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CHIZIQLI TENGLAMALAR SISTEMALARINI YECHISH USULLARI

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A R T I C L E I N F O.

Kalit so'zlar: chiziqli tenglama, sistemani yechish usuli, matematik usullar, iteratsiya, koeffitsiyent.

Annotatsiya

Maqolada chiziqli tenglamalar sistemalarini yechish usullarini ko'rib chiqildi va ikki usullarini ko'rib chiqildi.

KIRISH

Talabalarga ta'lim berayotgan pedagoglar "Ta'lim to'g'risida"gi qonun va "Kadrlar tayyorlash milliy dasturi" talablarini to'liq bajarishlari va uni amalga oshirish uchun barcha imkoniyatlardan foydalanishlari davr talabi hisoblanadi.

Oliy ta'lim pedagogikasi har bir pedagogdan ta'lim jarayonida talabani faollashtiradigan interfaol metodlardan foydalanish, ta'lim jarayonida talaba bilan hamkorlikda ishlash, ma'lum bilimlar hajmini talabaga yetkazish bilan cheklanmay, talabani mustaqil bilim olishga da'vat etish g'oyasini ilgari surmoqda.

Chiziqli tenglamalar sistemalarini yechish usullarini asosan ikki guruhga ajratish mumkin:

1) aniq usullar – bu usullarga oliy matematika kursidan ma'lum bo'lgan Kramer qoidasi, Gauss usuli, teskari matritsalar usuli kiradi. Bu usullar sistemalarni yechish uchun sistema koeffitsiyentlariga bog'liq bo'lgan formulalarni hosil qilish imkonini beradi;
2) iteratsion usullar – ular qatoriga iteratsiya usuli , Zeydel usuli va hokazolar kiradi . Bu usullar sistemaning berilgan aniqlikdagi yechimini topish imkonini beradi.

Noma'lum soni katta bo'lganda Gauss usulining aniq yechimlar beruvchi chiziqli sxemasi juda murakkab bo'lib qoladi. Bunday hollarda sistema ildizlarini topish uchun ba'zan taqribiy sonly usullardan foydalanish qulaydir, bu usullardan biri ***iteratsiya*** usulidir.

$$\begin{cases} a_{11}x_1 + a_{12}x_2 + \cdots + a_{1n}x_n = b_1 \\ a_{21}x_1 + a_{22}x_2 + \cdots + a_{2n}x_n = b_2 \\ \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \\ a_{n1}x_1 + a_{n2}x_2 + \cdots + a_{nn}x_n = b_n \end{cases} \tag{1}$$

Quyidagi matritsalarni kiritamiz:

$$A=\begin{pmatrix} a_{11} & a_{12}\dots & a_{1n} \\ a_{21} & a_{22}\dots & a_{2n} \\ \dots. & \dots & \dots \\ a_{n1} & a_{n2}\dots & a_{nn} \end{pmatrix},\quad x=\begin{pmatrix} x_1 \\ x_2 \\ \vdots \\ x_n \end{pmatrix},\quad b=\begin{pmatrix} b_1 \\ b_2 \\ \vdots \\ b_n \end{pmatrix}$$

U holda (1) sistema matritsa shaklida quyidagi ko'rinishni oladi:

Ax = b

Dioganal koeffitsiyentlar noldan farqli (ya'ni $a_{11}, a_{22}, \dots, a_{nn} \neq 0$) deb faraz qilib, sistemaning 1-chi tenglamasini x_1 ga nisbatan , 2- chi tenglamasini x_2 ga nisbatan, 3 –chisini x_3 ga nisbatan yechamiz. Natijada (1) sistemaga teng

kuchli quyidagi sistemaga ega bo'lamiz.

$$\begin{cases} a_{11}x_1 + a_{12}x_2 + a_{13}x_3 + a_{14}x_4 = b_1 \\ a_{21}x_1 + a_{22}x_2 + a_{23}x_3 + a_{24}x_4 = b_2 \\ a_{31}x_1 + a_{32}x_2 + a_{33}x_3 + a_{34}x_4 = b_3 \\ a_{41}x_1 + a_{42}x_2 + a_{43}x_3 + a_{44}x_4 = b_4 \end{cases}$$

