MATLAB PROJECT 2

Please include this page in your Group file, as a front page. Type in the group number and the names of all members WHO PARTICIPATED in this project.

GROUP # 12

FIRST & LAST NAMES (UFID numbers are NOT required):

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4. Christian Fowler

5. Spencer Dupee

By signing your names above, each of you had confirmed that you did the work and agree with the work submitted.

```
%Exercise1
type ele1

function [ E1 ] = ele1( n, r, i, j )

E1 = eye(n);
E1(j,:)= E1(j,:)+E1(i,:)*r;

end

type ele2

function [ E2 ] = ele2( n, i, j )

E2 = eye(n);
E2([i, j], :) = E2([j, i], :);

end

type ele3

function [ E3 ] = ele3( n, j, k )

E3=eye(n);
E3(j, :)=E3(j, :)*k;

end

type closetozeroroundoff

function [ B ] = closetozeroroundoff( A )

[m,n]=size(A);
for i=1:m
      for j=1:n
            if abs(A(i,j))<10^(-7)
                  A(i,j) = 0;
        end %if
      end
end
B=A;
end %function

format compact
format rat
A=[2 1 3; 1 0 2; 2 3 -1]
A =
       2      1      3
       1      0      2
       2      3      -1
E2=ele2(3, 1, 2)
E2 =
       0      1      0
       1      0      0
       0      0      1
A1=E2*A
A1 =
       1      0      2
```

```
       2     1     3
       2     3     -1
E1=ele1(3, -2, 1, 2)
E1 =
       1     0     0
      -2     1     0
       0     0     1
A2=E1*A1
A2 =
       1     0     2
       0     1     -1
       2     3     -1
E1=ele1(3, -2, 1, 3)
E1 =
       1     0     0
       0     1     0
      -2     0     1
A3=E1*A2
A3 =
       1     0     2
       0     1    -1
       0     3    -5
E1=ele1(3, -3, 2, 3)
E1 =
       1     0     0
       0     1     0
       0     -3    1
A4=E1*A3
A4 =
       1     0     2
       0     1     -1
       0     0     -2
E1=ele1(3,1,3,1)
E1 =
       1     0     1
       0     1     0
       0     0     1
A5=E1*A4
A5 =
       1     0     0
       0     1    -1
       0     0    -2
E3=ele3(3, 3, -1/2)
E3 =
       1     0     0
       0     1     0
       0     0     -1/2
A6=E3*A5
A6 =
       1     0     0
       0     1    -1
       0     0     1
E1=ele1(3, 1, 3, 2)
E1 =
       1     0     0
       0     1     1
       0     0     1
A7=E1*A6
```

```
A7 =
     1     0     0
     0     1     0
     0     0     1
```

```
%Excerise2
type inverses

function [ D ] = inverses( A )

[m, n] = size( A )
if m~= n
    D = [];
    disp('Matrix A is not invertible')
    return
end %if
if rank( A ) < m
    D = [];
    disp('Matrix A is not invertible')
    return
end %if
B = [A eye(n)];
C = rref( B );
for i = 1:n
    C(: , 1) = []
end %for
D = C;
end %function


%a
A = [4 0 -7 -7; -6 1 11 9; 7 -5 10 19; -1 2 3 -1]
A =
     4     0    -7    -7
    -6     1    11     9
     7    -5    10    19
    -1     2     3    -1
D = inverses(A)
m =
     4
n =
     4
C =
     0     0     0   -19   -14     0     7
     1     0     0  -549  -401    -2   196
     0     1     0   267   195     1   -95
     0     0     1  -278  -203    -1    99
C =
     0     0   -19   -14     0     7
     0     0  -549  -401    -2   196
     1     0   267   195     1   -95
     0     1  -278  -203    -1    99
C =
     0   -19   -14     0     7
     0  -549  -401    -2   196
     0   267   195     1   -95
     1  -278  -203    -1    99
C =
   -19   -14     0     7
  -549  -401    -2   196
   267   195     1   -95
  -278  -203    -1    99
D =
```

```
   -19   -14     0     7
  -549  -401    -2   196
   267   195     1   -95
  -278  -203    -1    99

%b
A = [1 -3 2 -4; -3 9 -1 5; 2 -6 4 -3; -4 12 2 7]
A =
     1    -3     2    -4
    -3     9    -1     5
     2    -6     4    -3
    -4    12     2     7
D = inverses(A)
m =
     4
n =
     4
Matrix A is not invertible
D =
     []

%c
A = magic(5)
A =
    17    24     1     8    15
