necessary to generate elements of trains of linguistic variables [2].

The linguistic variable is described by a kind train $<\beta, T, U, G, M>$, where $\beta$ – a name of a linguistic variable; $T$ – the set of its values (terms) representing the name of indistinct variables, area of interpretation of everyone is set $U$ named universal set of a linguistic variable; $G$ – syntactic procedure of formation of term-set $T$; $M$ – semantic procedure of formation of indistinct sets of elements of set $T$.

Let's consider the data on which basis linguistic variables are formed.

As us, the decision that methods of indistinct regulation we will use at the decision of problems of distribution the initial data of an indistinct regulator is formed on the basis of sets of alternatives-distributions is accepted.

At generation of sets of alternatives-distributions we carry out splitting of signs $X = \{x_1, K, x_k\}$ sets of objects $U = \{U^1, \ldots, U^n\}$ and signs $Y = \{y_1, K, y_k\}$ sets of objects $V = \{V^1, \ldots, V^m\}$. Sets $X$ and $Y$ have been broken into subsets: simple $X^1 \subseteq X$ and compound $X^2 \subseteq X$ signs. On the basis of subsets of signs $X^1$ and $Y^1$ classes of equivalence on sets of objects $U$ and $V$ are constructed and the set of alternatives-distributions $A = \{a_i \mid a_i = (u_i, v_i), u_i, v_i$ are described by set of signs $X^1$ and $Y^1$ accordingly$\}$.

The alternative is generated on conformity each other signs $x_r \in X^1$ and $y_s \in Y^1$, having accurate character. For an alternative estimation $a_i$ it is necessary to analyse compound signs on set in rules of an indistinct regulator conformity, i.e. on maintenance of the restrictions set in a problem.

At formation of set of entrance and target linguistic variables we will use signs $x \in X$ and $y \in Y$, characterized by indistinct character and described by trains $<\beta_x, U, T, G, M>$ and $<\beta_y, U, T, G, M>$ accordingly.

Values of a linguistic variable are indistinct variable (terms) of term-set $T$.

## 2. Term-set formation

For formation of term-set $T$ syntactic procedure $G$ and semantic procedure of M are used.

According to works [1,3,4,5] procedure $G$ has two definitions:

1. $G$ – a syntactic rule which can be set in the form of the context-free grammar generating terms of set $T$ by means of approximate splitting of universal set $U$ on ranges [1].

2. $G$ – the syntactic procedure describing process of formation from set $T$ of new values comprehended for a given problem of a linguistic variable [3].

According to definition 1 term-set $T$ of a linguistic variable $\beta$ is formed by syntactic procedure $G$. By definition 2 syntactic procedure $G$ forms new additional elements of set $T$ of elements of in advance generated set $T$.

In our opinion, both definitions are necessary, definition 2 supplements definition 1, therefore we will enter the generalized definition 3.

3. Syntactic procedure $G$ is a procedure of formation of term-set $T$ on the basis of generation of primary terms of set $T'$ and compound (additional) terms of set $T''$, comprehended for the given problem.

Let's consider an essence of syntactic procedure $G$. Term-set $T$ is a set of the indistinct variables defined on universal set $U$. According to an indistinct variable the kind train is called

$$<X, U, \tilde{\tilde{X}}>,$$

where $X$ - the name of an indistinct variable; $U$ - universal set;

$$\tilde{X} = \bigvee_{u \in U} \mu_{\tilde{X}}(u)/u$$

- Indistinct set on $U$, describing restriction on possible numerical values of an indistinct variable $X$.

Definition of an indistinct variable is an appointment to it of the term - names of an indistinct variable and definition for it indistinct set $\tilde{X}$.

Thus, the essence of syntactic procedure $G$ consists in the decision of the first of two problems – formation of elements $X$ of trains of indistinct variables. The second problem dares by means of semantic procedure of $M$ - formation of elements of trains of indistinct variables.