Har bir tenglamani $a_{11}, a_{22}, a_{33}, a_{44}$ bo'lamiz va bizga kerakli bo'lgan noma'lum sonlarni topish tenglamalar sistemasi hosil bo'ladi.

$$\begin{cases} x_1 = \dfrac{b_1}{a_{11}} + \dfrac{a_{12}}{a_{11}}x_2 + \dfrac{a_{13}}{a_{11}}x_3 + \dfrac{a_{14}}{a_{11}}x_4 \\ x_2 = \dfrac{b_2}{a_{22}} + \dfrac{a_{21}}{a_{22}}x_1 + \dfrac{a_{23}}{a_{22}}x_3 + \dfrac{a_{24}}{a_{22}}x_4 \\ x_3 = \dfrac{b_3}{a_{33}} + \dfrac{a_{31}}{a_{33}}x_1 + \dfrac{a_{32}}{a_{33}}x_2 + \dfrac{a_{34}}{a_{33}}x_4 \\ x_4 = \dfrac{b_4}{a_{44}} + \dfrac{a_{41}}{a_{44}}x_1 + \dfrac{a_{42}}{a_{44}}x_2 + \dfrac{a_{43}}{a_{44}}x_3 \end{cases}$$

Chiziqli tenglamalar sistemasiga belgilash kiritamiz:

$$\begin{cases} x_1 = \beta_1 + 0 + \alpha_{12}x_2 + \alpha_{13}x_3 + \cdots + \alpha_{1n}x_n \\ x_2 = \beta_2 + \alpha_{21}x_2 + 0 + \alpha_{23}x_3 + \cdots + \alpha_{2n}x_n \\ \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots. \\ x_n = \beta_n + \alpha_{n1}x_1 + \alpha_{n2}x_2 + \cdots + \alpha_{nn-1}x_n \end{cases} \qquad (2)$$

Ushbu

$$\alpha = \begin{pmatrix} 0 & \alpha_{12}\dots & \alpha_{1n} \\ \alpha_{21} & 0\dots. & \alpha_{2n} \\ \dots & \dots.. & \dots. \\ \alpha_{n1} & \alpha_{n2}\dots\dots & 0 \end{pmatrix} \text{ va } \beta = \begin{pmatrix} \beta_1 \\ \beta_2 \\ \vdots \\ \beta_n \end{pmatrix}$$

matritsiyalarni kiritish bilan (2) tenglamalar sistemasini matritsa shaklida quyidagicha yozish mumkin:

$$x = \beta + \alpha \cdot x \qquad (3)$$

(3)sistemasini ketma – ket yaqinlashishlar usuli bilan yechamiz. Nolinchi yaqinlashish sifatida, masalan, ozod handing ustunini qilib qilamiz.

$$x^{(0)} = \beta$$

$x^{(0)}$ ni (3) o'ng tomoniga qo'yib, $x^{(1)}$ birinchi yaqinlashishga ega bo'lamiz:

$x^{(1)} = \beta + \alpha \cdot x^{(0)}$

keyin $x^{(1)}$ ni (3) ning o'ng tomoniga qo'yib, $x^{(2)}$ ikkinchi yaqinlashishga ega bo'lamiz va hakozo.

$x^{(2)} = \beta + \alpha \cdot x^{(1)}$, …., $x^{(n-1)} = \beta + \alpha \cdot x^{(n)}$ (4)

Shu formula bo'yicha hosil qilinuvchi quyidagi yaqinlashishlar ketma – ketligiga ega bo'lamiz:

$x^{(0)}, x^{(1)}, x^{(2)}, \dots, x^{(n)}$

Bu ketma –ketlikning limiti, agar y mavjud bo'lsa, (1) sistemaning yechimi bo'ladi. ***n*** noma'lumli ***n*** ta tenglamaning sistemasi uchun jarayonning yaqinlashuvchi bo'lishining yetarlilik shartini isbotlab keltiramiz.

