

Метою даного дослідження є обґрунтування методу розкриття невизначеності у задачах протидії двох сторін при конфлікті стратегій, що визначаються функціями двох змінних за наявності специфічних додаткових умов і обмежень.

Ключові слова: невизначеність, протидія, стратегії, конфлікт, функція двох змінних, специфічні умови та обмеження.

O.V. BOROVYK, L.V. BOROVYK, V.A. KRYSKOV
Khmelnitsky National University

THE METHOD OF DISCLOSURE OF UNIQUENESS IN THE PROBLEMS OF CONTINGENCY OF TWO PARTIES AT STRATEGY CONFLICT

For a significant class of formal problems of system analysis, an important problem is the disclosure of uncertainties. Applied tasks that do not contain uncertainties are rather an exception than a rule. An adequate description of the problem usually contains various types of uncertainty, reflecting the natural state in which the researcher is located. The most common practice is the uncertainty of goals, situations, conflicts. One of the most important classes of problems of uncovering the problems is the problems in which cases of conflict between the strategies of subjects are investigated. Tasks of this class, for example, include tasks of choosing a rational strategy of competitors' actions in the common market, if there are no agreements between them and restrictions in behaviour. Study of the properties and features of conflict situations - one of the main tasks of such discipline, as the theory of games. In the framework of this theory, cases of counteraction to the parties whose strategies are determined by the payment matrix are sufficiently fully analysed. Cases of disclosure of uncertainty in counteracting two opponents related to the assessment of the degree and level of risk based on point and interval principle are also researched. However, for today, the question of determining the optimal (rational) compromise in the event of counteraction to the parties, the strategies of which are described functionally, in the presence of additional conditions and assumptions, have not yet been fully studied. The paper defines a class of problems of counteraction of two parties in the conflict of strategies determined by the functions of two variables in the presence of restrictions and additional conditions that provide an opportunity: to achieve a guaranteed result at the worst variants of the situation for the party; achieve the maximum possible result in the worst case scenario for the party; achievement of the best result for the party at the most probable variants of behaviour of the opposing party. On the basis of the analysis of existing methods of solving such problems, approaches to the solution of the investigated problem in all possible described cases of the implementation of specific conditions are proposed.

Keywords: uncertainty, counteraction, strategy, conflict, function of two variables, specific conditions and constraints.

[1]

[2–6].

[4–6].

[2].

()

