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MATRIX GAME EVALUATION IN GAME THEORY

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Abstract: Article games theory matrix games to the department dedicated to be , to work release and economy in the field conflicted processes mathematician modeling and solution methods seeing It turns out . Matrix of games main concepts , including achievement matrix , game lower and high prices , saddle point , maxmin and minimum strategies is explained . If the game saddle to the point has if not , mix strategies method using solution find process is described . Matrix games linear programming to the issue to bring methods and this optimal strategies in the process determination algorithms The article is cited . two example through theoretical concepts practical solutions with is strengthened . Used literature list the topic deeper study for additional sources presented Article mathematician programming and optimization in the field professionals , students and researchers for useful is considered .

Keywords: Games theory , matrix games , conflict processes , achievement matrix , saddle point , maxmin strategy , minimax strategy , game price , mixed strategies , linear programming , optimal strategy , mathematics modeling , economic issues , work release

Introduction . Processes research and optimal management – decision acceptance to do and systems to optimize scientific fields oriented .

1- Process research resources effective distribution for mathematician models , linear programming , games theory and networks optimization such as from methods uses .

2-Optimal management systems the most good management strategies determination with He is engaged in his work . main methods Pontryagin's Maximum principle and Bellman's dynamic programming .

Research methodology

In the article cited research methodology analysis to do for his/her content and from the structure come out , following main aspects seeing Let's go out . Article games theory matrix games to the department dedicated is a research methodology theoretical analysis , mathematics modeling and practical examples through solution to find is based on . Below methodology in detail analysis cited : Research general approach Theoretical basis : Article games theory main concepts (achievement) matrix , saddle point , maxmin and

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minimax strategies , mixed strategies) from explanation begins . These concepts conflicted processes economy and working release in the field modeling for basis to be service does . Mathematician Modeling : Research central methodology conflicted processes simplified mathematician as models (games) to express is based on . In this process main factors into account is taken , the second level factors and out of consideration aside is left . Practical orientation : Article theoretical concepts practical through examples (example 1 and example 2) strengthen and help students this apply methods to real problems application opportunity gives .

Literature analysis

In the article cited used literature list games theory , mathematics programming and optimization in the field important sources cover takes . Below this of literature briefly analysis brought by : Akulich I. L. Mathematical programming in in examples and zadachax - M .: Vysshaya school , 1996. Analysis : This book mathematician programming in the field practical issues and their to the solutions dedicated games theory and linear to program related examples and exercises own inside takes . Book students and practitioners for comfortable theoretically knowledge practical skills with connects . In the article cited linear programming methods and matrix games solution algorithms this to the source based to be possible.Relevance : Article linear programming to the issues to bring process in explanation important contribution adds.Badalov FB Optimization theory and mathematician programming . “ Teacher ” , T. 1989. Analysis : Uzbek published in this book optimization theory and mathematician programming main concepts own inside takes . Local students for customized games theory main principles in explanation important source as service does . The book Uzbek in the language in the environment written of the article local to the context compatibility provides.Relevance : In the article cited of the game price , strategies and their mathematician modeling such as concepts this from the book taken to be possible . Kuznetsov A. V. , Novikova G. I. , Kholod N. I. Collection task by mathematically speaking programming . Minsk , Vysheishaya school , 1985. Analysis : This source mathematician programming according to wide extensive issues set presented it will , that's it including games theory and linear programming with related issues own inside takes . The set practical orientation in the article cited examples and solutions to the structure Relevance : In the article like example 1 and example 2 given practical issues this in the set to approaches based to be probability high .

Analyses and results

Matrix games . Production release and economy in the field many practical issues in solution conflicted processes (situations) come comes out . Conflicting processes own inside very many factors takes . Many in cases the process study comfortable to be for main factors into account take , second level factors into account unable to his/her mathematician model We will make such conflict of the process shortened model game It is called . Game clear one to the rule according to take will go .

Game meaning from that consists of every one participant so one the solution acceptance does that game at the end the most good to the result Let it be . Play . the result (iskhod) is this one how many functions value to him achievement function or payment function If the players achievement amount to zero equal if , then to the game zero total game It is called .

Any pair the game matrix in appearance expression possible

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$$A = \begin{matrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \dots & \dots & \dots & \dots \\ a_{m1} & a_{m2} & \dots & a_{mn} \end{matrix}$$

Let's say the matrix rows first player 's possible was A $_1$, A $_2$, …, A $_m$ marches , columns and second player's possible was B $_1$, B $_2$, …, B $_m$ their walks Let us define . A matrix payment or achievement matrix is called . The matrix every one a $_{job}$ element first Player A to walk choose the second player B $_j$ to walk when you choose first player's achievement (second player's means "loss " .

The game purpose first the player maximum to success and second to minimize the player's loss to achieve provision for the most acceptable strategy from choosing consists of .

