1.5行の交換、逆行列、まるめの誤差

交換行列

```
P = [0,1;1,0]
```

```
P =
      0             1
      1             0
```

```
A = [0,2;3,4]
```

```
A =
      0             2
      3             4
```

```
P*A
```

```
ans =
      3             4
      0             2
```

Pは交換行列

1.5.1

```
clear
A = [1,4,2;-2,-8,3;0,1,1]
```

```
A =
      1             4             2
     -2            -8             3
      0             1             1
```

```
b = [-2;32;1]
```

```
b =
     -2
     32
      1
```

```
E21 = eye(3);
E21(2,1) = 2
```

```
E21 =
      1             0             0
      2             1             0
      0             0             1
```

```
U1 = E21 * A
```

```
U1 =
```

```
     1              4              2
     0              0              7
     0              1              1
```

第2行と第３行を交換

```
P32 = [1,0,0;0,0,1;0,1,0];
U = P32 * U1
```

```
 U =
     1              4              2
     0              1              1
     0              0              7
```

```
c1 = E21 * b
```

```
 c1 =
    -2
    28
     1
```

```
c = P32*c1
```

```
 c =
    -2
     1
    28
```

$$\begin{bmatrix} 1 & 4 & 2 \\ 0 & 1 & 1 \\ 0 & 0 & 7 \end{bmatrix} x = \begin{bmatrix} -2 \\ 1 \\ 28 \end{bmatrix}$$

```
% 要 Symbolic Math Toolbox
syms x y z;
eqn = U * [x;y;z] == c;
solx = solve(eqn, x,y,z);
Answer = [solx.x;solx.y;solx.z]
```

```
 Answer =
```

$$\begin{pmatrix} 2 \\ -3 \\ 4 \end{pmatrix}$$

1.5.2

```
clear
A = [1,1;3,3]
```

```
 A =
     1              1
     3              3
```

```
E21 = [1,0;-3,1]
```

```
E21 =
      1              0
     -3              1
```

```
U = E21*A
```

```
U =
      1              1
      0              0
```

```
% 要 Symbolic Math Toolbox
syms b1 b2
b = [b1;b2]
```

```
b =
```

$$\begin{pmatrix} b_1 \\ b_2 \end{pmatrix}$$

```
c = E21 * b
```

```
c =
```

$$\begin{pmatrix} b_1 \\ b_2 - 3\,b_1 \end{pmatrix}$$

よって $0 = b_2 - 3b_1$ なので $b_2 = 3b_1$

交換行列は $P_{kl} = P_{kl}^{-1}$ となる

P32 例

```
clear
A = [1,2,3;2,4,2;0,1,1]
```

```
A =
      1              2              3
      2              4              2
      0              1              1
```

```
E21 = eye(3);
E21(2,1) = -2
```

```
E21 =
      1              0              0
     -2              1              0
      0              0              1
```

```
U1 = E21 * A
```

```
U1 =
     1          2          3
     0          0         -4
     0          1          1
```

```
P23 = [1,0,0;0,0,1;0,1,0]
```

```
P23 =
     1          0          0
     0          0          1
     0          1          0
```

```
U = P23*U1
```

```
U =
     1          2          3
     0          1          1
     0          0         -4
```

```
PA = P23*A
```

```
PA =
     1          2          3
     0          1          1
     2          4          2
```

```
E31 = eye(3);
E31(3,1) = -2
```

```
E31 =
     1          0          0
     0          1          0
    -2          0          1
```

```
U = E31 * PA
```

```
U =
     1          2          3
     0          1          1
     0          0         -4
```

```
L = E31^-1
```

```
L =
     1          0          0
     0          1          0
     2          0          1
```

1.5.3

```
clear
A = [0,1;2,3]
```

```
A =
```

```
        0                   1
        2                   3
```

```
P21 = [0,1;1,0]
```

```
P21 =
        0                   1
        1                   0
```

```
PA = P21 * A
```

```
PA =
        2                   3
        0                   1
```

```
L = [1,0;0,1]
```

```
L =
        1                   0
        0                   1
```

```
D = [2,0;0,1]
```

```
D =
        2                   0
        0                   1
```

```
U = [1,3/2;0,1]
```

```
U =
        1                   3/2
        0                   1
```