$$f_1(x_1, x_2) \geq f_1^* \tag{1}$$

$$f_2(x_1, x_2) \geq f_2^* \tag{2}$$

$$x_1 \in [a; b], x_2 \in [c; d]. \tag{3}$$

$$f_1(x_1, x_2) \geq f_1^* \tag{4}$$

$$f_2(x_1, x_2) \geq f_2^* \tag{5}$$

(4)-(5) f_1^*, f_2^* –

1. (1)–(5) , f_1^*, f_2^*

$$f_1^* = \max_{x_1} \min_{x_2} f_1(x_1, x_2), \tag{6}$$

$$f_2^* = \max_{x_2} \min_{x_1} f_2(x_1, x_2). \tag{7}$$

$$(6) \quad x_1 = x_1^*, \quad (7) - \quad x_2 = x_2^*,$$

$$x_1^* = \arg \max_{x_1} \min_{x_2} f_1(x_1, x_2), \tag{8}$$

$$x_2^* = \arg \max_{x_2} \min_{x_1} f_2(x_1, x_2). \tag{9}$$

$$x_1 = x_1^* \tag{10}$$

$$f_1(x_1, x_2) \geq f_1^* \tag{10}$$

$$x_2 = x_2^* \tag{11}$$

$$f_2(x_1, x_2) \geq f_2^* \tag{11}$$

$$f_1^*, f_2^* \tag{11}$$

$$D, \quad (4), (5).$$

$$\bar{x}_1^* \quad \bar{x}_2^*, \quad (1)-(5),$$

$$\max_{i=1,2} |f_i(x_1, x_2) - f_i^*| \rightarrow \min \quad (12)$$

$$D, \quad \forall (x_1, x_2) : (x_1, x_2) \in D.$$

$$2. \quad (1)-(5), \quad f_1^*, f_2^*$$

$$f_1^*$$

$$f_1^* = \max_{x_1} \max_{x_2} f_1(x_1, x_2), \quad (13)$$

$$f_2^* = \max_{x_2} \max_{x_1} f_2(x_1, x_2). \quad (14)$$

$$(13) \quad x_1 = x_1^*, \quad (14), \quad x_2 = x_2^*,$$

$$x_1^* = \arg \max_{x_1} \max_{x_2} f_1(x_1, x_2), \quad (15)$$

$$x_2^* = \arg \max_{x_2} \max_{x_1} f_2(x_1, x_2). \quad (16)$$

$$f_1^*, f_2^*$$

$$[7] \quad M^*(x_1^*; x_2^*), \quad f_1(x_1, x_2) \cdot f_1(x_1, x_2^*).$$

$$\bar{x}_1 \quad f_1(x_1, x_2^*). \quad f_1^*, \quad (17)$$

$$f_1^* = f_1(\bar{x}_1, x_2^*).$$

$$f_2^*.$$

$$N^*(x_1^*; x_2^*), \quad f_2(x_1, x_2) \cdot f_2(x_1^*, x_2).$$

$$f_2(x_1^*, x_2). \quad \bar{x}_2 \quad f_2(x_1^*, x_2).$$

$$f_2^*,$$

$$f_2^* = f_2(x_1^*, \bar{x}_2). \quad (18)$$

$$D, \quad 1.$$

$$\bar{x}_1^* \quad \bar{x}_2^*, \quad (1)-(5),$$

$$\max_{i=1,2} |f_i(x_1, x_2) - f_i^*| \rightarrow \max \quad (19)$$

$$D, \quad \forall (x_1, x_2) : (x_1, x_2) \in D.$$

$$3. \quad (1)-(5), \quad f_1^*, f_2^*$$

$$f_1^*$$

$$[8]$$

$$f_1^* = \frac{1}{S} \iint_D f_1(x, y) dS, \quad (20)$$

$$D - \quad f_1(x, y) \quad S = (b-a) \cdot (d-c).$$

$$(3), \quad S -$$

$$D ($$

$$f_2^*$$

$$f_2^* = \frac{1}{S} \iint_D f_2(x, y) dS. \tag{21}$$

(21) D S , (20).

$$x_1^* = \arg f_1^*, \tag{22}$$

$$x_2^* = \arg f_2^*. \tag{23}$$

D , 1, 2.

$$\bar{x}_1^*, \bar{x}_2^*, \tag{1)-(5),}$$

x (19),

2. 1.

$$1 - f_1(x_1, x_2) = -x_1^2 + 2x_1 + x_2^2 - 4x_2 + 8, \tag{24}$$

$$2 - f_2(x_1, x_2) = x_1^2 - 6x_1 - x_2^2 + 2x_2 + 2. \tag{25}$$

1, 2 $x_1 \in [0;4], x_2 \in [0;4]$.
(4), (5).

$$f_1^*, f_2^*.$$

(. 1, 2).

1

f_1^*

$x_1 \in [0;4]$	0					1					2					3					4									
$x_2 \in [0;4]$	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
$f_1(x_1, x_2)$	8	5	4	5	8	9	6	5	6	9	8	5	4	5	8	5	2	1	2	5	0	-3	-4	-3	0	0	-3	-4	-3	0

(. 1) $f_1^* = \max_{x_1} \min_{x_2} f_1(x_1, x_2) = f_1^*(1;2) = 5.$

2

f_2^*

$x_2 \in [0;4]$	0					1					2					3					4									
$x_1 \in [0;4]$	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
$f_2(x_1, x_2)$	2	-3	-6	-7	-6	3	-2	-5	-6	-5	2	-3	-6	-7	-6	-1	-6	-9	-10	-9	-6	-11	-14	-15	-14	-6	-11	-14	-15	-14