    23     5     7    14    16
     4     6    13    20    22
    10    12    19    21     3
    11    18    25     2     9
D = inverses(A)
m =
     5
n =
     5
C =
         0         0         0         0   -0.0049    0.0512   -0.0354
0.0012    0.0034
    1.0000         0         0         0    0.0431   -0.0373   -0.0046
0.0127    0.0015
         0    1.0000         0         0   -0.0303    0.0031    0.0031
0.0031    0.0364
         0         0    1.0000         0    0.0047   -0.0065    0.0108
0.0435   -0.0370
         0         0         0    1.0000    0.0028    0.0050    0.0415
-0.0450    0.0111
C =
         0         0         0   -0.0049    0.0512   -0.0354    0.0012
0.0034
         0         0         0    0.0431   -0.0373   -0.0046    0.0127
0.0015
    1.0000         0         0   -0.0303    0.0031    0.0031    0.0031
0.0364
         0    1.0000         0    0.0047   -0.0065    0.0108    0.0435
-0.0370
         0         0    1.0000    0.0028    0.0050    0.0415   -0.0450
0.0111
C =
         0         0   -0.0049    0.0512   -0.0354    0.0012    0.0034
```

```
         0         0    0.0431   -0.0373   -0.0046    0.0127    0.0015
         0         0   -0.0303    0.0031    0.0031    0.0031    0.0364
    1.0000         0    0.0047   -0.0065    0.0108    0.0435   -0.0370
         0    1.0000    0.0028    0.0050    0.0415   -0.0450    0.0111
C =
         0   -0.0049    0.0512   -0.0354    0.0012    0.0034
         0    0.0431   -0.0373   -0.0046    0.0127    0.0015
         0   -0.0303    0.0031    0.0031    0.0031    0.0364
         0    0.0047   -0.0065    0.0108    0.0435   -0.0370
    1.0000    0.0028    0.0050    0.0415   -0.0450    0.0111
C =
   -0.0049    0.0512   -0.0354    0.0012    0.0034
    0.0431   -0.0373   -0.0046    0.0127    0.0015
   -0.0303    0.0031    0.0031    0.0031    0.0364
    0.0047   -0.0065    0.0108    0.0435   -0.0370
    0.0028    0.0050    0.0415   -0.0450    0.0111
D =
   -0.0049    0.0512   -0.0354    0.0012    0.0034
    0.0431   -0.0373   -0.0046    0.0127    0.0015
   -0.0303    0.0031    0.0031    0.0031    0.0364
    0.0047   -0.0065    0.0108    0.0435   -0.0370
    0.0028    0.0050    0.0415   -0.0450    0.0111
D = inv(A)
D =
   -0.0049    0.0512   -0.0354    0.0012    0.0034
    0.0431   -0.0373   -0.0046    0.0127    0.0015
   -0.0303    0.0031    0.0031    0.0031    0.0364
    0.0047   -0.0065    0.0108    0.0435   -0.0370
    0.0028    0.0050    0.0415   -0.0450    0.0111

%d
A = magic(4)
A =
    16     2     3    13
     5    11    10     8
     9     7     6    12
     4    14    15     1
D = inverses(A)
m =
     4
n =
     4
Matrix A is not invertible
D =
     []
D = inv(A)
[_Warning: Matrix is close to singular or badly scaled. Results may be
inaccurate. RCOND =  1.306145e-17.]_
D =
   1.0e+14 *
    0.9382    2.8147   -2.8147   -0.9382
    2.8147    8.4442   -8.4442   -2.8147
   -2.8147   -8.4442    8.4442    2.8147
   -0.9382   -2.8147    2.8147    0.9382
%Matlab runs the numbers too early. The results obtained by using inv
function is inaccurate for part d because the function rounds the numbers to
find the determinant. Then, supposing that an inverse matrix could be made,
Matlab finds a similar inverse to the real inverse matrix.
```

```
%Exercise 3
type solvesys

function [ C,N ] = solvesys( A )
%This function will solve a matrix equation
%given an input nXn matrix, A , and a predetermined
%b matrix using 3 different methods.
%Output is an nX3 matrix,C, of the solutions
%calculated in the three different ways
%and a column vector, N, of the error between
%each method.

[n,n] = size(A);
b = fix(10*rand(n,1))
format long
if det(A) == 0
    disp('The system is either inconsistent')
    disp('or the solution is not unique.')