## 3. Formation of base of rules

The base of rules of system of an indistinct conclusion is intended for formal representation of solving rules of a problem of decision-making. In system of an indistinct conclusion rules indistinct productions are used.

The base of rules indistinct production represents final set of rules indistinct production, coordinated concerning linguistic variables used in them.

The coordination of rules concerning used linguistic variables means that as conditions and the conclusions of rules indistinct linguistic statements can be used only, thus in each of indistinct statements functions of an accessory of values of term-set for each of linguistic variables should be defined.

In systems of an indistinct conclusion, linguistic variables are used in indistinct statements of conditions indistinct production and are called as entrance linguistic variables. Variables, which are used in indistinct statements of the conclusions indistinct production, are called as target linguistic variables.

Thus, at the task or formation of base of rules indistinct продукций it is necessary to define set of rules indistinct продукций $P = \{R_1, R_2..., R_n\}$, set of entrance linguistic variables $In = \{\beta_1..., \beta_n\}$ and set of target linguistic variables $Out = \{\omega_1..., \omega_n\}$. The base of rules indistinct production is considered set if sets $P$, $In$ and $Out$ are set.

Formal representation of solving rules in the form of indistinct production is based on a formalism indistinct production models.

For creation of the formalized record of a solving rule in the form of indistinct production, it is necessary to define the elements entering into its structure. Indistinct production is defined by the expression which is looking like *(i): Q; P; A ⇒ B; S, F, N,* where *(i)* - a name of indistinct production; $Q$ - scope of application of indistinct production; $P$ – a condition of applicability of a kernel of indistinct production; $A \Rightarrow B$ – production kernel; $F$ – factor of definiteness of indistinct production or weight of indistinct production; $N$ – production postcondition, describes actions and procedures which are necessary for executing after realisation $B$.

The base of rules represents system indistinct production, consisting of several subsystems (blocks). Each subsystem is intended for the decision of separate subtasks. The accessory of production to a subsystem is reflected in scope of application of indistinct production.

The condition of applicability looks like the logic statement which validity defines necessity of activation of a kernel of production.

The logic statement has predicate idea and registers in the form of conjunction of the facts which defines a current situation on the entrance data. The entrance data are sets of signs $X = \{x_1, ..., x_k\}$ and $Y = \{y_1, ..., y_t\}$, describing distributed objects $P$ and $Q$ and having accurate character. The proof of the validity of statements is carried out on a method described in work[6].

The kernel of indistinct production looks like «if $A$, that $B$» in which $A$ is a condition, and $B$ – the conclusion. Condition $A$ and conclusion $B$ – some expressions of indistinct logic which are most often represented in the form of indistinct statements. As expressions $A$ and $B$ compound logic indistinct statements, i.e. the elementary indistinct statements connected by indistinct logic sheaves, such as indistinct negation *NOT*, indistinct conjunction *AND* and an indistinct disjunction can be used *OR*.

The requirement of a coordination of base indistinct production is connected with restriction on formation of elementary indistinct statements of a condition $A$ and conclusions $B$. It consists that elementary indistinct statements of a condition $A$ should be elements of set $In$ – entrance linguistic variables, and elementary indistinct statements of conclusion $B$ should be elements of set $Out$ – target linguistic variables.

As linguistic variables, we will use signs $x \in X$ and $y \in Y$, characterized by indistinct character and being properties of distributed objects $P$ and $Q$. And entrance linguistic variables can be both signs $x \in X$, and signs $y \in Y$, and signs $y \in Y$ as set $Y$ describes objects $Q$ can be target linguistic variables only. We will remind that objects $Q$ are objects of appointment on which objects $P$ are distributed.

Let's consider a subtask «Reduction of intensity of studying of disciplines of various cycles to one average value» problems «Formation of the curriculum of a speciality». In it on the basis of intensity of studying of disciplines of cycles (naturally – scientific disciplines – *EN*, the general professional disciplines - *OPD*, special disciplines – *SD*) average intensity of studying of disciplines of a cycle is calculated.

