Group 22

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

```
Diary on

format compact

type eigen


function [  ] = eigen( A )

L = transpose(eig(A));

L = sort(L);

L = closetozeroroundoff(L);

disp("All the eigenvalues:")

disp(L);

disp("All the unique eigenvalues:")

M = unique(L);

disp(M);

Q = length(A);

disp("The sum of multiplicities of the eigenvalues is Q = " );

disp(Q);

disp("The following is a list of eigenvalues with a basis for the coresponding eigenspace:")

P = [];

for i = 1:length(M)

    disp(M(i));

    disp(" ");

    temp = A - (eye(Q)*M(i));
```

```
    P = [P null(temp, 'r')];
    disp(null(temp, 'r'));
    disp(" ");
end
disp("The total sum of the dimensions of the eigenspaces is N = ");
N = length(P(1, :));
disp(N);
if Q ~= N
    disp("No, matrix A is not diagonalizable since N does not equal Q")
else
    disp("Yes, matrix A is diagonalizable since N=Q");
    D = diag(L);
    F = closetozeroroundoff(A*P - P*D);
    if F == 0
        disp("Great! I got a diagonalization!");
    else
        disp("Oops! I got a bug in my code.");
    end

end
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
end
end
B=A;
type jord

function J = jord (n, r)
A = ones(n);
J = tril(triu(A),1);
for i = 1: n
J(i, i) = r;
end
A = [2 2; 0 2];
eigen(A)
All the eigenvalues:
    2    2
All the unique eigenvalues:
    2
```

The sum of multiplicities of the eigenvalues is Q =

2

The following is a list of eigenvalues with a basis for the coresponding eigenspace:

2

1

0

The total sum of the dimensions of the eigenspaces is N =

1

No, matrix A is not diagonalizable since N does not equal Q

A = [4 0 0 0; 1 3 0 0; 0 -1 3 0; 0 -1 5 4];

eigen(A)

All the eigenvalues:

3 3 4 4

All the unique eigenvalues:

3 4

The sum of multiplicities of the eigenvalues is Q =

4

The following is a list of eigenvalues with a basis for the coresponding eigenspace:

3

0

0

-0.2000

1.0000

4

0

0

0

1

The total sum of the dimensions of the eigenspaces is N =

2

No, matrix A is not diagonalizable since N does not equal Q

A = jord(5,3);

eigen(A)

All the eigenvalues:

3 3 3 3 3

All the unique eigenvalues:

3

The sum of multiplicities of the eigenvalues is Q =

5

The following is a list of eigenvalues with a basis for the coresponding eigenspace:

3

1

0

0

0

0

The total sum of the dimensions of the eigenspaces is N =

1

No, matrix A is not diagonalizable since N does not equal Q

A = diag([3, 3, 3, 2, 2, 1]);

eigen(A)

All the eigenvalues:

1 2 2 3 3 3

All the unique eigenvalues:

1 2 3

The sum of multiplicities of the eigenvalues is Q =

6

The following is a list of eigenvalues with a basis for the coresponding eigenspace:

1

0

0

0

0

0

1

2

| | |
|---|---|
| 0 | 0 |
| 0 | 0 |
| 0 | 0 |
| 1 | 0 |
| 0 | 1 |
| 0 | 0 |

3

| | | |
|---|---|---|
| 1 | 0 | 0 |
| 0 | 1 | 0 |
| 0 | 0 | 1 |
| 0 | 0 | 0 |
| 0 | 0 | 0 |
| 0 | 0 | 0 |

The total sum of the dimensions of the eigenspaces is N =

6

Yes, matrix A is diagonalizable since N=Q

Great! I got a diagonalization!

A = magic(4);

eigen(A)

All the eigenvalues:

-8.9443 0 8.9443 34.0000

All the unique eigenvalues:

-8.9443 0 8.9443 34.0000

The sum of multiplicities of the eigenvalues is Q =

4

The following is a list of eigenvalues with a basis for the coresponding eigenspace:

-8.9443

-0.4570

-0.0287

-0.5143

1.0000

0

-1

-3

3

1

```
   8.9443


  -2.1882

   1.1254

   0.0627

   1.0000


  34.0000


   1.0000

   1.0000

   1.0000

   1.0000
```

The total sum of the dimensions of the eigenspaces is N =

```
    4
```

Yes, matrix A is diagonalizable since N=Q

Great! I got a diagonalization!

```
A= ones(5);

eigen(A)
```

All the eigenvalues:

```
    0     0     0     0     5
```

All the unique eigenvalues:

```
    0     5
```

The sum of multiplicities of the eigenvalues is Q =

5

The following is a list of eigenvalues with a basis for the coresponding eigenspace:

0

| | | | |
|---|---|---|---|
| -1 | -1 | -1 | -1 |
| 1 | 0 | 0 | 0 |
| 0 | 1 | 0 | 0 |
| 0 | 0 | 1 | 0 |
| 0 | 0 | 0 | 1 |

5

1

1

1

1

1

The total sum of the dimensions of the eigenspaces is N =

5

Yes, matrix A is diagonalizable since N=Q

Great! I got a diagonalization!