1.5.4

```
clear
A = [1,1,1;1,1,2;1,2,5]
```

```
A =
        1                   1                   1
        1                   1                   2
        1                   2                   5
```

```
E21 = [1,0,0;-1,1,0;0,0,1]
```

```
E21 =
        1                   0                   0
       -1                   1                   0
        0                   0                   1
```

```
U1 = E21 * A
```

```
U1 =
        1                   1                   1
        0                   0                   1
```

```
         1              2              5
```

```
P32 = [1,0,0;0,0,1;0,1,0]
```

```
P32 =
     1              0              0
     0              0              1
     0              1              0
```

```
U2 = P32 * U1
```

```
U2 =
     1              1              1
     1              2              5
     0              0              1
```

```
U3 = E21 * U2
```

```
U3 =
     1              1              1
     0              1              4
     0              0              1
```

=======

```
PA = P32 * A
```

```
PA =
     1              1              1
     1              2              5
     1              1              2
```

```
PU1 = E21 * PA
```

```
PU1 =
     1              1              1
     0              1              4
     1              1              2
```

```
E31 = eye(3);
E31(3,1) = -1
```

```
E31 =
     1              0              0
     0              1              0
    -1              0              1
```

```
U = E31 * PU1
```

```
U =
     1              1              1
     0              1              4
     0              0              1
```

1.5.5

その1

```
clear
A = [0,1,-1;1,-1,0;1,0,-1]
```

```
A =
     0          1         -1
     1         -1          0
     1          0         -1
```

```
b = [2;2;2]
```

```
b =
     2
     2
     2
```

```
P21 = [0,1,0;1,0,0;0,0,1]
```

```
P21 =
     0          1          0
     1          0          0
     0          0          1
```

```
PA = P21 * A
```

```
PA =
     1         -1          0
     0          1         -1
     1          0         -1
```

```
E31 = eye(3);
E31(3,1) = -1
```

```
E31 =
     1          0          0
     0          1          0
    -1          0          1
```

```
U = E31 * PA
```

```
U =
     1         -1          0
     0          1         -1
     0          1         -1
```

```
c = E31 * b
```

```
c =
     2
     2
     0
```

2行目と3行目が同じなのにbは異なるので特異＆解なし

その２

```
clear
A = [0,1,-1;1,-1,0;1,0,-1]
```

```
A =
       0            1           -1
       1           -1            0
       1            0           -1
```

```
b = [0;0;0]
```

```
b =
       0
       0
       0
```

```
P21 = [0,1,0;1,0,0;0,0,1]
```

```
P21 =
       0            1            0
       1            0            0
       0            0            1
```

```
PA = P21 * A
```

```
PA =
       1           -1            0
       0            1           -1
       1            0           -1
```

```
E31 = eye(3);
E31(3,1) = -1
```

```
E31 =
       1            0            0
       0            1            0
      -1            0            1
```

```
U = E31 * PA
```

```
U =
       1           -1            0
       0            1           -1
       0            1           -1
```

```
c = E31 * b
```

```
c =
       0
       0
       0
```

特異＆解は $u = v = w$

逆行列

$BA = I$ かつ $AC = I$ ならば $B = C$

つまり $AA^{-1} = A^{-1}A = I$

$$(\mathbf{AB})^{-1} = B^{-1}A^{-1}$$

P34 例

```
clear
A = [2,1,1,1,0,0;4,1,0,0,1,0;-2,2,1,0,0,1]
```

```
A =
      2            1            1            1            0            0
      4            1            0            0            1            0
     -2            2            1            0            0            1
```

```
E21 = eye(3);
E21(2,1) = -2
```

```
E21 =
      1            0            0
     -2            1            0
      0            0            1
```

```
U1 = E21*A
```

```
U1 =
      2            1            1            1            0            0
      0           -1           -2           -2            1            0
     -2            2            1            0            0            1
```

```
E31 = eye(3);
E31(3,1) = 1
```

```
E31 =
      1            0            0
      0            1            0
      1            0            1
```

```
U2 = E31 * U1
```

```
U2 =
      2            1            1            1            0            0
      0           -1           -2           -2            1            0
      0            3            2            1            0            1
```

```
E32 = eye(3);
E32(3,2) = 3
```

```
E32 =
      1            0            0
      0            1            0
      0            3            1
```

```
U = E32 * U2
```

```
U =
     2            1            1            1            0            0
     0           -1           -2           -2            1            0
     0            0           -4           -5            3            1
```