    C = [];
    N = [];
else
  %Backslash method
  C_back = A\b;



  %Inverse method
  C_inv = inv(A)*b;
```

```
  %Rref method
  sol = rref([A b]);
  C_rref = [];
  for ii = 1: size(sol)
  C_rref(ii,:) = sol(ii,end);
  end

end
C = [C_back C_inv C_rref]
N = [norm(C(:,1)-C(:,2));norm(C(:,2)-C(:,3));norm(C(:,3)-C(:,
1))]

end

%part a
A = magic(6)
A =
    35     1     6    26    19    24
     3    32     7    21    23    25
    31     9     2    22    27    20
     8    28    33    17    10    15
    30     5    34    12    14    16
     4    36    29    13    18    11
solvesys(A);
b =
     7
     3
```

```
     2
     4
     0
     1

[Warning: Matrix is close to singular or badly scaled.
Results may be inaccurate. RCOND =  4.800964e-18.]

C =
   1.0e+14 *
  Columns 1 through 2
  -7.505999378950825  -7.505999378950825
  -7.505999378950825  -7.505999378950830
   3.752999689475411   3.752999689475409
   7.505999378950829   7.505999378950830
   7.505999378950821   7.505999378950818
  -3.752999689475411  -3.752999689475411
  Column 3
                   0
                   0
                   0
                   0
                   0
   0.000000000000010
N =
   1.0e+15 *
   0.000000000000001
   1.592262918131443
```

```
   1.592262918131443

%Part b
A = eye(5)
A =
     1     0     0     0     0
     0     1     0     0     0
     0     0     1     0     0
     0     0     0     1     0
     0     0     0     0     1
solvesys(A);
b =
     9
     9
     5
     0
     2
C =
     9     9     9
     9     9     9
     5     5     5
     0     0     0
     2     2     2
N =
     0
     0
     0
%Each column in the matrix C is equal to the vector
```

```
%b since A is a 5X5 identity matrix.

%Part c
A = randi(20,4,4)
A =
     8     4    10     4
    17    13    11    14
     1    15     6     4
     1    13    15     8
solvesys(A);
b =
     6
     7
     0
     9
C =
  Columns 1 through 2
  -0.157971014492754  -0.157971014492754
  -0.401449275362319  -0.401449275362319
   0.672463768115942   0.672463768115942
   0.536231884057971   0.536231884057971
  Column 3
  -0.157971014492754
  -0.401449275362319
   0.672463768115942
   0.536231884057971
N =
   1.0e-15 *
```

```
   0.337661150723213
   0.124126707662364
   0.271947991102104


%Part d
A = magic(3)
A =
     8     1     6
     3     5     7
     4     9     2
solvesys(A);
b =
     7
     4
     4
C =
  Columns 1 through 2
   0.708333333333333   0.708333333333333
   0.083333333333333   0.083333333333333
   0.208333333333333   0.208333333333333
  Column 3
   0.708333333333333
   0.083333333333333
   0.208333333333333
N =
   1.0e-15 *
   0.117756934401283
```

```
   0.115277563368905

   0.013877787807814


%Part e

format rat,A = hilb(6)

A =

  Columns 1 through 3

       1              1/2            1/3

       1/2            1/3            1/4

       1/3            1/4            1/5

       1/4            1/5            1/6

       1/5            1/6            1/7

       1/6            1/7            1/8

  Columns 4 through 6

       1/4            1/5            1/6

       1/5            1/6            1/7

       1/6            1/7            1/8

       1/7            1/8            1/9

       1/8            1/9            1/10

       1/9            1/10           1/11

solvesys(A);

b =

       4

       3

       5

       5

       8

       7
```

```
C =

   1.0e+07 *

  Columns 1 through 2

   0.001833000000232   0.001833000000129
  -0.052290000006917  -0.052290000003871
   0.353640000048100   0.353640000026992
  -0.919296000127467  -0.919296000071650
   1.013922000142612   1.013922000080257
  -0.399168000056772  -0.399168000031978

  Column 3

   0.001833000000000
  -0.052290000000000
   0.353640000000000
  -0.919296000000000
   1.013922000000000
  -0.399168000000000

N =

   0.000898514234412
   0.001155035187572
   0.002053548401709

%The values in the matrix N are so much larger for the
%hilbert matrix because the solutions in C are
%of such a large order of magnitude greater than
%the solutions in previous parts.