A = magic(5);

eigen(A)

All the eigenvalues:

-21.2768 -13.1263 13.1263 21.2768 65.0000

All the unique eigenvalues:

-21.2768 -13.1263 13.1263 21.2768 65.0000

The sum of multiplicities of the eigenvalues is Q =

5

The following is a list of eigenvalues with a basis for the coresponding eigenspace:

-21.2768

-0.1440

-0.5200

-0.8114

0.4753

1.0000

-13.1263

-2.4172

2.2511

-1.4952

0.6613

1.0000

13.1263

-0.4137

-0.2736

0.6186

-0.9313

1.0000

21.2768

65.0000

The total sum of the dimensions of the eigenspaces is N =

3

No, matrix A is not diagonalizable since N does not equal Q

%this does not make sense as a magic square should be diagonizable

type eigen_1

function [  ] = eigen( A )

L = transpose(eig(A));

L = sort(L);

disp("All the eigenvalues:")

```
disp(L);

disp("All the unique eigenvalues:")

M = unique(L);

disp(M);

Q = length(A);

disp("The sum of multiplicities of the eigenvalues is Q = " );

disp(Q);

disp("The following is a list of eigenvalues with a basis for the coresponding
eigenspace:")

P = [];

for i = 1:length(M)

   disp(M(i));

   disp(" ");

   temp = A - (eye(Q)*M(i));

   P = [P null(temp)];

   disp(null(temp, 'r'));

   disp(" ");

end

disp("The total sum of the dimensions of the eigenspaces is N = ");

N = length(P(1, :));

disp(N);

if Q ~= N

   disp("No, matrix A is not diagonalizable since N does not equal Q")

else
```

```
    disp("Yes, matrix A is diagonalizable since N=Q");
    D = diag(L);
    F = closetozeroroundoff(A*P - P*D);
    if F == 0
        disp("Great! I got a diagonalization!");
    else
        disp("Oops! I got a bug in my code.");
    end

end
end
```

```
eigen_1(A)
All the eigenvalues:
  -21.2768  -13.1263   13.1263   21.2768   65.0000
All the unique eigenvalues:
  -21.2768  -13.1263   13.1263   21.2768   65.0000
The sum of multiplicities of the eigenvalues is Q =
     5
The following is a list of eigenvalues with a basis for the coresponding eigenspace:
  -21.2768


   -0.1440
   -0.5200
```

-0.8114

0.4753

1.0000

-13.1263

-2.4172

2.2511

-1.4952

0.6613

1.0000

13.1263

-0.4137

-0.2736

0.6186

-0.9313

1.0000

21.2768

65.0000

The total sum of the dimensions of the eigenspaces is N =

5

Yes, matrix A is diagonalizable since N=Q

Great! I got a diagonalization!

%all i had to do was find the null space, not necissailty a ration basis of of, of A - I

diary off

%excerise 2

diary on

format compact

A = [2 2; 0 2];

diagonal(A)

The number of linearly independent columns in P is k =

1

A is not diagonizable.

A does not have enough linearly independent eigenvectors to create a basis for R^n

ans =

2 2

A = [4 0 0 0; 1 3 0 0; 0 -1 3 0; 0 -1 5 4]

A =

4 0 0 0

1 3 0 0

0 -1 3 0

0 -1 5 4

diagonal(A)

The number of linearly independent columns in P is k =

2

A is not diagonizable.

A does not have enough linearly independent eigenvectors to create a basis for R^n

ans =

4 3 3 4

A = jord(5,3);

{ Undefined function or variable 'jord'.}

A = jord(5,3);

diagonal(A)

The number of linearly independent columns in P is k =

1

A is not diagonizable.

A does not have enough linearly independent eigenvectors to create a basis for R^n

ans =

3 3 3 3 3

A = diag([3 3 3 2 2 1]);

diagonal(A);

The number of linearly independent columns in P is k =

6

A is diagonalizable.

A basis for R^n is:

```
   0   0   0   0   0   1

   0   0   0   1   0   0

   0   0   0   0   1   0

   0   1   0   0   0   0

   0   0   1   0   0   0

   1   0   0   0   0   0
```

A = magic(4);

diagonal(A);

The number of linearly independent columns in P is k =

```
    4
```

A is diagonalizable.

A basis for R^n is:

```
  -0.5000   -0.8236    0.3764   -0.2236

  -0.5000    0.4236    0.0236   -0.6708

  -0.5000    0.0236    0.4236    0.6708

  -0.5000    0.3764   -0.8236    0.2236
```

A = ones(5);

diagonal(A);

The number of linearly independent columns in P is k =

```
    5
```

A is diagonalizable.

