Mark Musil
February 5, 2022

Computational Tools for Engineers
Linear Equations and Function M-Files

Ohio University
Homework 5

1. Do exercise 6.3 on page 160 of the textbook.

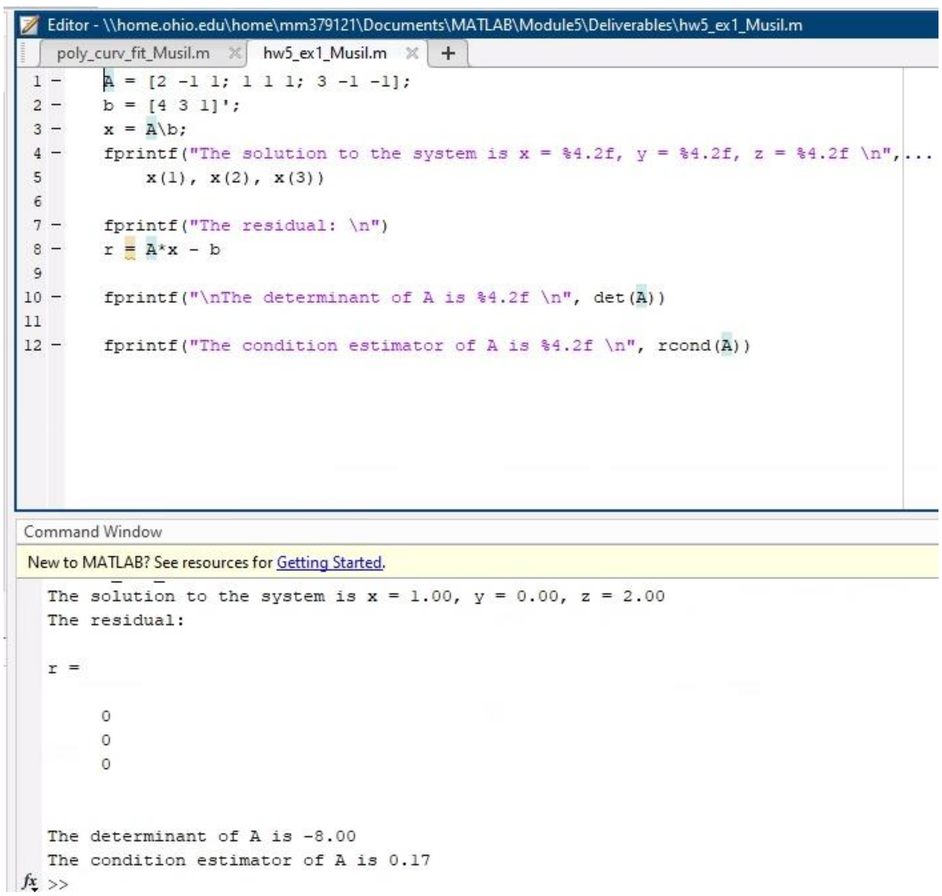
6.3 Solve the equations

$$2x - y + z = 4$$
$$x + y + z = 3$$
$$3x - y - z = 1$$

using the left division operator. Check your solution by computing the residual. Also compute the determinant (`det`) and the condition estimator (`rcond`). What do you conclude?

Answer

Because A has a non-zero determinant we are certain that we can find a solution to the system. And in fact we see that the residual vector is all zeros (see screenshot below). Because the reciprocal condition estimator yielded a value of 0.17, we know that the matrix is ill-conditioned. This means that a small change in coefficients (the B vector) yields a large change in the solution as well.



Editor - \\home.ohio.edu\home\mm379121\Documents\MATLAB\Module5\Deliverables\hw5_ex1_Musil.m

poly_curv_fit_Musil.m | hw5_ex1_Musil.m

```
A = [2 -1 1; 1 1 1; 3 -1 -1];
b = [4 3 1]';
x = A\b;
fprintf("The solution to the system is x = %4.2f, y = %4.2f, z = %4.2f \n",...
    x(1), x(2), x(3))

fprintf("The residual: \n")
r = A*x - b

fprintf("\nThe determinant of A is %4.2f \n", det(A))

fprintf("The condition estimator of A is %4.2f \n", rcond(A))
```

Command Window

New to MATLAB? See resources for Getting Started.