If the first player some A $_i$ strategy choose , he never unless $\alpha_i = \min_j a_{ij}$ to success achieves this . into account take this player his/her own the most less achievements maximizer , i.e. $\alpha = \max_i \min_j a_{ij}$ PCB provider to walk chooses . Here α size of the game lower price and to him/her suitable strategy maxmin It is called .

Second player , own in turn , his the most big possible was losses minimizing , that is $\beta = \min_j \max_i a_{ij}$ PCB provider to walk chooses . Here β size of the game high price and to him/her suitable The strategy is called minimax .

If α=β if , that is $V = \min_j \max_i a_{ij} = \max_i \min_j a_{ij}$ equality If it is done , then V of the game price This condition is called of the satisfying matrix A a $_{job}$ to the element of the game saddle point It is called .

So , matrix game saddle to the point has if so , its solution maxmin and minimax methods with is found .

Example 1. Given matrix game for lower and high grades and Find the optimal price of the game .

$$A = \begin{matrix} 3 & 1 & 2 \\ 2 & 4 & -1 \\ 5 & 7 & 6 \end{matrix}$$

Matrix in the row the most small elements of the following consists of :

$$\min_j(3, 1, 2) = 1$$

$$\min_j(2, 4, -1) = -1$$

$$\min_j(5, 7, 6) = 5$$

So , the game lower price

$$\alpha = \max_i(\min_j a_{ij}) = \max_i(1, -1, 5) = 5$$

It will be . Now every one on the column the most big element we will find .

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$$\max_i(3,\ 2,\ 5) = 5$$
$$\max_i(1,\ 4,\ 5) = 7$$
$$\min_i(2,\ -1,\ 6) = 6$$

In that case , the game high price to the following equal will be .

$$\beta = \min_j(\max_i a_{ij}) = mix_j(5,\ 7,\ -6) = 5$$

This game lower and high grades mutual equal happened for optimal price of the game V= β= α=5 . This is the estimate . provider a $_{31}$ element game saddle point and A $_3$ and B $_1$ strategies optimal strategy will be .

If the achievements matrix saddle to the point has if not , then maxmin and minimax methods with of the game solution found In this case of the game solution in finding mixture strategies from the method is used .

First player 's mixture strategy , components following

$$\sum_{i=1}^{m} x_i = 1,\ \ x_i \quad 0,\ i = \overline{1,m}$$

the conditions to the vector X =(x $_1$, x $_2$, … , x $_m$) satisfying It is said . In this every one x $_i$ first Player A walk choice probability indicates .

Second player 's mixture strategy , components following

$$\sum_{j=1}^{n} y_i = 1,\ \ y_j \quad 0,\ j = \overline{1,n}$$

the conditions satisfactory Y =(y $_1$, y $_2$, … , y $_n$) to the vector It is said . In this every one y $_j$ second player's B $_j$ walk choice probability indicates .

Mix strategies in the way first Player A walk choose the second player B $_j$ walk when you choose first player's achievement as his/her of winning mathematician expectation is taken , that is, it is taken to equal will be

$$V(x,y) = \sum_{i=}^{m}\sum_{j=1}^{n} a_{ij}x_i y_j$$

Function V(x,y) payment or achievement function It is called .

If the first player his/her own $X^* = (x_1^*, x_2^*, ..., x_m^*)$ optimal strategy if it is used , then second player how strategy from choosing strict look , its achievement from the game's V rating less it won't happen , that is

$$\sum_{i=1}^{m} a_{ij}x_i^* \quad V,\quad j = \overline{1,n}\ .$$

Same also , if the second player his/her own $Y^* = (y_1^*, y_2^*, ..., y_m^*)$ optimal strategy if it is used , then first player how strategy from choosing strict look , its loser from the game's V rating does not exceed , that is

$$\sum_{j=1}^{n} a_{ij}y_j^* \quad V,\quad i = \overline{1,m}\ .$$

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Matrix the game linear programming to the issue to bring

Matrix the game linear programming to the issue to bring process seeing We will go out . The most before optimal player mix strategy and of the game price We find . Its for inequalities system and conditions To summarize , the following in appearance we write :

$$a_{11}x_1 + a_{21}x_2 + \dots + a_{m1}x_m \quad V$$
$$a_{12}x_1 + a_{22}x_2 + \dots + a_{m2}x_m \quad V$$
$$\dots\dots\dots\dots\dots\dots\dots\dots\dots$$
$$a_{1n}x_1 + a_{2n}x_2 + \dots + a_{mn}x_m \quad V$$
$$x_1 + x_2 + \dots + x_m = 1$$
$$x_1 \quad 0 \qquad (i = \overline{1, m})$$