A basis for R^n is:

```
    0.4082    0.7071    0.2236    0.2887    0.4472

    0.4082   -0.7071    0.2236    0.2887    0.4472
```

```
  -0.8165   -0.0000    0.2236    0.2887    0.4472
        0   -0.0000    0.2236   -0.8660    0.4472
        0         0   -0.8944         0    0.4472
A = magic(5);
diagonal(A)
The number of linearly independent columns in P is k =
     5
A is diagonalizable.
A basis for R^n is:
  -0.4472    0.0976   -0.6330    0.6780   -0.2619
  -0.4472    0.3525    0.5895    0.3223   -0.1732
  -0.4472    0.5501   -0.3915   -0.5501    0.3915
  -0.4472   -0.3223    0.1732   -0.3525   -0.5895
  -0.4472   -0.6780    0.2619   -0.0976    0.6330
ans =
  65.0000  -21.2768  -13.1263   21.2768   13.1263
diary off
%Exercise 3
diary on
format compact
type shrink
function B = shrink(A)
%Function given.
[~,pivot] = rref(A);
```

```
B = A(:,pivot);

end

type proj

function [p, z] = proj(A,b)

%The function computes the projection of b onto the Column Space of

%an matrix A. The program allow a possibility that the

%columns of A are not linearly independent. The algorithm create a

%basis for Col A.

%Required. Code Given

format compact,

A=shrink(A);

b=transpose(b);

%Set the dimension of matrix A. (m=columns, n=rows)due to shrink function.

[m,n]=size(A);

%Remove Negative zeros.

tol = 1.e-7;

%Check if the input vector b has exactly m entries.

%If the porgram doesn’t have m entries, the program breaks with a

%message and returns empty vectors p and z.

if(size(b)~= m)

 disp("No solution: dimensions of A and b disagree")

 p = [ ];

 z = [ ];

 return
```

```
else
%If b has exactly m components,determine whether it is a case when the
%vector b ? Col A.
if rank(A)== rank([A,b])
%If vector b ? Col A, outputs (without any computations): the
%vector p, vector z, and a message. After that, the program
%terminates.
p=b;
z=b-p;
%Remove Negative zeros.
p(p<0 & p>-tol) = 0;
z(z<0 & z>-tol) = 0;
disp("b is in the Col A")
return
%If vector b ? Col A,(1)Determine whether it is a case when b is
%orthogonal to Col A.
else
true=1;
for i =1:n
if(abs(dot(A(:,i),b))>10^-7)
%b is not orthogonal to Col A
true=0;
end
```

```
end

%If b is orthogonal to Col A,outputs (without any computations):
%the vector p, vector z, and a message. After that, the program
%terminates.
if(true == 1)
p=b;
z=b-p;
%Remove Negative zeros.
p(p<0 & p>-tol) = 0;
z(z<0 & z>-tol) = 0;
disp("b is orthogonal to Col A")
return;
%If b is not orthogonal to Col A,
else
if (true ==0)
%Find the solution of the normal equations x^.
%Then calculate vector p = Ax^ . The vector z = b – p.
x=(A'*A)\(A'*b);
p=A*x;
z=b-p;
%Remove Negative zeros.
p(p<0 & p>-tol) = 0;
z(z<0 & z>-tol) = 0;
```

```
%Check whether the vector p is orthogonal to the vector z.
if(abs(dot(p,z))<10^-7)
disp("Yes, p and z are orthogonal! Great Job!")
else
disp("Oops! Is there a bug in my code?")
end
end
end
end
end
end
%a)
A= magic(6); A=A( : , 1 : 4), b = (1 : 6)
A =
 35 1 6 26
 3 32 7 21
 31 9 2 22
 8 28 33 17
 30 5 34 12
 4 36 29 13
b =
 1 2 3 4 5 6
[p,z] = proj(A,b)
```

Yes, p and z are orthogonal! Great Job!

p =

0.9492

2.1599

2.9492

3.9180

5.1287

5.9180

z =

0.0508

-0.1599

0.0508

0.0820

-0.1287

0.0820

%b)

A= magic(6), E= eye(6); b = E( 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

b =

0 0 0 0 0 1

[p,z] = proj(A,b)

Yes, p and z are orthogonal! Great Job!

p =

-0.2500

0.0000

0.2500

0.2500

0.0000

0.7500

z =

0.2500

0.0000

-0.2500

-0.2500

0.0000

0.2500

%c)

A = magic(4), b = (1 : 5)

A =

16 2 3 13

5 11 10 8

9 7 6 12

4 14 15 1

b =

1 2 3 4 5

[p,z] = proj(A,b)

No solution: dimensions of A and b disagree

p =

[]

z =

[]

%d)

A = magic(5), b = rand(1,5)

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

b =

0.8147 0.9058 0.1270 0.9134 0.6324

[p,z] = proj(A,b)

b is in the Col A

p =

0.8147

0.9058

0.1270

0.9134

0.6324

z =

0

0

0

0

0

%e)

A= ones(6); A( : ) = 1 : 36, b = [1,0,1,0,1,0]

A =

1 7 13 19 25 31

2 8 14 20 26 32

3 9 15 21 27 33

4 10 16 22 28 34

5 11 17 23 29 35

6 12 18 24 30 36

b =

1 0 1 0 1 0

[p,z] = proj(A,b)

Yes, p and z are orthogonal! Great Job!

p =

0.7143

0.6286

0.5429

0.4571

0.3714

0.2857

z =

0.2857

-0.6286

0.4571

-0.4571

0.6286

-0.2857

%f)

