

列主元消去法-陈扬-石晓晨

本算法将消元结果覆盖A，乘数 m_{ik} 冲掉

$$a_{ik},$$

方程组解x存放在b内。

1) 对于 $k=1, 2, \dots, n-1$ ，依次做到第5)步；

2) 按列选主元，即确定 ik ，使

$$|a_{ik,k}| = \max_{k \leq i \leq n} |a_{ik}|.$$

3) 如果

$$a_{ik,k} = 0,$$

则输出无解信息，停机；

4) 如果 $ik=k$ ，则转向5)，否则换行

$$\begin{aligned} a_{kj} &\leftrightarrow a_{ik,j} & (j = k, k+1, \dots, n) \\ b_k &\leftrightarrow b_{ik} \end{aligned}$$

5) 消元过程

$$\begin{aligned} a_{ik} &\leftarrow m_{ik} = \frac{a_{ik}}{a_{kk}}, & (i = k+1, \dots, n); \\ a_{ij} &\leftarrow a_{ij} - m_{ik}a_{kj}, & (i, j = k+1, \dots, n); \\ b_i &\leftarrow b_i - m_{ik}b_k, & (i = k+1, \dots, n). \end{aligned}$$

6) 如果

$$a_{nn} = 0,$$

则停机；

7) 回代求解

$$\begin{aligned} b_n &\leftarrow \frac{b_n}{a_{nn}}, \\ b_i &\leftarrow \frac{b_i - \sum_{j=i+1}^n a_{ij}b_j}{a_{ii}}, & (i = n-1, \dots, 2, 1) \end{aligned}$$

8) 输出结果x。

```
1 import math
2 import numpy as np
3 from numpy import *
4 import matplotlib.pyplot as plt
5 def Fun(n): #函数形式
6     a=np.random.randint(low=1, high=100, size=(n, n+1)) #产生随机数组
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7     return a
8     def GJ(a):                                #高斯-约旦法，除对角元素外全是零，
9         row=a.shape[0]
10        print(a)
11        for j in range(0,row):
12            if j<row:
13                b=FindLarge(a[j:,j])           #最后一个元素不用找最大值；只找对角线下方的
主元
14            else:
15                b=0
16            b1=b+j                             # 主元和对角线所在行交换
17            c= np.copy(a[b1,:]) # 更方便的方法：    a[[b1,j], :] = a[[j,b1], :]
18            a[b1,:]=a[j,:]
19            a[j,:]=c
20            for i in range(j, row):
21                if i==j:
22                    continue
23                a[i,:]=a[i,:]-a[j,:]*a[i,j]/a[j,j]
24        return a
25    def FindLarge(a0):                         #寻找主元
26        b0=np.argmax(a0)
27        return b0
28    a=Fun(10)
29    a1=GJ(a)
30    print(a1)

```

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1  [[27 19 55 79 17 52 36 68 61 16 36]
2   [75 11 87  4 18 37 57 50 28 39 59]
3   [73 97 85 30 70 82 57 26 78  2 61]
4   [38 24 24 49 87 99  1 33 66 36  5]
5   [26 21 78 26 41 90 86 92 92 73 42]
6   [76 58 50 42 77 53 21 97 72 56 21]
7   [20 46 48 15 14 69 16 38 60 19 17]
8   [16 61 37 75 38 85 88 62 90 21 23]
9   [21 65 98 35 19 70 15 89 70 50 13]
10  [42 66 16 32 20 40 33 23 24 54 18]]
11  [[ 76  58  50  42  77  53  21  97  72  56  21]
12   [  0 -46  37 -37 -57 -15  36 -45 -43 -16  38]
13   [ 73  97  85  30  70  82  57  26  78  2  61]
14   [ 38  24  24  49  87  99  1  33  66  36  5]
15   [ 26  21  78  26  41  90  86  92  92  73  42]
16   [ 27  19  55  79  17  52  36  68  61  16  36]
17   [ 20  46  48  15  14  69  16  38  60  19  17]
18   [ 16  61  37  75  38  85  88  62  90  21  23]
19   [ 21  65  98  35  19  70  15  89  70  50  13]
20   [ 42  66  16  32  20  40  33  23  24  54  18]]
21  -----
22  [[ 76  58  50  42  77  53  21  97  72  56  21]
23   [  0 -46  37 -37 -57 -15  36 -45 -43 -16  38]