Teorema. Agar keltirilgan (2) sistema uchun ushbu

$$\sum_{j=1}^{n} |a_{ij}| < 1 \quad (i = \overline{1,n}) \ \ yoki \ \ \sum_{i=1}^{n} |a_{ij}| < 1 \ (j = \overline{1,n})$$

Shartlardan kamida bittasi bajarilsa, u holda (4) itertsiya jarayoni bu sistemaning boshlang'ich yaqinlashishni tanlashga bog'liq bo'lmagan yagona yechimiga yaqinlashadi.

Natija. Agar quyidagi tengsizliklar bajarilsa, (1) tenglamalar sistemasi uchun ***iteratsiya*** usuli yaqinlashuvchi bo'ladi: ya'ni (1) sistemaning har bir tenglamasini uchun diagonal koeffitsiyentlar moduli , ozod hadlarni hisobga olmaganda , tenglamaning boshqa barcha koeffitsiyentlari modullari yig'indisidan katta.

$$\begin{cases} |a_{11}| > \sum_{j=1}^{n} |a_{1j}| \\ |a_{22}| > \sum_{j=1}^{n} |a_{2j}| \\ \dots\dots\dots\dots\dots \\ |a_{nn}| > \sum_{j=1}^{n} |a_{nj}| \end{cases} \qquad (5)$$

Misol. Uch noma'lumli uchta tenglamalar sistemasining yechimini toping.

$$\begin{cases} 4x_1 + 0,24x_2 - 0,08x_3 = 8 \\ 0,09x_1 + 3x_2 - 0,15x_3 = 9 \\ 0,04x_1 - 0,08x_2 + 4x_3 = 20 \end{cases} \qquad (6)$$

Yechish. Jarayon yaqinlashuvchi bo'lishining so'nggi sharti bajariladi:

$$\begin{cases} |a_{11}| = 4 > |0{,}24| + |-0{,}08| = 0{,}32 \\ |a_{22}| = 3 > |0{,}09| + |-0{,}15| = 0{,}24 \\ |a_{33}| = 4 > |0{,}04| + |-0{,}08| = 0{,}12 \end{cases}$$

Shuning uchun iteratsiya jarayoni yaqinlashuvchi bo'ladi. (1) sistemani unga teng kuchli quyidagi sistema bilan almashtiramiz:

$$\begin{cases} 4x_1 + 0{,}24x_2 - 0{,}08x_3 = 8 \quad /:4 \\ 0{,}09x_1 + 3x_2 - 0{,}15x_3 = 9 \quad /:3 \\ 0{,}04x_1 - 0{,}08x_2 + 4x_3 = 20 \quad /:4 \end{cases}$$

Har qaysi tenglamani bizga kerakli bo'lgan noma'lumlarga bo'lib chiqamiz.

$$\begin{cases} x_1 + 0{,}06x_2 - 0{,}02x_3 = 2 \\ 0{,}03x_1 + x_2 - 0{,}05x_3 = 3 \\ 0{,}01x_1 - 0{,}02x_2 + x_3 = 5 \end{cases} \rightarrow \begin{cases} x_1 = 2 + 0 - 0{,}06x_2 + 0{,}02x_3 \\ x_2 = 3 - 0{,}03x_1 + 0 + 0{,}05x_3 \\ x_3 = 5 - 0{,}01x_1 + 0{,}02x_2 + 0 \end{cases} \quad (7) \rightarrow$$