A= ones(6); A( : ) = 1 : 36; A= null(A,'r'), b = ones(1,6)

A =

1 2 3 4

-2 -3 -4 -5

1 0 0 0

0 1 0 0

0 0 1 0

0 0 0 1

b =

1 1 1 1 1 1

[p,z] = proj(A,b)

b is orthogonal to Col A

p =

1

1

1

1

1

1

z =

0

0

0

0

0

0

diary off

```
%Exercise 4
>> type shrink
function B = shrink(A)
%Function given.
[~,pivot] = rref(A);
B = A(:,pivot);
end
>> type solvemore
```

```
%Exercise 4

>> type shrink

function X = solvemore(A,b)

%The function find the “exact” solution of a matrix equation Ax=b if the

%equation is consistent, b?Col A; or find the “least-squares” solution

%if the equation is inconsistent, b?Col A .

%Required. Code Given

format long,

A=shrink(A);

[m, n] = size(A);

%To check whether b?Col A or b?Col A

if rank(A)== rank([A,b])

 %Part A: If b?Col A

 disp("The equation is consistent – look for the exact solution")


 %Required. Code Given

 B=closetozeroroundoff(A'*A-eye(n));


 %Part 1A: does not have orthonormal columns

 if(B~=zeros(n))

 disp("A does not have orthonormal columns")

 %the solution of Ax=b

 x1=A\b;

 %Required. Code Given
```

```
X=x1;

end


if(B==zeros(n))

%Part 2A: has orthonormal columns but is not orthogonal

if(m~=n)

disp("A has orthonormal columns but is not orthogonal")

%the solution of Ax=b

x1=A\b;

%Required. Code Given

X=x1;

%Part 3A: is orthogonal

else

disp("A is orthogonal")

x1=A\b;

x2=A'*b;

%Required. Code Given

X=[x1,x2];

N=norm(x1-x2);


fprintf("The norm of the difference between two solutions is N
=\n",N);

end

end
```

```
%Part B: If b?Col A
else
 disp("The system is inconsistent – look for the least-squares solution")
 %Part 1B: unique least-squares solution by solving the normal equations
 %and estimate the least-squares error of the approximation
 x3=((A'*b)\(A'*A))';
 disp("The solution of the normal equations is x3=");
 disp(x3)
 %Required. Code Given
 n1=norm(b-A*x3);


 disp("The least-squares error of the approximation is n1=");
 disp(n1)


 %Part 2B: Find an orthonormal basis U for Col A
 %Check if the matrix A has orthonormal columns (part (a))
 B=closetozeroroundoff(A'*A-eye(n));
 if(B==zeros(n))
 disp("A has orthonormal columns: an orthonormal basis for Col A is
U=A")
 %Required. Code Given
 U=A;
 end
 if(B~=zeros(n))
```

```
%Required. Code Given
U = orth(A);

disp("An orthonormal basis for Col A is U=");
disp(U)
end

%Part 3B: calculate the vector b1, least-squares solution of x4, and
%estimate the least-squares error of the approximation of b by the
%vectors in Col A
%Required. Code Given
b1=U*U'*b;
disp("The projection of b onto Col A is");
disp(b1)

x4=A\b1;
disp("The least-squares solution by using the projection onto Col A is
x4=");
disp(x4)

n2 = norm(b-A*x4);
disp("The least-squares error of this approximation is n2 =");
disp(n2)
```

```
%Part 4B: Calculate the norm n3 of the difference between the
%solutions x3 and x4
n3 = norm(x3 - x4);
disp("The norm of the difference between the solutions is x3= ");
disp(n3)

x=rand(n,1);
n4=norm(b-A*x);
fprintf("An error of approximation of b by Ax for a random vector x in
R^%i is %e",n,n4);
X=[x3 x4];
end
end
>> %a)
>> A=magic(4); b=A( : ,1), A=orth(A)
b =
16
5
9
4
A =
-0.5000 0.6708 0.5000
-0.5000 -0.2236 -0.5000
-0.5000 0.2236 -0.5000
```

-0.5000 -0.6708 0.5000

>> X = solvemore(A,b)

The equation is consistent – look for the exact solution

A has orthonormal columns but is not orthogonal

X =

-16.999999999999993

8.944271909999161

3.000000000000000

>> %b)

>> A= magic(5); A= orth(A), b = rand(5,1)

A =

Columns 1 through 3

-0.447213595499958 -0.545634873129948 0.511667273601714

-0.447213595499958 -0.449758363151205 -0.195439507584838

-0.447213595499958 -0.000000000000024 -0.632455532033676

-0.447213595499958 0.449758363151189 -0.195439507584872

-0.447213595499958 0.545634873129987 0.511667273601672

Columns 4 through 5

0.195439507584854 -0.449758363151198

-0.511667273601691 0.545634873129969

0.632455532033676 -0.000000000000002

-0.511667273601694 -0.545634873129966

0.195439507584856 0.449758363151196

b =

0.814723686393179

0.905791937075619

0.126986816293506

0.913375856139019

0.632359246225410

>> X = solvemore(A,b)