最初の3列がいつもの上3角行列U、後ろの3列がL^{-1}

つまり$L^{-1} = E_{32}E_{31}E_{21}$

Gauss-Jordan法

```
clear
```

$$\mathbf{AI} = \begin{bmatrix} A, I \end{bmatrix}$$

```
AI = [2,1,1,1,0,0;0,-1,-2,-2,1,0;0,0,-4,-5,3,1]
```

```
A =
     2            1            1            1            0            0
     0           -1           -2           -2            1            0
     0            0           -4           -5            3            1
```

第2列のピボットより上を0にする

```
E12 = eye(3);
E12(1,2)=1
```

```
E12 =
     1            1            0
     0            1            0
     0            0            1
```

```
U1 = E12*AI
```

```
U1 =
     2            0           -1           -1            1            0
     0           -1           -2           -2            1            0
     0            0           -4           -5            3            1
```

第3列のピボットより上を0にする

```
E13 = eye(3);
E13(1,3) = -1/4
```

```
E13 =
     1            0          -1/4
     0            1            0
     0            0            1
```

```
U2 = E13 * U1
```

```
U2 =
     2            0            0           1/4          1/4         -1/4
```

```
       0              -1             -2             -2              1              0
       0               0             -4             -5              3              1
```

```
E23 = eye(3);
E23(2,3) = -1/2
```

```
E23 =
       1               0              0
       0               1             -1/2
       0               0              1
```

```
U3 = E23 * U2
```

```
U3 =
       2               0              0             1/4            1/4            -1/4
       0              -1              0             1/2            -1/2           -1/2
       0               0             -4             -5              3              1
```

各ピボットで割り算を行う

```
pdiv = [1/2,0,0;0,-1,0;0,0,-1/4]
```

```
pdiv =
       1/2             0              0
       0              -1              0
       0               0             -1/4
```

```
U = pdiv * U3
```

```
U =
       1               0              0             1/8            1/8            -1/8
       0               1              0            -1/2            1/2            1/2
       0               0              1             5/4            -3/4           -1/4
```

$$U = \begin{bmatrix} I, A^{-1} \end{bmatrix}$$

1.5.6

$\mathbf{AB}^{-1}\boldsymbol{C}$ の逆行列

$$\left(\mathbf{AB}^{-1}\boldsymbol{C}\right)^{-1} = \boldsymbol{C}^{-1}\mathbf{BA}^{-1}$$

1.5.7

```
A = [0,1;1,0]
```

```
A =
       0               1
       1               0
```

```
A^-1
```

```
ans =
     0          1
     1          0
```

A*A

```
ans =
     1          0
     0          1
```

$$B = \begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix}$$

$$B^{-1} = \begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{bmatrix}$$

1.5.8

```
clear
A = [1,1;3,3]
```

```
A =
     1          1
     3          3
```

B = eye(2)

```
B =
     1          0
     0          1
```

AB = [A,B]

```
AB =
     1          1          1          0
     3          3          0          1
```

```
E21 = eye(2);
E21(2,1) = -3
```

```
E21 =
     1          0
    -3          1
```

U1 = E21*AB

```
U1 =
     1          1          1          0
     0          0         -3          1
```

特異になってしまうため逆行列が作れない

```
A^-1
```

警告: 行列は、特異行列に近いか、正しくスケーリングされていません。結果は不正確になる可能性があります。RCOND = 6.938894e-18。

```
ans =
     *          *
     *          *
```

1.5.9

$$E = \begin{bmatrix} 1 & 0 & 8 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

E は 3 行目の 8 倍を 1 行目に加える行列

```
clear
E = [1,0,8;0,1,0;0,0,1]
```

```
E =
     1          0          8
     0          1          0
     0          0          1
```

```
E^-1
```

```
ans =
     1          0         -8
     0          1          0
     0          0          1
```

```
A = [E,eye(3)]
```

```
A =
     1          0          8          1          0          0
     0          1          0          0          1          0
     0          0          1          0          0          1
```

```
E13 = eye(3);
E13(1,3) = -8
```

```
E13 =
     1          0         -8
     0          1          0
     0          0          1
```

```
U = E13 * A
```

```
U =
     1          0          0          1          0         -8
     0          1          0          0          1          0
     0          0          1          0          0          1
```

```
U(:,4:6)
```

