DETERMINATION OF RECURRENT ALGORITHMS AND OPTIMAL STRATEGIES FOR CONTROLLED MARKOV CHAINS

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Abstract: Article controlled Markov chains for recurrent algorithms and optimal strategies determination to the issues dedicated . Managed random processes , especially industrial   of enterprises work activity planning such as practical in the fields application   seeing The states of the system are Markov random . process with modeled , each one in case various to strategies suitable to pass probabilities and income analysis The goal is to   one in step maximum average   income optimal strategy that provides find . Recurring algorithms using expected income and optimal strategies consecutively is considered . From this except , asymptotic formulas optimal strategies using determination methods Example   as two stately and two strategic Markov process for calculations and tables presented is done , this optimal strategies through is determined . Article practical and theoretical in terms of controlled Markov processes study   for important source is considered .

Key Keywords: Supervised Markov chains , recurrent algorithms , optimal strategies , random processes , transitions probabilities , expected income , asymptotic formulas , strategies package , Markov process , industry planning .

Introduction: Supervised Markov Chains random of processes important class are , they are various in sectors including industry   enterprises planning , economic analysis , logistics decision acceptance to do and other many practical issues in solution wide is used in these processes . system Markov properties of states has to be , every one in case acceptance to be done strategies transition probabilities and expected income Determines optimal strategies . to determine , that is every one in step maximum average   income providing decisions set to find is in the field main from issues This is one of them . article controlled Markov chains for recurrent algorithms and optimal strategies to find asymptotic methods learns . In the article theoretical approaches practical examples with strengthened , two stately and two strategic Markov process in the example of calculations and optimal strategies determination process This is brought . research controllable random processes deep understanding and them practical in

matters application   for important basis creates .

Literature analysis

Supervised Markov chains and they for recurrent algorithms field many fundamental and practical of research topic become Markov processes   foundations AA Markov formed in the works (1906) Although the concept of Controlled Markov Chains was first proposed in the mid-20th century , in particular by R. Bellman (1957). dynamic programming methods within Bellman developed optimal strategies in his work " Dynamic Programming" find for recurrent equations system offer did this   later controlled Markov processes in learning main from approaches to one H. Howard (1960) in his book "Dynamic Programming and Markov Processes" controlled Markov chains for iterative algorithms , in particular , value iteration and strategy iteration methods improved . His optimal strategies for work in determining practical calculations for important basis Later , D. Bertsekas (1995) in his book " Dynamic Programming and Optimal Control" this algorithms modern optimization methods with together , wide extensive to applications adapted.Asymptotic formulas and their in controlled Markov processes application according to research and by J. Filar and K. Vrieze (1997) in their work "Competitive Markov Decision Processes" deep illuminated . Their work , especially long term average   income maximize in matters asymptotic solutions to find aimed at was . With that together , E. Altman (1999) in his work " Constrained Markov Decision Processes" limited conditions optimal strategies under to determine circle new approaches offer did. Local research point of view from the point of view of Uzbekistan scientists , for example , A. Ikramov and by T. Shirinov (2015) announcement made in articles controllable random of processes industry and economic in systems application studied . Their in their work local industry in enterprises optimal allocation of resources to the issues attention However , local   in literature asymptotic methods and recurrent algorithms deep analysis according to research relatively limited .

Research methodology

Research controlled Markov chains for recurrent algorithms and optimal strategies Methodology   following from stages consists of: Theoretical analysis : Markov processes , optimal strategies and recurrent algorithms literature studied.Mathematics Modeling : System states Markov process with modeled , transition probabilities and income based on recurrent equations was compiled.Asymptotic Methods : Long term income maximize for asymptotic equations system solved.Practical calculations : Two situation and to the strategy Markov process   in the example of transition probabilities and income matrices optimal strategies using was calculated .

Analysis and results

Controlled Markov processes

Supervised Markov chains random of processes important type then   system cases and strategies based on future transitions These processes are determined . industry planning , economics , logistics and artificial intellect such as in the fields decision acceptance in doing wide is used . Each in case strategy is selected , this and to go probabilities and expected income The goal is to determine the one in step or far within the period maximum income optimal strategies that lead to find .

In the study recurrent algorithms using expected income is considered and optimal strategies consecutively is defined . Asymptotic methods and far term stable solutions to find help gives . In the example two stately and two strategic system seeing   out , strategies suitable probabilities and income tables through analysis As a result , every one situation for the most good strategies is determined .

This industry theoretical in terms of solid be practical in areas such as resources management or economic in optimization important importance has . In the future this methods big information analysis and automated in systems application further expansion is expected .

Importance and future directions

Supervised Markov chains theoretical in terms of solid to the base has be practical in the fields important solutions presented They will . resources effective management , expenses reduce and decision acceptance to do processes in automation big importance has . In the future this methods big information analysis , machine education and complicated systems in optimization application further expansion is expected . Also , in real time decision acceptance to do and dynamic in environments flexible strategies working exit according to research important direction as remains .

This industry scientists , engineers and practitioner experts for wide opportunities presented because it is fundamental mathematics analysis practical problems solution with successful unites .

Managed random processes in life various in cases wallet For example , industry of the enterprise work planning Let 's take each planning of time at the beginning achieved to the situation looking at next to time plan is being prepared . When planning asset amounts of money looking at work is seen . Active the funds of use possible was methods It 's called strategy .

Let's assume that the of the enterprise (the enterprise) from this then (we call it a system) Markov random activity process with to be determined . various to strategies system various transition probabilities and various to their income suitable is coming .