The equation is consistent – look for the exact solution

A is orthogonal

The norm of the difference between two solutions is N =

X =

-1.517501961599936 -1.517501961599936

-0.096093467150121 -0.096093467150121

0.304574206628231 0.304574206628231

-0.567677934732546 -0.567677934732546

-0.086157982822825 -0.086157982822825

>> %c)

>> A= magic(4), b = ones(4,1)

A =

16 2 3 13

5 11 10 8

9 7 6 12

4 14 15 1

b =

1

1

1

1

>> X = solvemore(A,b)

The equation is consistent – look for the exact solution

A does not have orthonormal columns

X =

0.058823529411765

0.117647058823529

-0.058823529411765

>> %d)

>> A = magic(4), b = rand(4, 1)

A =

16 2 3 13

5 11 10 8

9 7 6 12

4 14 15 1

b =

0.097540404999410

0.278498218867048

0.546881519204984

0.957506835434298

>> X = solvemore(A,b)

The system is inconsistent – look for the least-squares solution

The solution of the normal equations is x3=

13.219850693725473

17.863381290095088

17.935052780168906

The least-squares error of the approximation is n1=

8.573128698484909e+02

An orthonormal basis for Col A is U=

-0.363225569906992 -0.839773278980323 0.335928601456289

-0.511952614823082 0.201051551215513 -0.497476425501395

-0.413098103234259 -0.228706948321817 -0.571876812690966

-0.659789104673461 0.449502219631666 0.559129763025005

The projection of b onto Col A is

0.180796221571844

0.528265668584352

0.297114069487679

0.874251018861863

The least-squares solution by using the projection onto Col A is x4=

-0.001240611967882

-0.031004149639099

0.087551437445385

The least-squares error of this approximation is n2 =

0.372331330756435

The norm of the difference between the solutions is x3=

28.522615408790429

An error of approximation of b by Ax for a random vector x in R^3 is

3.680584e+01

```
X =

 13.219850693725473 -0.001240611967882

 17.863381290095088 -0.031004149639099

 17.935052780168906 0.087551437445385

>> %e)

>> A= magic(4); A = orth(A), b = rand(4,1)

A =

 -0.500000000000000 0.670820393249937 0.500000000000000

 -0.500000000000000 -0.223606797749979 -0.500000000000000

 -0.500000000000000 0.223606797749979 -0.500000000000000

 -0.500000000000000 -0.670820393249937 0.500000000000000

b =

 0.392227019534168

 0.655477890177557

 0.171186687811562

 0.706046088019609

>> X = solvemore(A,b)
```

The system is inconsistent – look for the least-squares solution

The solution of the normal equations is x3=

```
 -0.919766830206403

 -0.304662471966935

 0.129779014755094
```