(. 2) $f_2^* = \max_{x_2} \min_{x_1} f_2(x_1, x_2) = f_2^*(3;1) = -6.$

$$f_1^*, f_2^*$$

$$\frac{\partial f_1}{\partial x_2} = 2x_2 - 4 = 0. \tag{26}$$

$$x_2 = 2.$$

$$x_1, f_1(x_1, x_2)$$

$$x_2 = 2$$

$$\frac{\partial f_1(x_1, 2)}{\partial x_1} = -2x_1 + 2 = 0.$$

$$x_1 = 1.$$

$$x_1 = 1$$

$$\max_{x_1} \min_{x_2} f_1(x_1, x_2) = f_1^*(1;2) = 5.$$

$$f_2(x_1, x_2).$$

$$\frac{\partial f_2}{\partial x_2} = 2x_1 - 6 = 0.$$

$$x_1 = 3.$$

$$\frac{\partial f_2(3, x_2)}{\partial x_1} = -2x_2 + 2 = 0,$$

$$x_2 = 1$$

$$f_2^* = \max_{x_2} \min_{x_1} f_2(x_1, x_2) = f_2^*(3;1) = -6.$$

$$f_1^*, f_2^*$$

$$f_1^*$$

$$x_1,$$

$$f_1(x_1, x_2) \quad x_2$$

(. 1).

$$x_2 = 2 \quad x_1 = 1, \quad f_1^* = 5.$$

$$f_2^*$$

$$x_2,$$

$$f_2(x_1, x_2) \quad x_1 \quad (. 1).$$

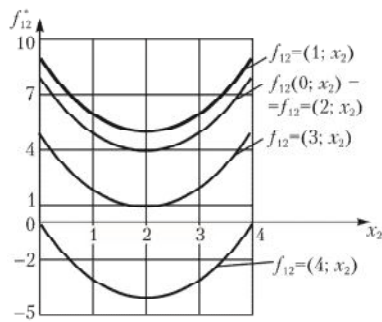
$$x_1 = 3 \quad x_2 = 1,$$

$$f_2^* = -6, \quad f_1^* = 5 \quad f_2^* = -6./$$

$$f_1^*(x) \geq 5; \quad f_2^*(x) \geq -6. \quad C$$

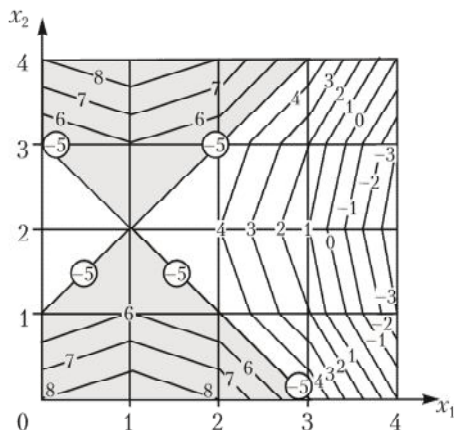
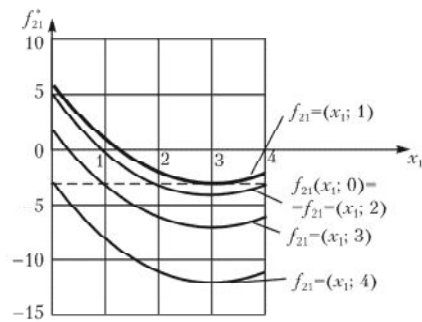
(4)-(5)

(. 2)



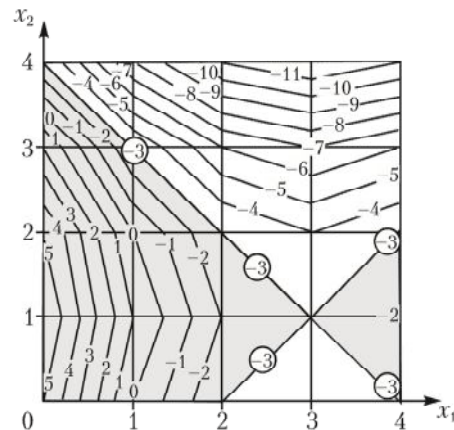
. 1.

$$f_1^* \quad f_2^*$$



Множина точок для нерівності 4.87, а

. 2.



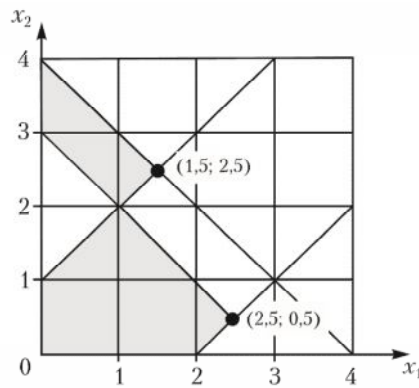
Множина точок для нерівності 4.87, б

(4)-(5)

(12).