警告: 行列は、特異行列に近いか、正しくスケーリングされていません。結果は不正確になる可能性があります。

```
ans =
       1          0         -8
       0          1          0
       0          0          1
```

1.5.10

```
clear
syms a b c d;
A = [a,b;c,d]
```

A =

$$\begin{pmatrix} a & b \\ c & d \end{pmatrix}$$

```
A = [A,eye(2)]
```

A =

$$\begin{pmatrix} a & b & 1 & 0 \\ c & d & 0 & 1 \end{pmatrix}$$

```
E21 = [1,0;-c/a,1]
```

E21 =

$$\begin{pmatrix} 1 & 0 \\ -\dfrac{c}{a} & 1 \end{pmatrix}$$

```
U1 = E21*A
```

U1 =

$$\begin{pmatrix} a & b & 1 & 0 \\ 0 & d - \dfrac{bc}{a} & -\dfrac{c}{a} & 1 \end{pmatrix}$$

```
U1(2,2) = (a*d-b*c)/a
```

U1 =

$$\begin{pmatrix} a & b & 1 & 0 \\ 0 & \dfrac{ad - bc}{a} & -\dfrac{c}{a} & 1 \end{pmatrix}$$

```
E12 = [1,-(a*b)/(a*d-b*c);0,1]
```

E12 =

$$\begin{pmatrix} 1 & -\dfrac{ab}{ad - bc} \\ 0 & 1 \end{pmatrix}$$

```
U2 = E12 * U1
```

U2 =

$$\begin{pmatrix} a & 0 & \dfrac{bc}{ad-bc}+1 & -\dfrac{ab}{ad-bc} \\ 0 & \dfrac{ad-bc}{a} & -\dfrac{c}{a} & 1 \end{pmatrix}$$

```
U2(1,3) = (a*d)/(a*d-b*c)
```

U2 =

$$\begin{pmatrix} a & 0 & \dfrac{ad}{ad-bc} & -\dfrac{ab}{ad-bc} \\ 0 & \dfrac{ad-bc}{a} & -\dfrac{c}{a} & 1 \end{pmatrix}$$

```
E11 = [1/a,0;0,1]
```

E11 =

$$\begin{pmatrix} \dfrac{1}{a} & 0 \\ 0 & 1 \end{pmatrix}$$

```
U3 = E11 * U2
```

U3 =

$$\begin{pmatrix} 1 & 0 & \dfrac{d}{ad-bc} & -\dfrac{b}{ad-bc} \\ 0 & \dfrac{ad-bc}{a} & -\dfrac{c}{a} & 1 \end{pmatrix}$$

```
E22 = [1,0;0,a/(a*d - b*c)]
```

E22 =

$$\begin{pmatrix} 1 & 0 \\ 0 & \dfrac{a}{ad-bc} \end{pmatrix}$$

```
U4 = E22 * U3
```

U4 =

$$\begin{pmatrix} 1 & 0 & \dfrac{d}{ad-bc} & -\dfrac{b}{ad-bc} \\ 0 & 1 & -\dfrac{c}{ad-bc} & \dfrac{a}{ad-bc} \end{pmatrix}$$

```
Ain = U4(:,3:4)
```

Ain =

$$\begin{pmatrix} \dfrac{d}{ad-bc} & -\dfrac{b}{ad-bc} \\ -\dfrac{c}{ad-bc} & \dfrac{a}{ad-bc} \end{pmatrix}$$