The least-squares error of the approximation is n1=

0.258712381419412

A has orthonormal columns: an orthonormal basis for Col A is U=A

The projection of b onto Col A is

0.335274292603541

0.484619709385675

0.342044868603444

0.762998814950236

The least-squares solution by using the projection onto Col A is x4=

-0.962468842771448

-0.318807035870279

0.135804264782329

The least-squares error of this approximation is n2 =

0.254700337841731

The norm of the difference between the solutions is x3= \n

0.045385396362836

An error of approximation of b by Ax for a random vector x in R^3 is

1.190141e+00

X =

-0.919766830206403 -0.962468842771448

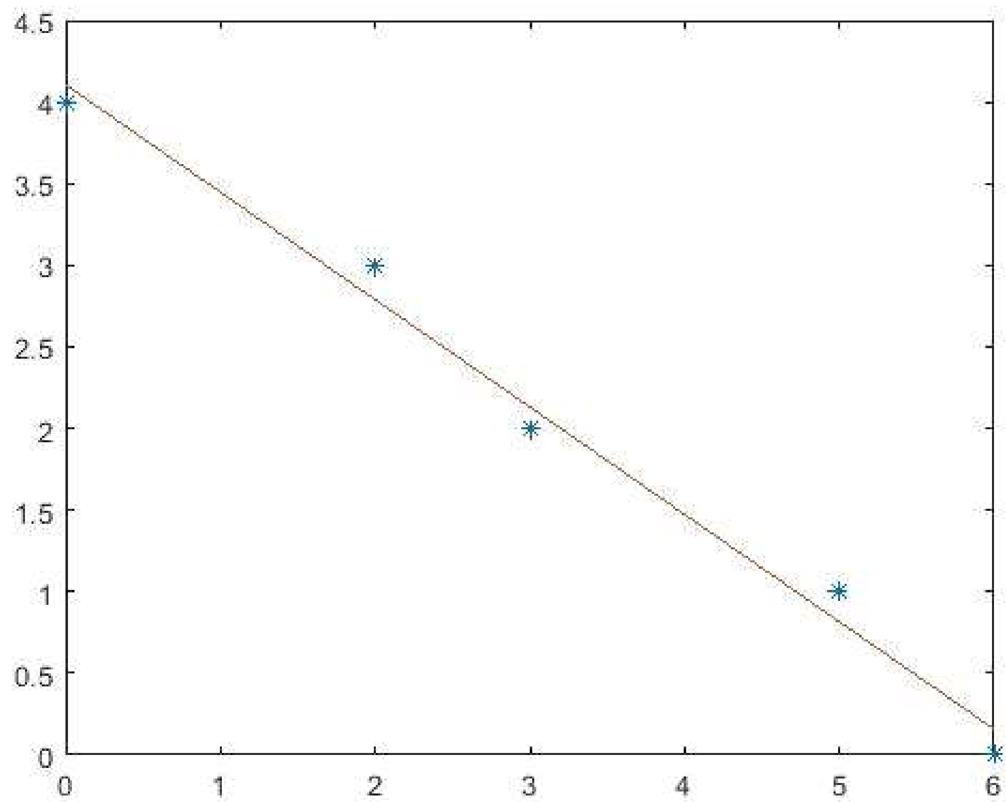
-0.304662471966935 -0.318807035870279

0.129779014755094 0.135804264782329

```
diary Project4
diary on
format compact
```

```
 %Exercise 5
%Matthew Leonard
 type polyplot

function [ ] = polyplot(a, b, p)
x = (a : (b-a)/50 : b)';
y = polyval(p, x);
plot (x, y)
end

 type lstsqline

function c = lstsqline(x, y)
format rat,
x = x';
y = y';
a = x(1);
m = length(x);
b = x(m);
X = [x, ones(m,1)];
c = lscov(X, y);

c1 = (inv(X'*X))*(X'*y)
c2 = (X'*X)\(X'*y)


% the next command calculates the 2-norm of the residual vector
N=norm(y-X*c)
% plot data points and the least-squares regression line:
plot(x, y, ' * '), hold
polyplot(a, b, c');
% output the polynomial:
P=poly2sym(c)
end

 x=[0,2,3,5,6]
x =
   0    2    3    5    6
 y=[4,3,2,1,0]
y =
   4    3    2    1    0
 c=lstsqline(x,y)
c1 =
```

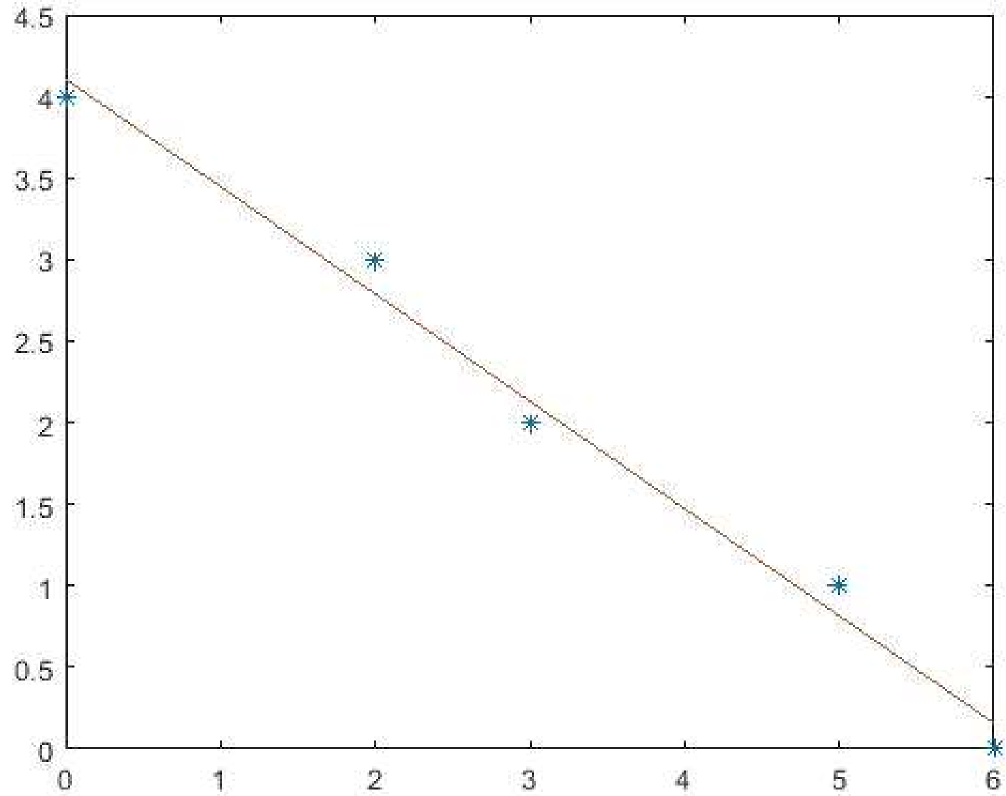
```
   -25/38
    78/19
c2 =
   -25/38
    78/19
N =
   514/1417
Warning: MATLAB has disabled some advanced graphics rendering features by
switching to
software OpenGL. For more information, click here.
Current plot held
P =
78/19 - (25*x)/38
c =
   -25/38
    78/19
```




```
%
%
%Exercise 6
```