. 3.

$$\bar{x}_1^* \quad \bar{x}_2^*$$



с. 3.

1. Nagel E. Teorema gedelya / E. Nagel, Dzh. R. Nyuman – Moskva; Znanie, 1970. – 63 s.
2. Zgurovskij M. Z. Osnovi sistemnogo analizu: p druchnik dlya vishnix navchal'nix zakladov / M.Z. Zgurovskij, N.D. Pankratova – Ki v: Vidavnichna grupa BHV, 2007. – 544 s.
3. Moiseev N. N. Matematicheskie zadachi sistemnogo analiza. / Moiseev N. N. – Moskva.: Nauka, 1981. – 488 s.
4. Ventcel' E. S. Issledovanie operacij: zadachi, principy, metodologiya / E. S. Ventcel' – Moskva: Sovetskoe radio, 1972. – 552 s.
5. Borovik O.V. Dosl dzhennya operacij v ekonomice: Navchal'nij posibnik / Borovik O.V., Borovik L.V. – Ki v: Centr uchbovo l teraturi, 2007. – 424 s.
6. Borovik O. V. Dosl dzhennya operacij v operativno-sluzhbovj d yal'nost organ v oxoroni derzhavnogo kordonu: p druchnik / Borovik O. V., Borovik L. V. – Xmel'nic'kij: Vidavnicтво Nac onal'no akadem Derzhavno prikordonno sluzhbi Ukra ni men B. Xmel'nic'kogo, 2009. – 444 s.
7. Borovik O.V. Vishha matematika: Diferenc al'ne chislennya funkcion bagat'ox zm nnix. Chastina 2: navchal'nij posibnik / Borovik O.V., Borovik L.V., Matoxnyuk L.O. – Xmel'nic'kij: Vidavnicтво NADPSU, 2016. – 640 s.
8. Borovik O.V. Vishha matematika: ntegral'ne chislennya. Chastina 3: navchal'nij posibnik / Borovik O.V., Gashhuk .V., Traskovecka L.M. – Xmel'nic'kij: Vidavnicтво NADPSU, 2016. – 630 s.

References

1. Nagel E. Teorema gedelya / E. Nagel, Dzh. R. Nyuman – Moskva; Znanie, 1970. – 63 s.
2. Zgurovskij M. Z. Osnovi sistemnogo analizu: p druchnik dlya vishnix navchal'nix zakladov / M.Z. Zgurovskij, N.D. Pankratova – Ki v: Vidavnichna grupa BHV, 2007. – 544 s.
3. Moiseev N. N. Matematicheskie zadachi sistemnogo analiza. / Moiseev N. N. – Moskva.: Nauka, 1981. – 488 s.
4. Ventcel' E. S. Issledovanie operacij: zadachi, principy, metodologiya / E. S. Ventcel' – Moskva: Sovetskoe radio, 1972. – 552 s.
5. Borovik O.V. Dosl dzhennya operacij v ekonomice: Navchal'nij posibnik / Borovik O.V., Borovik L.V. – Ki v: Centr uchbovo l teraturi, 2007. – 424 s.
6. Borovik O. V. Dosl dzhennya operacij v operativno-sluzhbovj d yal'nost organ v oxoroni derzhavnogo kordonu: p druchnik / Borovik O. V., Borovik L. V. – Xmel'nic'kij: Vidavnicтво Nac onal'no akadem Derzhavno prikordonno sluzhbi Ukra ni men B. Xmel'nic'kogo, 2009. – 444 s.
7. Borovik O.V. Vishha matematika: Diferenc al'ne chislennya funkcion bagat'ox zm nnix. Chastina 2: navchal'nij posibnik / Borovik O.V., Borovik L.V., Matoxnyuk L.O. – Xmel'nic'kij: Vidavnicтво NADPSU, 2016. – 640 s.
8. Borovik O.V. Vishha matematika: ntegral'ne chislennya. Chastina 3: navchal'nij posibnik / Borovik O.V., Gashhuk .V., Traskovecka L.M. – Xmel'nic'kij: Vidavnicтво NADPSU, 2016. – 630 s.

/Received : 27.2.2018 . /Printed :26.3.2018 .

: . . . , . . .