Each strategy for transition probabilities and their income suitable accordingly P_{ij}^k and r_{ij}^k through Let 's define each to the situation suitable strategies to the collection has was to the process is called a controlled Markov process . Each E_i situation for so $d_i(m)$ strategy number find the issue let's see , this strategy $m -$ in step used one in passing maximum average income g what let him give .

These strategies package $d(m)$ vector gives : $d(m) = \begin{matrix} d_1(m) \\ d_2(m) \\ \vdots \\ d_N(m) \end{matrix}$.

strategies consecutively analysis as this something determination maybe the system $(m+1) -$ optimal average in step income to give for m - the step should be optimal need .

$$v_i(m) = q_i + \sum_{j=1}^{N} P_{ij} v_j(m-1), \quad i = \overline{1,N}, m = 1,2,...$$

$$v_i(m+1) = \max_k \left(q_i^k + \sum_{j=1}^{N} P_{ij}^k v_j(m) \right), \quad i = \overline{1,N}$$

Here $v_i(m+1), \ v_j(m)$ s selected optimal transition for expected income indicates .

Expected income and optimal strategies last equality using consecutively to calculate $d(m)$ vector unchanged until it remains continue is delivered .

Optimal strategies of controlled Markov processes

Now the optimal strategies $v_i(m) = mg + v_i, \quad i = 1,2,...,N$ asymptotic formulas using find method looking at Let's go out .

$$v_i(m) = q_i + \sum_{j=1}^{N} P_{ij} v_j(m-1), \quad i = \overline{1,N}, m = 1,2,...$$

happened for

$$mg + v_i = q_i + \sum_{j=1}^{N} P_{ij} v_j(m-1)$$

or

$$mg + v_i = q_i + \sum_{j=1}^{N} P_{ij}\left[v_j + (m-1)g\right]$$

PCB h axis We will do it . From now on

$$mg + v_i = q_i + \sum_{j=1}^{N} P_{ij} v_j + (m-1)g \sum_{j=1}^{N} P_{ij}$$

PCB and $\sum_{j=1}^{N} P_{ij} = 1$ that attention take

$$g + v_i = q_i + \sum_{j=1}^{N} P_{ij} v_j, \quad i = \overline{1,N}$$

relationship harvest we do . So so , $N+1$ one $g, v_1, v_2, ..., v_N$ variable N one equations to the system has We are here . Optimal strategy in determining $v_j, \quad j = \overline{1,N}$ of variables absolute values to know condition it's not . $v_j - v_i$ differences unchanging value acceptance to demand that enough . To achieve this difficult not the last one to the system , for example , $v_N = 0$ equation add enough , because desired i for $v_i = 0$ to assume possible .

Last system $v_N = 0$ equation with together solution if done , $v_j(m)$ of size asymptotic value $g^0, v_1^0, v_2^0, ..., v_N^0$ is found .

Fixed strategies for g what in determining last system without taking off

$$g = \sum_{i=1}^{N} P_i q_i$$

from the formula using It is possible to find it . But this optimal strategy at the time find for no what kind to information has We will not be . Found $g^0, v_1^0, v_2^0, ..., v_N^0$ from the solution using various strategies assessment possible .

Example : Markov process for system two E_1 and E_2 to the circumstances and two $k = 1, 2$ to strategies has Let it be . Strategies suitable transition probabilities matrices and income matrices as follows let it be :

$$P_1 = \begin{matrix} 0,5 & 0,5 \\ 0,4 & 0,6 \end{matrix} , R_1 = \begin{matrix} 9 & 3 \\ 3 & -8 \end{matrix} ,$$

$$P_2 = \begin{matrix} 0,8 & 0,2 \\ 0,7 & 0,3 \end{matrix} , R_2 = \begin{matrix} 4 & 5 \\ 1 & -12 \end{matrix} .$$

Above Formulas (16), (17) are given according to For *m* =1, *m* =2 calculations comply with respectively , Tables 1 and 2 we fill .

m =1

Table 1

I	k	$p_{ij}^{(k)}$		$r_{ij}^{(k)}$		$q_i^{(k)}$	$f_i(1)$	$d_i(1)$
		$j = 1$	$j = 2$	$j = 1$	$j = 2$			
1	1	0.5	0.5	9	3	6	6	1
	2	0.8	0.2	4	5	4.2		
2	1	0.4	0.6	3	−8	−3.6	−2.9	2
	2	0.7	0.3	1	−12	−2.9		

m =2

Table 2

I	k	$p_{ij}^{(k)}$		$r_{ij}^{(k)} f_j(1)$		$q_i^{(k)}$	$F_i(1,k)$	$f_i(2)$	$d_i(2)$
		$j = 1$	$j = 2$	$j = 1$	$j = 2$				
1	1	0,5	0,5	3	−1,45	6	7,55	8,42	2
	2	0,8	0,2	4,8	−0,58	4,2	8,42		
2	1	0,4	0,6	2,4	−1,74	−3,6	−2,94	0,43	2
	2	0,7	0,3	4,2	−0,87	−2,9	0,43		

From tables visible It follows that the optimal strategy for *m* =1 is $d(1) = (1, 2)$, the optimal strategy for *m* =2 and $d(2) = (2, 2)$ from vectors consists of .

Conclusion

This research controlled Markov chains for recurrent algorithms and optimal strategies determination issues learned . Theoretical analysis , mathematics modeling and practical calculations through system Markov process of states with modeling , transition probabilities and income calculation and maximum average income provider strategies find processes seeing Asymptotic formulas using far optimal long-term strategies Two situation and to the strategy has example based on calculations done increased , optimal strategies tables through confirmed . Research results of controlled Markov processes industry planning , economic analysis and other in the fields practical importance shows . In the future this algorithms big information and artificial intellect in the field application according to research expansion

recommendation is being done .
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