Set $In$ of entrance linguistic variables make $Int^{EN}$ «Intensity of studying of disciplines of cycle *EN*», $Int^{OPD}$ «Intensity of studying of disciplines of cycle *OPD*» and $Int^{SD}$ «Intensity of studying of disciplines of cycle *SD*», $In = \{Int^{EN}, Int^{OPD}, Int^{SD}\}$. A target linguistic variable is average intensity of studying of disciplines of cycle $IntAll \in Out$. The term-set of entrance linguistic

variables looks like *T = {Low, Normal, High}*, a term-set of a target linguistic variable – *T = {Low, SlightlyLow, Normal, SlightlyHigh, High}*.

Then examples of kernels indistinct production can have the following appearance:

1. If $(Int^{EN}=Low)$ and $(Int^{OPD}=Low)$ and $(Int^{SD}=Low)$ then *IntAll = Low*.
2. If $(Int^{EN}=Low)$ and $(Int^{OPD}=Low)$ and *(IntSD=Normal)* then *IntAll=SlightlyLow*.
3. If $(Int^{EN}=Low)$ and $(Int^{OPD}=Low)$ and *(IntSD =High)* then *IntAll=SlightlyLow*.
4. If $(Int^{EN}=Low)$ and $(Int^{OPD}=Normal)$ and *(IntSD =Low)* then *IntAll=Low*.
5. If $(Int^{EN}=Low)$ and $(Int^{OPD}=Normal)$ and *(IntSD =High)* then *IntAll=SlightlyHigh*.
6. If $(Int^{EN}=Low)$ and $(Int^{OPD}=Normal)$ and *(IntSD =Normal)* then *IntAll=SlightlyLow*.
7. If $(Int^{EN}=Low)$ and $(Int^{OPD}=High)$ and *(IntSD =Low)* then *IntAll=SlightlyLow*.
8. And so on.

Value of target linguistic variable *IntAll* will be used further by a regulator, which is carrying out check of conformity of the list of disciplines of a semester to restrictions, imposed on a semester.

Factor of definiteness of indistinct production name weight of indistinct production. In the given work for all rules *F = 1*. It means that all indistinct production of base of rules of an indistinct regulator have equal weight.

Production postcondition describes actions and procedures, which are necessary for executing after realization *B*. Performance *N* can occur right after realizations of a kernel of production.

Procedure of an indistinct conclusion includes operations of aggregation, activation, accumulation and unessential operation defuzzification.

## Conclusion

In management problems, educational process the big sets of alternatives appear at the decision of the subtasks connected with distribution. In work for them special methods are allocated: the method of generation of set of alternatives-distributions, and of an estimation of alternatives and a conclusion of the unique decision is developed the device of an indistinct regulator is adapted.

The method of generation of set of alternatives-distributions is constructed on strategy of the directed search and consists in a data control on the basis of the analysis of signs of distributed sets of alternatives and allocation in them of subsets of simple and compound signs.

Methods of indistinct regulation, which can be divided into two blocks roughly, are applied to an estimation of set of alternatives-distributions in work: methods fuzzification and methods of an indistinct conclusion.

Methods fuzzification are adapted for the decision of problems of management by educational process, methods of an indistinct conclusion can be applied without changes.

As a rule, methods of indistinct regulation are used in automatic control problems. Adaptation of methods of indistinct regulation for the decision of problems of organizational management expands area of their application.

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### МЕТОДЫ НЕЧЕТКОГО РЕГУЛИРОВАНИЯ В ВОПРОСАХ УПРАВЛЕНИЯ ОБРАЗОВАТЕЛЬНЫМ ПРОЦЕССОМ


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В задачах управления учебным процессом большие множества альтернатив появляются при решении подзадач, связанных с распределением. В работе для них выделены специальные методы: разработан метод генерации множества альтернатив-распределений, а для оценки альтернатив и вывода единственного решения адаптирован аппарат нечеткого регулятора.



**Ключевые слова:** принятие решений, нечёткое регулирование, генерирование альтернатив, подготовка задачи для решения методами нечеткой логики.