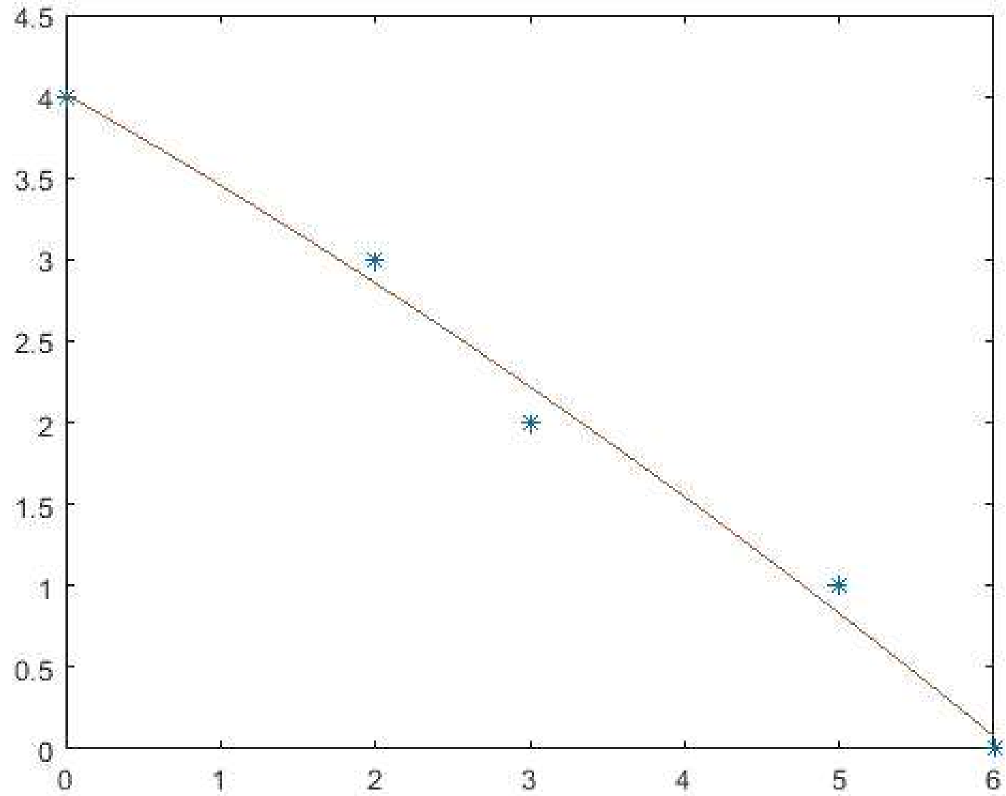
```
%Matthew Leonard
type lstsqpoly

function c = lstsqpoly(x, y, n)
format rat,
x = x';
y = y';
a = x(1);
m = length(x);
b = x(m);
for i = 1:n
   X(:,n-i+1) = x.^i;
end
X(:,n+1) = ones(m,1);
c = lscov(X, y);
c1 = (inv(X'*X))*(X'*y)
c2 = (X'*X)\(X'*y)
% the next command calculates the 2-norm of the residual vector
N=norm(y-X*c)
% plot data points and the least-squares regression line:
plot(x, y, ' * '), hold
polyplot(a, b, c');
% output the polynomial:
P=poly2sym(c)
end

c = lstsqpoly(x,y,1)
c1 =
    -25/38
     78/19
c2 =
    -25/38
     78/19
N =
    514/1417
Current plot held
P =
78/19 - (25*x)/38
c =
    -25/38
     78/19
%c1, c2, and c all match.
%n=1 is consistent for both lstsqpoly and lstsqline because the matrix is designed the
```