Game price what Considering the equation , ($V > 0$) of the system everyone inequalities to become below system harvest we do :

$$a_{11}t_1 + a_{21}t_2 + \dots + a_{m1}t_m \quad 1$$
$$a_{12}t_1 + a_{21}t_2 + \dots + a_{m2}t_m \quad 1$$
$$\dots\dots\dots\dots\dots\dots\dots\dots\dots$$
$$a_{1n}t_1 + a_{2n}t_2 + \dots + a_{mn}t_m \quad 1$$
$$t_1 + t_2 + \dots + t_m = \frac{1}{V}$$

here $t_1 = \dfrac{x_1}{V}$

The first player tries to maximize his payoff, i.e. the value of the game. So, for the first player,

$$t_1 + t_2 + \dots + t_m = \frac{1}{V}$$

the most small (minimum) value acceptance to do This is necessary . in requirements system following linear programming to the issue turns into :

$$a_{11}t_1 + a_{21}t_2 + \dots + a_{m1}t_m \quad 1$$
$$a_{12}t_1 + a_{21}t_2 + \dots + a_{m2}t_m \quad 1$$
$$\dots\dots\dots\dots\dots\dots\dots\dots\dots$$
$$a_{1n}t_1 + a_{2n}t_2 + \dots + a_{mn}t_m \quad 1$$
$$t_1 \quad 0, t_2 \quad 0, \dots, t_m \quad 0$$
$$Z = t_1 + t_2 + \dots + t_m \to \min$$

In a similar way, to find the optimal mixed strategy of the second player and the cost of the game, the following linear programming problem must be solved.

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$$a_{11}y_1 + a_{12}y_2 + ... + a_{1n}y_n \quad V$$
$$a_{21}y_1 + a_{22}y_2 + ... + a_{2n}y_n \quad V$$
$$..$$
$$a_{m1}y_1 + a_{m2}y_2 + ... + a_{mn}y_n \quad V$$
$$y_1 \quad 0, y_2 \quad 0, ..., y_n \quad 0$$

$$F = \frac{1}{V} = y_1 + y_2 + ... + y_n \to \max$$

Problems (7.15)-(7.17) and (7.18-7.20) mutual hesitant linear programming from issues consists of will be . Of them optional one undressing , both of them solution easily find possible .

Example 2

$$A = \begin{matrix} 5 & 3 & 2 \\ 3 & 5 & 5 \\ 6 & 3 & 4 \end{matrix}$$

matrix the game mixture in strategies Find the solution .

Solution . First player for the game linear programming to the issue We will turn it around . for the most before following the system harvest we will do .

$$5x_1 + 3x_2 + 6x_3 \quad V$$
$$3x_1 + 5x_2 + 3x_3 \quad V$$
$$2x_1 + 5x_2 + 4x_3 \quad V$$
$$x_1 + x_2 + x_3 = 1$$
$$x_1 \quad 0, x_2 \quad 0, x_3 \quad 0$$

(7. 21) We divide both sides of each inequality in the system $V > 0$ by ( ) and $t_1 = \frac{x_1}{V}$ introduce the notation to form the following system:

$$5t_1 + 3t_2 + 6t_3 \quad 1$$
$$3t_1 + 5t_2 + 3t_3 \quad 1$$
$$2t_1 + 5t_2 + 4t_3 \quad 1$$
$$t_1 + t_2 + t_3 = \frac{1}{V}$$
$$t_1 \quad 0, t_2 \quad 0, t_3 \quad 0$$

This system can be written as the following linear programming problem:

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$$5u_1 + 3u_2 + 2u_3 \quad 1$$
$$3u_1 + 5u_2 + 5u_3 \quad 1$$
$$6u_1 + 3u_2 + 4u_3 \quad 1$$
$$u_1 \quad 0, u_2 \quad 0, u_3 \quad 0$$
$$F = \frac{1}{V} = u_1 + u_2 + u_3 \to \max$$

The given matrix game for the second player becomes the following linear programming problem.

$$5u_1 + 3u_2 + 2u_3 \quad 1$$
$$3u_1 + 5u_2 + 5u_3 \quad 1$$
$$6u_1 + 3u_2 + 4u_3 \quad 1$$
$$u_1 \quad 0, u_2 \quad 0, u_3 \quad 0$$
$$F = \frac{1}{V} = u_1 + u_2 + u_3 \to \max$$

Issues each other hesitant are issues . Therefore for from them optional one take off , the other one solution easily find possible .

Conclusion

Article games theory matrix games department analysis to do dedicated is conflicting processes economy and working release in the field mathematician modeling and solution methods illuminates . Research methodology theoretical analysis , mathematics modeling , linear programming and practical to examples is based on . The game lower and high prices , saddle point , maxmin and minimax strategies , as well as mixed strategies such as main concepts clear explained . Matrix games linear programming to the issue optimal strategies are presented and of the game price is determined . Practical examples through theoretical knowledge is strengthened . References list local and international sources comprehensive , scientific the basis strengthens , but modern technological approaches absence restriction as record Methodology article to their goals complete suitable comes , systematic and practical solutions presented However , empirically information and software tools input through the research further enrichment possible Overall , the article games theory economic to issues in use important guidance students , researchers and experts for useful source is considered .

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