$$A^{-1} = \frac{1}{ad-bc} \begin{bmatrix} d & -b \\ -c & a \end{bmatrix}$$

```
clear
A = [2,-1,0;-1,2,-1;0,-1,2]
```

```
A =

     2            -1             0
    -1             2            -1
     0            -1             2
```

```
A = [A,eye(3)]
```

```
A =

     2            -1             0             1             0             0
    -1             2            -1             0             1             0
     0            -1             2             0             0             1
```

```
E21 = eye(3);
E21(2,1) = 1/2
```

```
E21 =

     1             0             0
    1/2            1             0
     0             0             1
```

```
U1 = E21 * A
```

```
U1 =

     2            -1             0             1             0             0
     0            3/2           -1            1/2            1             0
     0            -1             2             0             0             1
```

```
E32 = eye(3);
E32(3,2) = 2/3
```

```
E32 =

     1             0             0
     0             1             0
     0            2/3            1
```

```
U2 = E32 * U1
```

```
U2 =

     2            -1             0             1             0             0
     0            3/2           -1            1/2            1             0
     0             0            4/3            1/3           2/3            1
```

```
E12 = eye(3);
E12(1,2) = 2/3
```

E12 =

1	2/3	0
0	1	0
0	0	1

U3 = E12 * U2

U3 =

2	*	-2/3	4/3	2/3	0
0	3/2	-1	1/2	1	0
0	0	4/3	1/3	2/3	1

E13 = eye(3);
E13(1,3) = 1/2

E13 =

1	0	1/2
0	1	0
0	0	1

U4 = E13 * U3

U4 =

2	*	*	3/2	1	1/2
0	3/2	-1	1/2	1	0
0	0	4/3	1/3	2/3	1

E23 = eye(3);
E23(2,3) = 3/4

E23 =

1	0	0
0	1	3/4
0	0	1

U5 = E23 * U4

U5 =

2	*	*	3/2	1	1/2
0	3/2	*	3/4	3/2	3/4
0	0	4/3	1/3	2/3	1

E11 = eye(3);
E11(1,1) = 1/2

E11 =

1/2	0	0
0	1	0
0	0	1

U6 = E11 * U5

U6 =

1	*	*	3/4	1/2	1/4
0	3/2	*	3/4	3/2	3/4
0	0	4/3	1/3	2/3	1

```
E22 = eye(3);
E22(2,2) = 2/3
```

```
E22 =
    1              0              0
    0              2/3            0
    0              0              1
```

```
U7 = E22 * U6
```

```
U7 =
    1         *         *         3/4       1/2       1/4
    0         1         *         1/2       1         1/2
    0         0         4/3       1/3       2/3       1
```

```
E33 = eye(3);
E33(3,3) = 3/4
```

```
E33 =
    1              0              0
    0              1              0
    0              0              3/4
```

```
U8 = E33 * U7
```

```
U8 =
    1         *         *         3/4       1/2       1/4
    0         1         *         1/2       1         1/2
    0         0         1         1/4       1/2       3/4
```

```
Ain = U8(:,4:6)
```

```
Ain =
    3/4            1/2            1/4
    1/2            1              1/2
    1/4            1/2            3/4
```

```
Ain * 4
```

```
ans =
    3              2              1
    2              4              2
    1              2              3
```

$$A^{-1} = 4 \begin{bmatrix} 3 & 2 & 1 \\ 2 & 4 & 2 \\ 1 & 2 & 3 \end{bmatrix}$$

まるめの誤差

部分選択

同じ列の中の選び得るピボットを比較、最大値を選び、それがピボットになるように行交換する

$$\mathbf{A'} = \begin{bmatrix} .0001 & 1 \\ 1 & 1 \end{bmatrix}$$

$$\mathbf{A''} = \mathbf{PA'} = \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} \begin{bmatrix} .0001 & 1 \\ 1 & 1 \end{bmatrix} = \begin{bmatrix} 1 & 1 \\ .0001 & 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ .0001 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 \\ 0 & .9999 \end{bmatrix} \begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix}$$

1.5.11

```
clear
%format rat
%format short
A = [1,1/2,1/3;1/2,1/3,1/4;1/3,1/4,1/5]
```

```
A =
    1.0000    0.5000    0.3333
    0.5000    0.3333    0.2500
    0.3333    0.2500    0.2000
●
```

```
A = [A,eye(3)]
```

```
A =
    1.0000    0.5000    0.3333    1.0000         0         0
    0.5000    0.3333    0.2500         0    1.0000         0
    0.3333    0.2500    0.2000         0         0    1.0000
●
```

```
E21 = eye(3);
E21(2,1) = -1/2
```

```
E21 =
    1.0000         0         0
   -0.5000    1.0000         0
         0         0    1.0000
●
```

```
U1 = E21 * A
```

```
U1 =
    1.0000    0.5000    0.3333    1.0000         0         0
         0    0.0833    0.0833   -0.5000    1.0000         0
    0.3333    0.2500    0.2000         0         0    1.0000
●
```

```
E31 = eye(3);
E31(3,1) = -1/3
```

```
E31 =
    1.0000         0         0
         0    1.0000         0
   -0.3333         0    1.0000
```

```
U2 = E31 * U1
```

```
U2 =
    1.0000    0.5000    0.3333    1.0000         0         0
         0    0.0833    0.0833   -0.5000    1.0000         0
         0    0.0833    0.0889   -0.3333         0    1.0000
```