Sistemaning matritsa shaklidagi yozuvi quyidagicha:

$$\begin{pmatrix} x_1 \\ x_2 \\ x_3 \end{pmatrix} = \begin{pmatrix} 2 \\ 3 \\ 5 \end{pmatrix} + \begin{pmatrix} 0 & -0{,}06 & 0{,}02 \\ -0{,}03 & 0 & 0{,}05 \\ -0{,}01 & 0{,}02 & 0 \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \\ x_3 \end{pmatrix}$$

yoki $x = \beta + \alpha x$, bu yerda

$$x = \begin{pmatrix} x_1 \\ x_2 \\ x_3 \end{pmatrix}, \; \beta = \begin{pmatrix} 2 \\ 3 \\ 5 \end{pmatrix}, \; \alpha = \begin{pmatrix} 0 & -0{,}06 & 0{,}02 \\ -0{,}03 & 0 & 0{,}05 \\ -0{,}01 & 0{,}02 & 0 \end{pmatrix}$$

Nolinchi yaqinlashish sifatida quyidagini olamiz:

$$x^{(0)} = \beta = \begin{pmatrix} 2 \\ 3 \\ 5 \end{pmatrix} \text{ yoki } x_1^{(0)} = 2, \; x_2^{(0)} = 3, \; x_3^{(0)} = 5$$

$x^{(0)}$ ni (7) sistemaning o'ng tomoniga qo'yib , $x^{(1)} = \begin{pmatrix} x_1^{(1)} \\ x_2^{(1)} \\ x_3^{(1)} \end{pmatrix}$ birinchi yaqinlashishga ega bo'lamiz:

$$\begin{cases} x_1^{(1)} = 2 - 0{,}06 \cdot 3 + 0{,}02 \cdot 5 = 1{,}92 \\ x_2^{(1)} = 3 - 0{,}03 \cdot 2 + 0{,}05 \cdot 5 = 3{,}19 \\ x_3^{(1)} = 5 - 0{,}01 \cdot 2 + 0{,}02 \cdot 3 = 5{,}04 \end{cases} \text{ yoki } x^{(1)} = \begin{pmatrix} 1{,}92 \\ 3{,}19 \\ 5{,}04 \end{pmatrix}$$

$x^{(1)}$ ni (7) sistemaning o'ng tomoniga qo'yib , ikkinchi yaqinlashishga ega bo'lamiz:

$$\begin{cases} x_1^{(2)} = 2 - 0{,}06 \cdot 3{,}19 + 0{,}02 \cdot 5{,}04 = 1{,}9094 \\ x_2^{(2)} = 3 - 0{,}03 \cdot 1{,}92 + 0{,}05 \cdot 5{,}04 = 3{,}1944 \\ x_3^{(2)} = 5 - 0{,}01 \cdot 1{,}92 + 0{,}02 \cdot 3{,}19 = 5{,}0446 \end{cases} \text{ yoki } x^{(2)} = \begin{pmatrix} 1{,}9094 \\ 3{,}1944 \\ 5{,}0446 \end{pmatrix}$$

$x^{(3)}$ ni shunga o'xshash topamiz:

$$\begin{cases} x_1^{(3)} = 2 - 0{,}06 \cdot 3{,}1944 + 0{,}02 \cdot 5{,}0446 = 1{,}90928 \\ x_2^{(3)} = 3 - 0{,}03 \cdot 1{,}9094 + 0{,}05 \cdot 5{,}0446 = 3{,}19498 \\ x_3^{(3)} = 5 - 0{,}01 \cdot 1{,}9094 + 0{,}02 \cdot 3{,}1944 = 5{,}04485 \end{cases} \text{ yoki } x^{(3)} = \begin{pmatrix} 1{,}90928 \\ 3{,}19498 \\ 5{,}04485 \end{pmatrix}$$

Natijalarni quyidagi jadvalga yozamiz:

yaqinlashishlar	x_1	x_2	x_3
0	2	3	5
1	1,92	3,19	5,04
2	1,19094	3,1944	5,0446
3	1,90928	3,19498	5,04485

Shunday qilib , ildizlarning taqribiy qiymatlari quyidagilar ekan:

$x_1 = 1{,}90928$; $x_2 = 3{,}19498$; $x_3 = 5{,}04485$ ■.

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