Table of Contents


```
% Zain Bhaila
% Math 401
% Homework 5
```

9.1

```
% on seperate sheet
syms x;
A = [ -1 0 2 2 2 ; 0 2 3 0 1 ; 1 2 -2 1 2]
C = transpose(A)
B = A*C
y = det(B - x * eye(3))
z = double(solve(y == 0, x))
s = sqrt(z)
[T,E] = eig(B)
T = T*-1
v1 = C * T(:,3)/norm(C * T(:,3))
v2 = C * T(:,2)/norm(C * T(:,2))
v3 = C * T(:,1)/norm(C * T(:,1))
[U,S,V] = svd(A)
```

```
A =

    -1     0     2     2     2
     0     2     3     0     1
     1     2    -2     1     2


C =

    -1     0     1
     0     2     2
     2     3    -2
     2     0     1
     2     1     2


B =

    13     8     1
     8    14     0
```

```
     1     0    14


y =

- x^3 + 41*x^2 - 495*x + 1638


z =

   14.0000
    5.4223
   21.5777


s =

    3.7417
    2.3286
    4.6452


T =

    0.7287    0.0000   -0.6849
   -0.6796   -0.1240   -0.7230
   -0.0849    0.9923   -0.0904


E =

    5.4223         0         0
         0   14.0000         0
         0         0   21.5777


T =

   -0.7287   -0.0000    0.6849
    0.6796    0.1240    0.7230
    0.0849   -0.9923    0.0904


v1 =

   -0.1280
    0.3502
    0.7229
    0.3143
    0.4894


v2 =
```

```
   -0.2652
   -0.4641
    0.6298
   -0.2652
   -0.4972


v3 =

    0.3494
    0.6567
    0.1767
   -0.5894
   -0.2610


U =

    0.6849         0   -0.7287
    0.7230   -0.1240    0.6796
    0.0904    0.9923    0.0849


S =

    4.6452         0         0         0         0
         0    3.7417         0         0         0
         0         0    2.3286         0         0


V =

   -0.1280    0.2652    0.3494    0.6403    0.6175
    0.3502    0.4641    0.6567   -0.0176   -0.4801
    0.7229   -0.6298    0.1767    0.1601    0.1544
    0.3143    0.2652   -0.5894    0.6051   -0.3427
    0.4894    0.4972   -0.2610   -0.4450    0.4970
```

10.1

```
p1 = [1 ; 2] % points
p2 = [4 ; 3]
p3 = [-1 ; -3]
p4 = [-5 ; -8]
hold on;
axis([-10 10 -10 10])
scatter(p1(1,1), p1(2,1)) % plot points
scatter(p2(1,1), p2(2,1))
scatter(p3(1,1), p3(2,1))
scatter(p4(1,1), p4(2,1))
A= [p1 p2 p3 p4] % matrix of points
M = mean(A, 2) % average of points
```

```
C = A - M % center matrix
[U,S,V] = svd(C) % SVD of centered matrix
% variance is greatest in direction of the first column of U
plot([0 ; U(1,1) * 20], [0 ; U(2,1) * 20] , 'k') % plot variance line
plot([0 ; U(1,1) * -20], [0 ; U(2,1) * -20] , 'k')
```

```
p1 =

     1
     2
```

```
p2 =

     4
     3
```

```
p3 =

    -1
    -3
```

```
p4 =

    -5
    -8
```

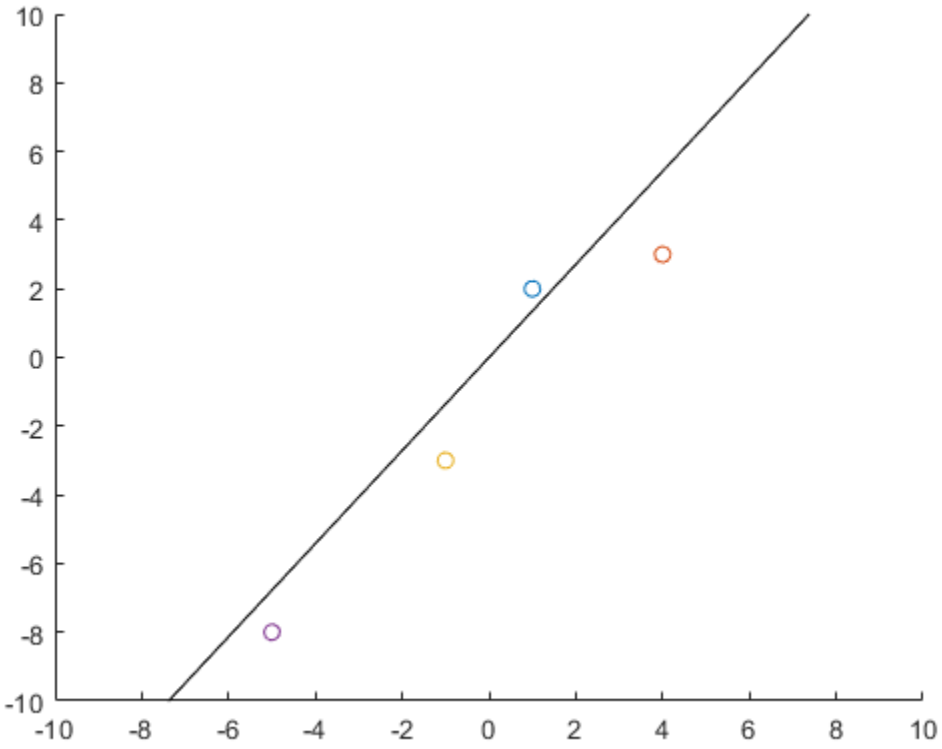
```
A =

     1     4    -1    -5
     2     3    -3    -8
```

```
M =

   -0.2500
   -1.5000
```

```
C =

    1.2500    4.2500   -0.7500   -4.7500
    3.5000    4.5000   -1.5000   -6.5000
```

```
U =

   -0.5938   -0.8046
   -0.8046    0.5938
```

```
S =

   10.8608         0         0         0
         0    1.3390         0         0


V =

   -0.3276    0.8009    0.2357    0.4423
   -0.5657   -0.5583   -0.0267    0.6062
    0.1521   -0.2145    0.9647   -0.0130
    0.7412   -0.0281   -0.1142    0.6608
```