●

```
E32 = eye(3);
E32(3,2) = -1
```

```
E32 =
     1     0     0
     0     1     0
     0    -1     1
```

●

```
U3 = E32 * U2
```

```
U3 =
    1.0000    0.5000    0.3333    1.0000         0         0
         0    0.0833    0.0833   -0.5000    1.0000         0
         0    0.0000    0.0056    0.1667   -1.0000    1.0000
```

●

```
E12 = eye(3);
E12(1,2) = -6
```

```
E12 =
     1    -6     0
     0     1     0
     0     0     1
```

●

```
U4 = E12 * U3
```

```
U4 =
    1.0000    0.0000   -0.1667    4.0000   -6.0000         0
         0    0.0833    0.0833   -0.5000    1.0000         0
         0    0.0000    0.0056    0.1667   -1.0000    1.0000
```

●

```
E13 = eye(3);
E13(1,3) = 30
```

```
E13 =
     1     0    30
     0     1     0
     0     0     1
```

●

```
U5 = E13 * U4
```

```
U5 =
    1.0000    0.0000    0.0000    9.0000  -36.0000   30.0000
         0    0.0833    0.0833   -0.5000    1.0000         0
         0    0.0000    0.0056    0.1667   -1.0000    1.0000
```

-

```
E23 = eye(3);
E23(2,3) = -15
```

```
E23 =

     1     0     0
     0     1   -15
     0     0     1
```

-

```
U6 = E23 * U5
```

```
U6 =

    1.0000    0.0000    0.0000    9.0000  -36.0000   30.0000
         0    0.0833   -0.0000   -3.0000   16.0000  -15.0000
         0    0.0000    0.0056    0.1667   -1.0000    1.0000
```

```
E22 = eye(3);
E22(2,2) = 12
```

```
E22 =

     1     0     0
     0    12     0
     0     0     1
```

-

```
U7 = E22 * U6
```

```
U7 =

    1.0000    0.0000    0.0000    9.0000  -36.0000   30.0000
         0    1.0000   -0.0000  -36.0000  192.0000 -180.0000
         0    0.0000    0.0056    0.1667   -1.0000    1.0000
```

-

```
E33 = eye(3);
E33(3,3) = 180
```

```
E33 =

     1     0     0
     0     1     0
     0     0   180
```

-

```
U8 = E33 * U7
```

```
U8 =

    1.0000    0.0000    0.0000    9.0000  -36.0000   30.0000
         0    1.0000   -0.0000  -36.0000  192.0000 -180.0000
         0    0.0000    1.0000   30.0000 -180.0000  180.0000
```

-

1.5.12

```
clear
A = [0.001,0;1,1000]
```

```
 A =
    1.0e+03 *

    0.000001000000000                   0
    0.001000000000000   1.000000000000000
```

```
E21 = eye(2);
E21(2,1) = -1000
```

```
 E21 =
           1          0
       -1000          1
```

```
U1 = E21 * A
```

```
 U1 =
    1.0e+03 *

    0.000001000000000                   0
                   0   1.000000000000000
```

```
Ad = [0,1;1,0]*A
```

```
 Ad =
    1.0e+03 *

    0.001000000000000   1.000000000000000
    0.000001000000000                   0
```

```
E21 = eye(2);
E21(2,1) = -0.001
```

```
 E21 =
    1.000000000000000                   0
   -0.001000000000000   1.000000000000000
```

```
U1 = E21*Ad
```

```
 U1 =
           1       1000
           0         -1
```

一番目の計算だとピボットが0.001と1000になる

二番目の計算だとピボットが1と−1になる