```

```
%Exercise 4

type arevol


function D = arevol( B )

%Calculates the area of a parallelogram or parallelepiped

if (size(B, 2) == 3)

    v1 = B(:,2) - B(:,1);

    v2 = B(:,3) - B(:,1);

    A = [v1 v2];

else

    v1 = B(:,2) - B(:,1);

    v2 = B(:,3) - B(:,1);

    v3 = B(:,4) - B(:,1);

    A = [v1 v2 v3];

end


D = abs(det(A));

D = closetozeroroundoff(D);


if (D == 0)

    if (size(A, 2) == 2)

        disp('The points lie on the same line and no
parallelogram can be built');

    else

        disp('The points lie in the same plane and no
parallelepiped can be built');

    end

else

    if (size(A, 2) == 2)
```

```
        fprintf('The area of the parallelogram is %d', D);
    else
        fprintf('The volume of the parallelepiped is %d', D);
    end
end
end

B = randi([-10,10], 2, 3)


B =
     7    -8     3
     9     9    -8

D=arevol(B)
The area of the parallelogram is 255
D =
   255

B = randi([-10,10], 3, 4)


B =
    -5    10    10    -8
     1    -7     0    -2
    10    10     6     9

D=arevol(B)
The volume of the parallelepiped is 3.810000e+02
D =
```

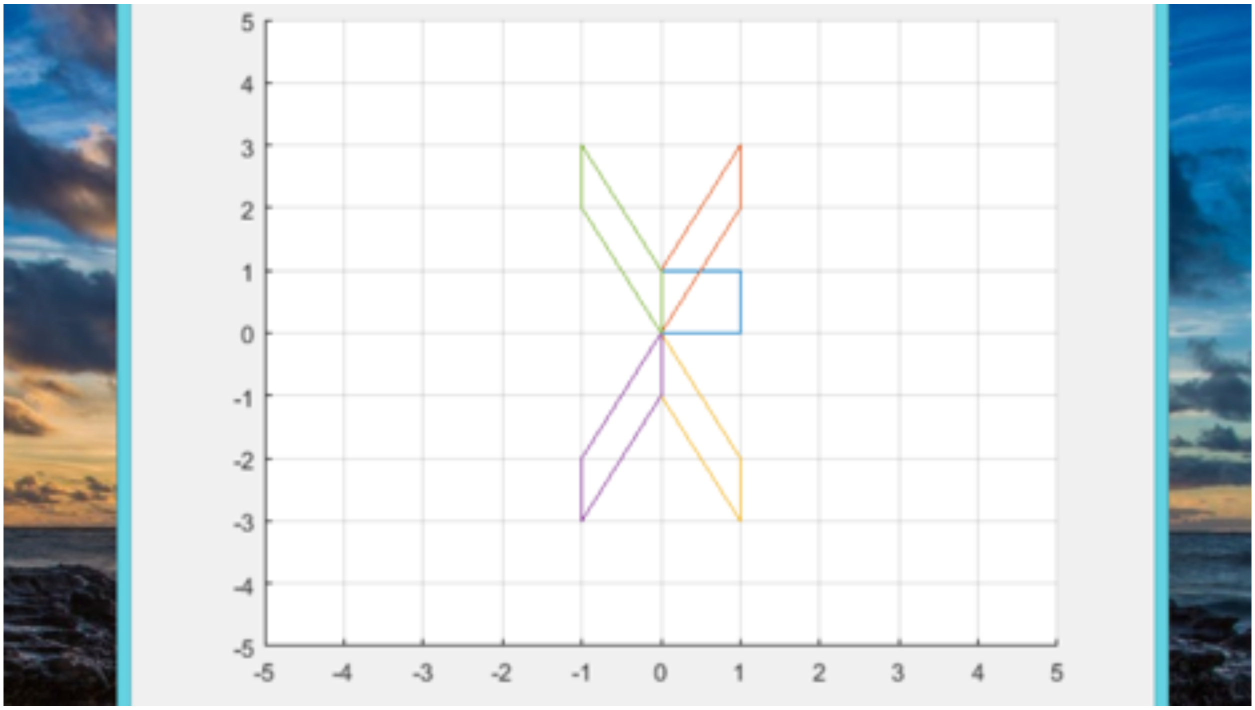
```
  381.0000


X = randi([-10,10], 2, 1), B = [X, -X, 2*X]


X =

     6

    10




B =

     6    -6    12

    10   -10    20


D=arevol(B)

The points lie on the same line and no parallelogram can be
built


D =

     0


>> D=arevol(X)

Index exceeds matrix dimensions.