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```
24 [ 0 41 36 -10 -3 31 36 -67 8 -51 40]
25 [ 38 24 24 49 87 99 1 33 66 36 5]
26 [ 26 21 78 26 41 90 86 92 92 73 42]
27 [ 27 19 55 79 17 52 36 68 61 16 36]
28 [ 20 46 48 15 14 69 16 38 60 19 17]
29 [ 16 61 37 75 38 85 88 62 90 21 23]
30 [ 21 65 98 35 19 70 15 89 70 50 13]
31 [ 42 66 16 32 20 40 33 23 24 54 18]]
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32 -----
33 [[ 76 58 50 42 77 53 21 97 72 56 21]
34 [ 0 -46 37 -37 -57 -15 36 -45 -43 -16 38]
35 [ 0 41 36 -10 -3 31 36 -67 8 -51 40]
36 [ 0 -5 -1 28 48 72 -9 -15 30 8 -5]
37 [ 26 21 78 26 41 90 86 92 92 73 42]
38 [ 27 19 55 79 17 52 36 68 61 16 36]
39 [ 20 46 48 15 14 69 16 38 60 19 17]
40 [ 16 61 37 75 38 85 88 62 90 21 23]
41 [ 21 65 98 35 19 70 15 89 70 50 13]
42 [ 42 66 16 32 20 40 33 23 24 54 18]]
```

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44 [[ 76 58 50 42 77 53 21 97 72 56 21]
45 [ 0 -46 37 -37 -57 -15 36 -45 -43 -16 38]
46 [ 0 41 36 -10 -3 31 36 -67 8 -51 40]
47 [ 0 -5 -1 28 48 72 -9 -15 30 8 -5]
48 [ 0 1 60 11 14 71 78 58 67 53 34]
49 [ 27 19 55 79 17 52 36 68 61 16 36]
50 [ 20 46 48 15 14 69 16 38 60 19 17]
51 [ 16 61 37 75 38 85 88 62 90 21 23]
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56 [ 0 -46 37 -37 -57 -15 36 -45 -43 -16 38]
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58 [ 0 -5 -1 28 48 72 -9 -15 30 8 -5]
59 [ 0 1 60 11 14 71 78 58 67 53 34]
60 [ 0 -1 37 64 -10 33 28 33 35 -3 28]
61 [ 20 46 48 15 14 69 16 38 60 19 17]
62 [ 16 61 37 75 38 85 88 62 90 21 23]
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```

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65 -----
66 [[ 76 58 50 42 77 53 21 97 72 56 21]
67 [ 0 -46 37 -37 -57 -15 36 -45 -43 -16 38]
68 [ 0 41 36 -10 -3 31 36 -67 8 -51 40]
69 [ 0 -5 -1 28 48 72 -9 -15 30 8 -5]
70 [ 0 1 60 11 14 71 78 58 67 53 34]
71 [ 0 -1 37 64 -10 33 28 33 35 -3 28]
72 [ 0 30 34 3 -6 55 10 12 41 4 11]
```