same



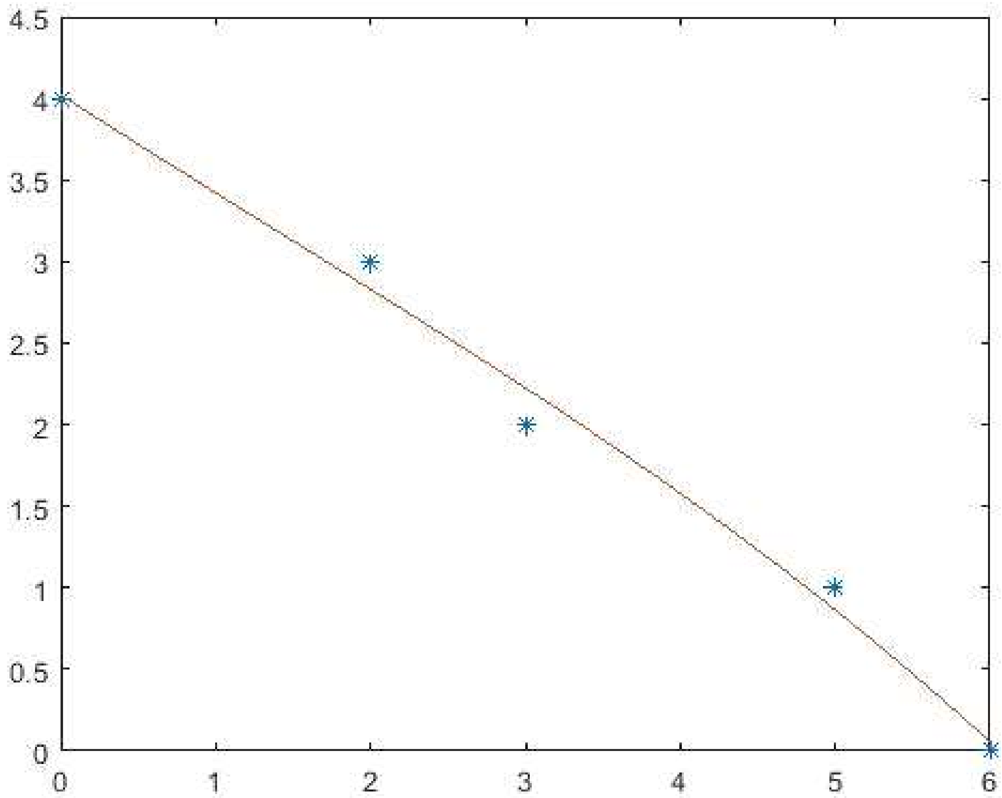

c = lstsqpoly(x,y,2)
c1 =
-3/154
-83/154
309/77
c2 =
-3/154
-83/154
309/77
N =
703/2181
Current plot held
P =
309/77 - (3*x^2)/154 - (83*x)/154
c =
-3/154
-83/154
309/77

%The coeffs of c1, c2, and c all match.



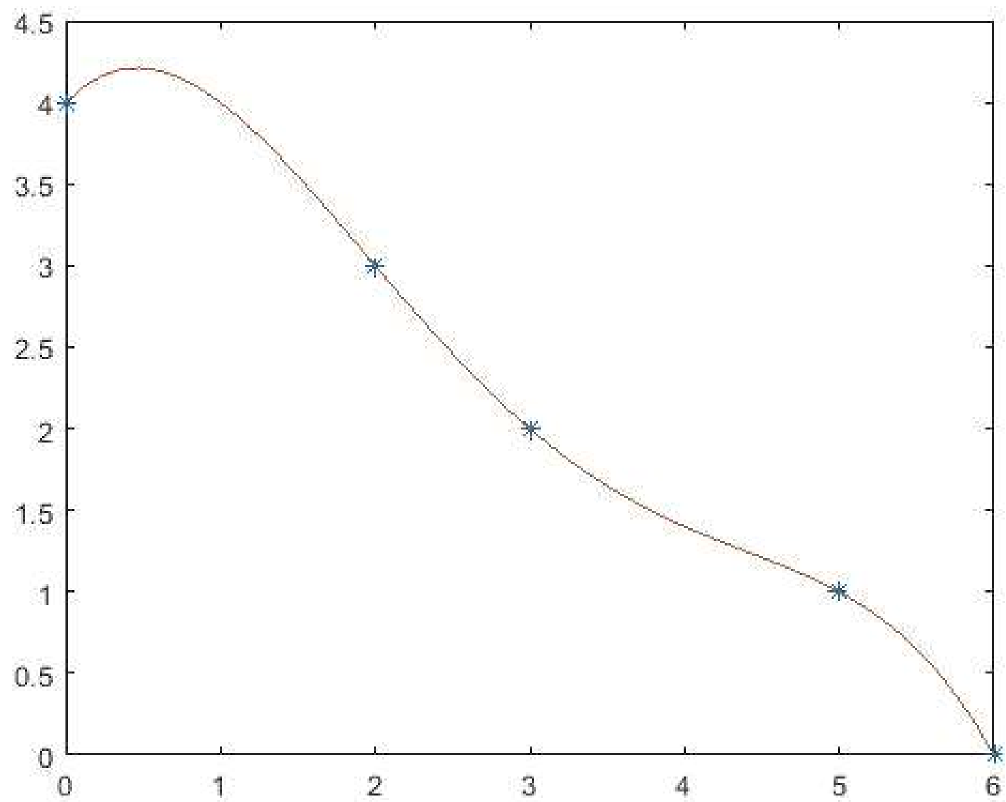

c = lstsqpoly(x,y,3)
c1 =
-1/228
5/266
-983/1596
535/133
c2 =
-1/228
5/266
-983/1596
535/133
N =
454/1425
Current plot held
P =
- x^3/228 + (5417864213378195*x^2)/288230376151711744 - (983*x)/1596 + 535/133
c =
-1/228

```
   5/266
 -983/1596
  535/133
%The coeffs of c1 c2 and c all match.
```




```
c = lstsqpoly(x,y,4)
c1 =
    -1/40
    19/60
   -51/40
    59/60
     4
c2 =
    -1/40
    19/60
   -51/40
    59/60
     4
N =
     1/77464268540332
```

Current plot held
P =
- x^4/40 + (19*x^3)/60 - (51*x^2)/40 + (59*x)/60 + 4
c =
-1/40
19/60
-51/40
59/60
4
%The coeffs of c1, c2, and c all match.




%The plot of n=4 shows strong correlation with the points and the norm proves this as well. Therefore, n=4 is the best fitted line.
diary off