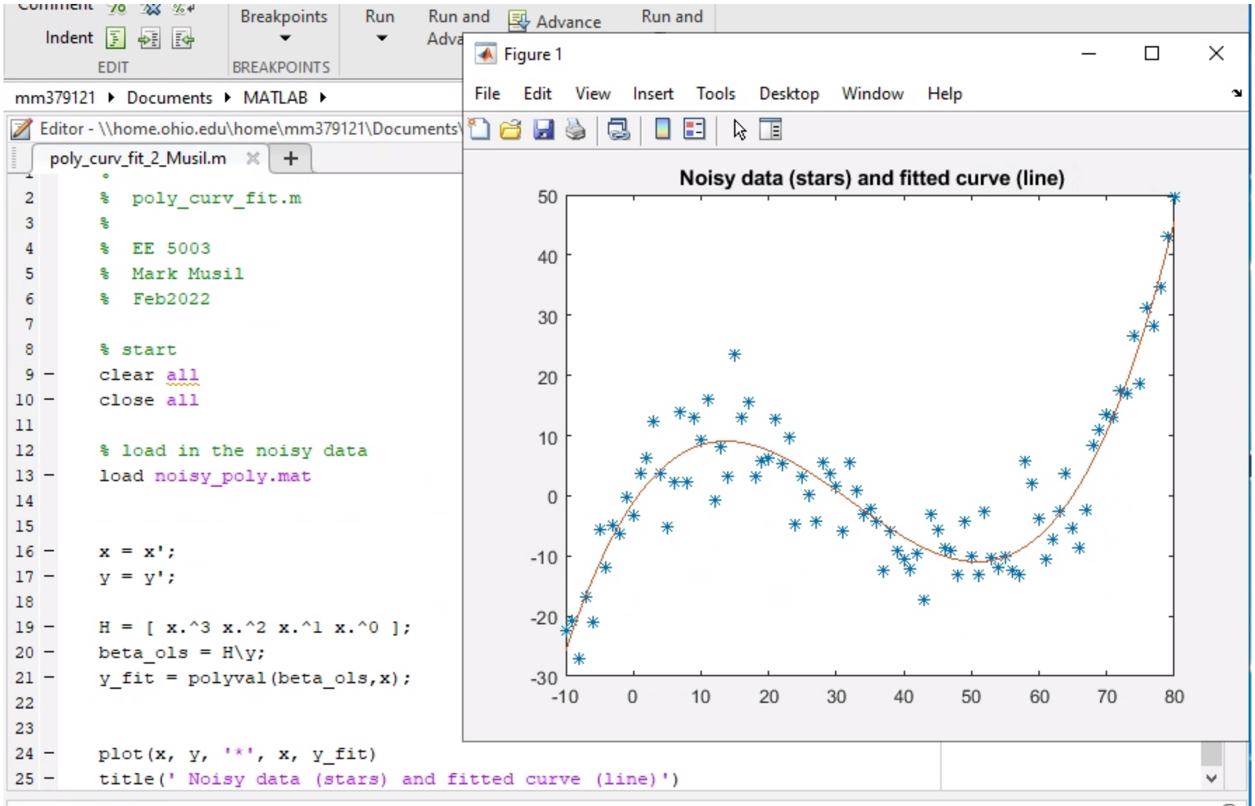
```
The solution to the system is x = 1.00, y = 0.00, z = 2.00
The residual:

r =

     0
     0
     0


The determinant of A is -8.00
The condition estimator of A is 0.17
>>
```

2. Modify your solution to last week's exercise (poly_curv_fit.m) by implementing left division rather than explicitly implementing the least-squares matrix solution.



3. Do a variation on exercise 7.5 on page 177 of the textbook. Do not implement an indefinite-length series. Instead, implement a fixed-length series that terminates at the seventh-power term. Test it in the range of -3 < x < +3.

7.5 Write your own MATLAB function to compute the exponential function directly from the Taylor series:

$$e^x = 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + \ldots$$

Editor - \\home.ohio.edu\home\mm379121\Documents\MATLAB\Module5\Deliverables\exponential_tester.m

poly_curv_fit_Musil.m | hw5_ex1_Musil.m | exponential_tester.m

```matlab
i = -3:1:3

for k = 1:length(i)

    myexp_Musil(i(k))
end

```

myexp_Musil.m

```matlab
function [f_of_x] = myexp_Musil(x)
%MY_EXP_MUSIL Summary of this function goes here
%   Detailed explanation goes here

e_to_the_x = 1

for i = 1:7
    e_to_the_x = e_to_the_x + ((x^i)/factorial(i))


fprintf("The seventh power series of the exponential yields the following estimation %4.2f \n",...
    e_to_the_x)

fprintf("The estimate yielded by MATLAB's exponential is %4.2f", exp(x))

f_of_x = e_to_the_x

end

```

Command Window

New to MATLAB? See resources for Getting Started.

```
e_to_the_x =

   19.8464

The seventh power series of the exponential yields the following estimation 19.85
The estimate yielded by MATLAB's exponential is 20.09
f_of_x =

   19.8464


ans =

   19.8464
```