73	[	16	61	37	75	38	85	88	62	90	21	23]
74	[	21	65	98	35	19	70	15	89	70	50	13]
75	[	42	66	16	32	20	40	33	23	24	54	18]]
76	-----											
77	[[	76	58	50	42	77	53	21	97	72	56	21]
78	[	0	-46	37	-37	-57	-15	36	-45	-43	-16	38]
79	[	0	41	36	-10	-3	31	36	-67	8	-51	40]
80	[	0	-5	-1	28	48	72	-9	-15	30	8	-5]
81	[	0	1	60	11	14	71	78	58	67	53	34]
82	[	0	-1	37	64	-10	33	28	33	35	-3	28]
83	[0	30	34	3	-6	55	10	12	41	4	11]
84	[0	48	26	66	21	73	83	41	74	9	18]
85	[21	65	98	35	19	70	15	89	70	50	13]
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88	[[76	58	50	42	77	53	21	97	72	56	21]
89	[0	-46	37	-37	-57	-15	36	-45	-43	-16	38]
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92	[0	1	60	11	14	71	78	58	67	53	34]
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94	[0	30	34	3	-6	55	10	12	41	4	11]
95	[0	48	26	66	21	73	83	41	74	9	18]
96	[0	48	84	23	-2	55	9	62	50	34	7]
97	[	42	66	16	32	20	40	33	23	24	54	18]]
98	-----											
99	[[	76	58	50	42	77	53	21	97	72	56	21]
100	[	0	-46	37	-37	-57	-15	36	-45	-43	-16	38]
101	[0	41	36	-10	-3	31	36	-67	8	-51	40]
102	[0	-5	-1	28	48	72	-9	-15	30	8	-5]
103	[0	1	60	11	14	71	78	58	67	53	34]
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105	[0	30	34	3	-6	55	10	12	41	4	11]
106	[0	48	26	66	21	73	83	41	74	9	18]
107	[0	48	84	23	-2	55	9	62	50	34	7]
108	[	0	33	-11	8	-22	10	21	-30	-15	23	6]]
109	-----											
110	[[	76	58	50	42	77	53	21	97	72	56	21]
111	[	0	48	26	66	21	73	83	41	74	9	18]
112	[	0	0	13	-66	-20	-31	-34	-102	-55	-58	24]
113	[	0	-5	-1	28	48	72	-9	-15	30	8	-5]
114	[	0	1	60	11	14	71	78	58	67	53	34]
115	[0	-1	37	64	-10	33	28	33	35	-3	28]
116	[0	30	34	3	-6	55	10	12	41	4	11]
117	[0	-46	37	-37	-57	-15	36	-45	-43	-16	38]
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126	[0	-1	37	64	-10	33	28	33	35	-3	28]
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135	[0	0	1	34	50	79	0	-10	37	8	-3]
136	[0	0	59	9	13	69	76	57	65	52	33]
137	[0	-1	37	64	-10	33	28	33	35	-3	28]
138	[0	30	34	3	-6	55	10	12	41	4	11]
139	[0	-46	37	-37	-57	-15	36	-45	-43	-16	38]
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159	[0	0	37	65	-9	34	29	33	36	-2	28]
160	[0	0	17	-38	-19	9	-41	-13	-5	-1	0]
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170	[0	0	37	65	-9	34	29	33	36	-2	28]

171	[0	0	17	-38	-19	9	-41	-13	-5	-1	0]
172	[0	0	61	26	-36	54	115	-5	27	-7	55]
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182	[0	0	17	-38	-19	9	-41	-13	-5	-1	0]
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214	[0	0	37	65	-9	34	29	33	36	-2	28]
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236	[0	0	0	49	12	1	-40	36	19	2	-5]
237	[0	0	0	-45	-8	-6	-73	-11	-12	0	-15]
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239	[0	0	58	-43	-23	-18	-74	21	-24	25	-11]
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247	[0	0	0	49	12	1	-40	36	19	2	-5]
248	[0	0	0	-45	-8	-6	-73	-11	-12	0	-15]
249	[0	0	0	-71	-12	-42	-58	-100	-60	-56	12]
250	[0	0	58	-43	-23	-18	-74	21	-24	25	-11]
251	[0	0	-28	-37	-36	-40	-36	-58	-65	16	-6]
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258	[0	0	0	49	12	1	-40	36	19	2	-5]
259	[0	0	0	-45	-8	-6	-73	-11	-12	0	-15]
260	[0	0	0	-71	-12	-42	-58	-100	-60	-56	12]
261	[0	0	0	-67	11	-69	-183	25	-49	31	-63]
262	[0	0	-28	-37	-36	-40	-36	-58	-65	16	-6]
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269	[0	0	0	49	12	1	-40	36	19	2	-5]
270	[0	0	0	-45	-8	-6	-73	-11	-12	0	-15]
271	[0	0	0	-71	-12	-42	-58	-100	-60	-56	12]
272	[0	0	0	-67	11	-69	-183	25	-49	31	-63]
273	[0	0	0	-25	-52	-15	16	-60	-52	12	19]]
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278	[0	0	0	49	12	1	-40	36	19	2	-5]
279	[0	0	0	0	50	16	-48	72	44	58	-21]
280	[0	0	0	33	50	78	-1	-9	36	8	-3]
281	[0	0	0	-45	-8	-6	-73	-11	-12	0	-15]
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390	[0	0	0	0	0	63	64	-92	-13	-41	17]
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