Error in arevol (line 8)

    v1 = B(:,2) - B(:,1);


X = randi([-10,10], 3, 1), Y = randi([-10,10], 3, 1), B = [X,
Y , X + Y , X - Y]
```

```
X =

     3
   -10
     7


Y =

     9
     4
     5


B =

     3     9    12    -6
   -10     4    -6   -14
     7     5    12     2

D=arevol(X)
Index exceeds matrix dimensions.

Error in arevol (line 8)
    v1 = B(:,2) - B(:,1);

D=arevol(Y)
Index exceeds matrix dimensions.

Error in arevol (line 8)
    v1 = B(:,2) - B(:,1);
```

```
D=arevol(B)

The points lie in the same plane and no parallelepiped can be
built


D =

     0
```

```
%Exercise 5
R1 = [1 0;0 -1];
R2 = [-1 0;0 1];
VS = [1 0;2 1];
type transf
function C = transf(A,E)
E=A*E; % Multiplies matrices A and E
x=E(1,:); % x is the first row of E
y=E(2,:); % y is the second row of E
plot(x,y) % plots x and y values on xy plane
v=[-5 5 -5 5]; % creates the vector v
axis(v) % sets x and y axis values to start at -5 and end at 5
(values in vector v)
grid % either displays or turns off gridlines depending on
current setting
C=E; % C is set equal to E
grid % Removes gridlines or displays gridlines depending on
current setting
end

E=[0 1 1 0 0; 0 0 1 1 0]
E =
0 1 1 0 0
0 0 1 1 0

A=eye(2)
A =
1 0
0 1

hold
Current plot held

grid

C = transf(A,E)
C =
0 1 1 0 0
0 0 1 1 0

E = C;

A = VS
A =
1 0
2 1
```

```
C = transf(A,E)
C =
0 1 1 0 0
0 2 3 1 0

E = C;

A = R1
A =
1 0
0 -1

C = transf(A,E)
C =
0 1 1 0 0
0 -2 -3 -1 0

E = C;

A = R2
A =
-1 0
0 1

C = transf(A, E)
C =
0 -1 -1 0 0
0 -2 -3 -1 0

E = C;

A = R1
A =
1 0
0 -1

A = transf(A, E)
A =
0 -1 -1 0 0
0 2 3 1 0
```


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

```
%Exercise 6

function C = cofactor(a)
%Outputs the cofactor matrix of matrix a
%   creates minor matricies of size (n-1)x(n-1) with current row i and
column j removed.
%   sets the output, C, to a matrix in which entry i,j =
%   [(-1)^(i+j)]*det(minor).

[m,n] = size(a);
for i=1:m
    for j=1:n
        y = a;              %copies a,
        y([i],:) = [];      %deletes row i,
        y(:,[j]) = [];      %deletes row j,
        C(i,j) = det(y)*(-1)^(i+j);     %inputs cofactor entry.
        clear('y');
    end
end
end

type determine

function D = determine(a,C)
%The function calculates the cofactor expansion across each row of a -
they form entries of a
%vector D1; and it calculates the cofactor expansion down each column of a
- they form
%entries of the vector D2.
%   constructs D1 and D2 according to the size of a, then fills in with
%   corresponding cofactor expansion: sum of a(i,j)*C(i,j) across row/
column.
format rat;
[m,n] = size(a);
D1 = zeros(m,1);
D2 = zeros(1,n);
for i=1:m
    for j=1:n
        D1(i,1) = D1(i,1) + a(i,j)*C(i,j);
        D2(1,i) = D2(1,i) + a(j,i)*C(j,i);
    end
end
for i = D1
    if abs(i-D2) > 1e-7         %confirms all entries are the same
        disp('theres an error with my code');
        D = [];
        return;
    end
end
if D1(1) < 1e-7
    D1(1) = 0;                  %corrects for rounding errors.
end
```

```
D = D1(1);
end

type inverse

function B = inverse(a,C,D)
%Inverts matrix a. Inputs C & D are the cofactor matrix of a and the
determinant of a respectively.
%   Sets each element of B = (1/D)*transpose(C), assuming B is not
singular.
[m,n] = size(a);
if rank(a) < m  %rank because det(a) could be very close but not exactly
zero due to rounding.
    B = [];
else
    B = (1/D)*transpose(C);

end

format rat
a = diag([1,2,3,4])
a =
       1              0              0              0
       0              2              0              0
       0              0              3              0
       0              0              0              4
C = cofactor(a)
C =
      24              0              0              0
       0             12              0              0
       0              0              8              0
       0              0              0              6
D = determine(a,C)
D =
      24
det(a)
ans =
      24
%they are the same.
