Lab 06

Dominik Csatári FV1TW4 *2024.04.28*

Task 1

In this lab we had only one task, which was to implement a constrained least square estimation algorithm. With the help of the *hw6help.pdf* I rearranged equation 7 and 8. Having this form, now I had all the constant values (given input data) on the left and on the right I had values depending upon a parameter or a combination of parameters. I had Y and X the following way:

```
X(it,1:5) = [-x1(k) + x1(k-1), x1(k)*x2(k)*0.1 - x1(k)*x1(k)*0.1, ...
            (-x1(k) + x1(k-1))*x3(k),x2(k)*0.1 - x1(k)*0.1, ...
            x3(k)*x2(k)*0.1 - x3(k)*x1(k)*0.1];

X(it2,6:10) = [-x3(k) + x3(k-1), x4(k)*x3(k)*0.1 - x3(k)*x3(k)*0.1, ...
            (-x3(k) + x3(k-1))*x1(k),x4(k)*0.1 - x3(k)*0.1, ...
            x1(k)*x4(k)*0.1 - x3(k)*x1(k)*0.1];

Y(it) = x1(k)+(x1(k) + x1(k-1))*x1(k);

Y(it2) = x3(k)+(x3(k) + x3(k-1))*x3(k);
```

Where *it* and it_2 were iterators being inceremented with 2 in each loop. Y was 2Nx1 vector while X was a 2Nx10 matrix, where N is the number of data gathered from the givel *.xlsx* file.

With the given method I have calculated k_c and k_a, their values were 2.5049 and 1.9951 respectively. For the other parameters I have used simple LSQ estimators. There values are: $alpha_1$ = -0.6556, $alpha_2$ = -0.8247, $beta_1$ = 1.1941, $beta_2$ = -1.2055.

With these values I have generated a a simulation to caluclate the equations given in the homework. After this, I have calculated the sum of the losses at each $x_a(t)$ to see how good is the estimation of the parameters. For this the simulation and the input I have generated a plot which is attached in *Figure 1*. On the Figure, we can see that at the beginning there are lot of false estimation which is why for some $x_a(t)$ values the squared loss will be higher. That is why I chose to calculate the losses in a smaller range, starting from the 10^{th} element.

Both of these values are sums in order of x1, x2, x3 and x4 estimations:

- Squared losses are in order(x1, x2, x3, x4):
    - 3.2049

- 0.2561
- 2.9116
- 0.3365

- Squared losses are in order(x1, x2, x3, x4) when k h goes from 10:
  - 0.1127
  - 0.0143
  - 0.1017
  - 0.0855

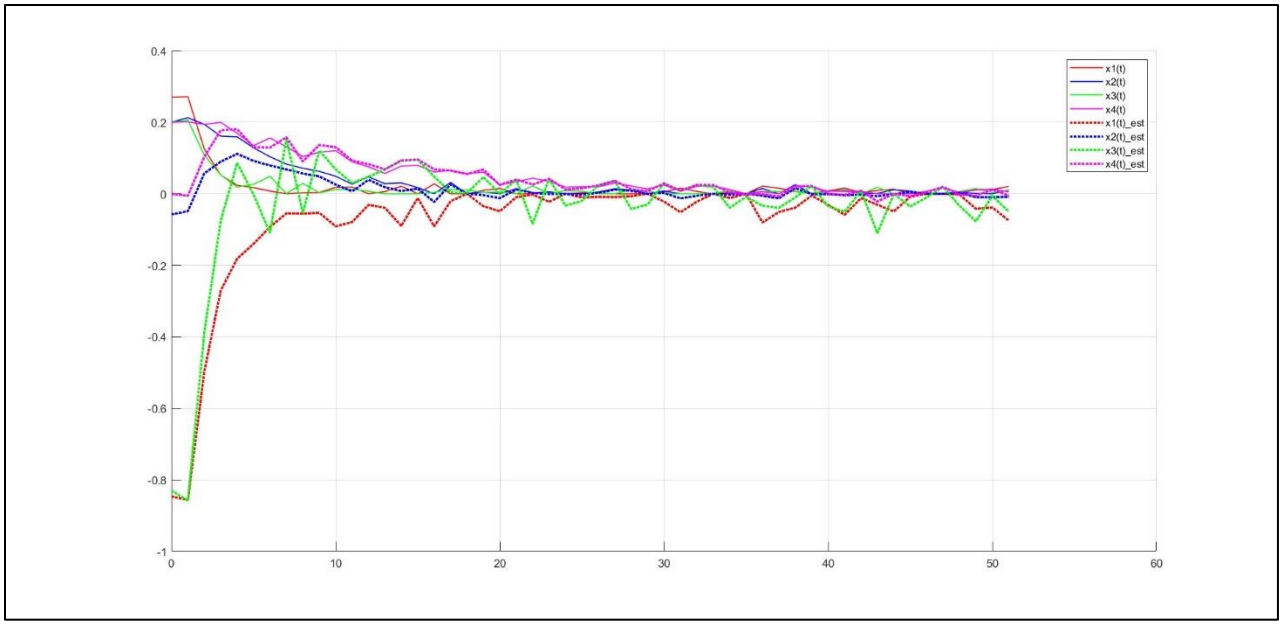

Figure 1 Plot of the original input data and the estimated values.