10.4

```
% part a
A = [ 2 3 0 0 0 0 ; 0 0 1 0 0 0 ;
      3 3 0 0 0 0 ; 0 0 5 5 5 5 ]
[U,S,V] = svd(A)

% part b
SP = S;
SP(3,3) = 0; % set two smallest singular values to 0
SP(4,4) = 0
```

```
B = U*SP*transpose(V) % B is A'
AC = A - mean(A) % center A
BC = B - mean(B) % center B
% variance of AC
x = norm(AC(:,1))^2 + norm(AC(:,2))^2 + norm(AC(:,3))^2 +
 norm(AC(:,4))^2 + norm(AC(:,5))^2 + norm(AC(:,6))^2
% variance of BC
y = norm(BC(:,1))^2 + norm(BC(:,2))^2 + norm(BC(:,3))^2 +
 norm(BC(:,4))^2 + norm(BC(:,5))^2 + norm(BC(:,6))^2
y/x * 100 % percent of variance preserved
```

A =

2	3	0	0	0	0
0	0	1	0	0	0
3	3	0	0	0	0
0	0	5	5	5	5

U =

0	-0.6464	0	0.7630
-0.0503	0	-0.9987	0
0	-0.7630	0	-0.6464
-0.9987	0	0.0503	0

S =

10.0126	0	0	0	0	0
0	5.5414	0	0	0	0
0	0	0.8649	0	0	0
0	0	0	0.5414	0	0

V =

-0.0000	-0.6464	-0.0000	-0.7630	0	0
0.0000	-0.7630	0.0000	0.6464	0	0
-0.5038	0	-0.8638	0	0	0
-0.4987	0	0.2908	0	-0.5774	-0.5774
-0.4987	0	0.2908	0	0.7887	-0.2113
-0.4987	0	0.2908	0	-0.2113	0.7887

SP =

10.0126	0	0	0	0	0
0	5.5414	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0

```
B =

    2.3152    2.7330         0         0         0         0
    0.0000   -0.0000    0.2538    0.2512    0.2512    0.2512
    2.7330    3.2262         0         0         0         0
    0.0000   -0.0000    5.0376    4.9873    4.9873    4.9873


AC =

    0.7500    1.5000   -1.5000   -1.2500   -1.2500   -1.2500
   -1.2500   -1.5000   -0.5000   -1.2500   -1.2500   -1.2500
    1.7500    1.5000   -1.5000   -1.2500   -1.2500   -1.2500
   -1.2500   -1.5000    3.5000    3.7500    3.7500    3.7500


BC =

    1.0531    1.2432   -1.3228   -1.3096   -1.3096   -1.3096
   -1.2620   -1.4898   -1.0691   -1.0584   -1.0584   -1.0584
    1.4709    1.7364   -1.3228   -1.3096   -1.3096   -1.3096
   -1.2620   -1.4898    3.7147    3.6777    3.6777    3.6777


x =

    89


y =

   88.1280


ans =

   99.0202
```

10.11

```
% calculate the svd of the matrix
% set all singular values less than 1 to 0
% calculate the new matrix using U, the new sigma, and V
% center both matrixes
% calculate the variance of each matrix by adding the squares of the
 norms
%       of each column of the matrices
% divide the variance of the original matrix by the variance of the
 new
%       matrix and see what percent of variance is preserved
% if the variance is less than 99%
%       repeat process but remove fewer singular values
```

```
% if the variance is greater than 99%
%       repeat process but remove more singular values
% continue to repeat until variance is as close to 99% as possible
```

Published with MATLAB® R2019a