B = inverse(a,C,D)
B =
       1              0              0              0
       0              1/2            0              0
       0              0              1/3            0
       0              0              0              1/4
inv(a)
ans =
       1              0              0              0
       0              1/2            0              0
       0              0              1/3            0
       0              0              0              1/4
%they are the same.
a = ones(5)
a =
```

```
  Columns 1 through 4
       1              1              1              1
       1              1              1              1
       1              1              1              1
       1              1              1              1
       1              1              1              1
  Column 5
       1
       1
       1
       1
       1
C = cofactor(a)
C =
  Columns 1 through 4
       0              0              0              0
       0              0              0              0
       0              0              0              0
       0              0              0              0
       0              0              0              0
  Column 5
       0
       0
       0
       0
       0
D = determine(a,C)
D =
       0
det(a)
ans =
       0
%they are the same.
B = inverse(a,C,D)
B =
     []
inv(a)
[_Warning: Matrix is singular to working precision.]_
ans =
  Columns 1 through 4
       1/0            1/0            1/0            1/0
       1/0            1/0            1/0            1/0
       1/0            1/0            1/0            1/0
       1/0            1/0            1/0            1/0
       1/0            1/0            1/0            1/0
  Column 5
       1/0
       1/0
       1/0
       1/0
       1/0
%My program is strictly superior.
a = magic(5)
a =
```

```
  Columns 1 through 4
      17             24              1              8
      23              5              7             14
       4              6             13             20
      10             12             19             21
      11             18             25              2
  Column 5
      15
      16
      22
       3
       9
C = cofactor(a)
C =
  Columns 1 through 4
  -25025         218725        -153400          23725
  259350        -189150          15600         -33150
 -179400         -23400          15600          54600
    5850          64350          15600         220350
   17225           7475         184600        -187525
  Column 5
   13975
   25350
  210600
 -228150
   56225
D = determine(a,C)
D =
 5070000
det(a)
ans =
 5070000
%they are the same.
B = inverse(a,C,D)
B =
  Columns 1 through 4
     -77/15600      133/2600       -23/650          3/2600
      89/2063       -97/2600        -3/650         33/2600
     -59/1950         1/325          1/325          1/325
      73/15600      -17/2600         7/650        113/2600
      43/15600        1/200         27/650         -9/200
  Column 5
      53/15600
      23/15600
      71/1950
    -577/15600
      98/8837
inv(a)
ans =
  Columns 1 through 4
     -77/15600      133/2600       -23/650          3/2600
      89/2063       -97/2600        -3/650         33/2600
     -59/1950         1/325          1/325          1/325
      73/15600      -17/2600         7/650        113/2600
```

```
      43/15600        1/200         27/650         -9/200
  Column 5
      53/15600
      23/15600
      71/1950
    -577/15600
      98/8837
%they are the same.
a = magic(4)
a =
      16              2              3             13
       5             11             10              8
       9              7              6             12
       4             14             15              1
C = cofactor(a)
C =
    -136           -408            408            136
    -408          -1224           1224            408
     408           1224          -1224           -408
     136            408           -408           -136
D = determine(a,C)
D =
       0
det(a)
ans =
      -1/689889648801
%My program used to give a similar answer but then I wrote an if statement
that corrects for determinants within 1e-7 of 0.
B = inverse(a,C,D)
B =
     []
inv(a)
[_Warning: Matrix is close to singular or badly scaled.
Results may be inaccurate. RCOND =  1.306145e-17.]_
ans =
       *              *              *              *
       *              *              *              *
       *              *              *              *
       *              *              *              *
%My program checks for singularity before computation.
a = hilb(4)
a =
       1              1/2            1/3            1/4
       1/2            1/3            1/4            1/5
       1/3            1/4            1/5            1/6
       1/4            1/5            1/6            1/7
C = cofactor(a)
C =
       1/378000      -1/50400        1/25200       -1/43200
      -1/50400        1/5040        -1/2240         1/3600
       1/25200       -1/2240         3/2800        -1/1440
      -1/43200        1/3600        -1/1440         1/2160
D = determine(a,C)
D =
```

```
        1/6048000
det(a)
ans =
        1/6048000
%they are the same.
B = inverse(a,C,D)
B =
      16            -120              240             -140
    -120            1200            -2700             1680
     240           -2700             6480            -4200
    -140            1680            -4200             2800
inv(a)
ans =
      16            -120              240             -140
    -120            1200            -2700             1680
     240           -2700             6480            -4200
    -140            1680            -4200             2800
%they are the same.
```