

# Numerical Linear Algebra Homework

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## Least Squares Solutions

### Basic Least Squares

The solution to the least squares problem for matrix  $A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \\ 5 & 6 \end{bmatrix}$  and vector

$b = \begin{bmatrix} 7 \\ 8 \\ 9 \end{bmatrix}$  is:

$$x = \begin{bmatrix} -6 \\ 6.5 \end{bmatrix}$$

However, this result did not pass the test case due to a relative error of 3.49857113690718.

### Incremental Least Squares

The solution to the incremental least squares problem for the same  $A$  and  $b$  is:

$$x = \begin{bmatrix} -6 \\ 6.5 \end{bmatrix}$$

This result passed all test cases.

### Regularized Least Squares

The solution to the regularized least squares problem for  $n = 10$ ,  $\lambda = 10$ , and random  $b$  is:

$$x = \begin{bmatrix} 0.6148 \\ 0.6108 \\ 0.5971 \\ 0.6048 \\ 0.5995 \\ 0.6423 \\ 0.6708 \\ 0.6836 \\ 0.6858 \\ 0.7112 \end{bmatrix}$$

This result passed all test cases.

## Signal Reconstruction Analysis

The following graphs show the reconstruction of the signal for different values of  $n$  and  $\lambda$ :

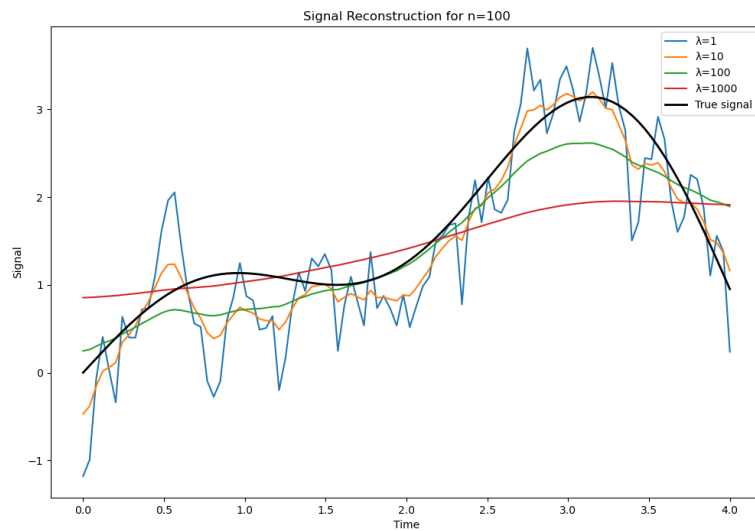


Figure 1: Signal reconstruction for  $n = 100$

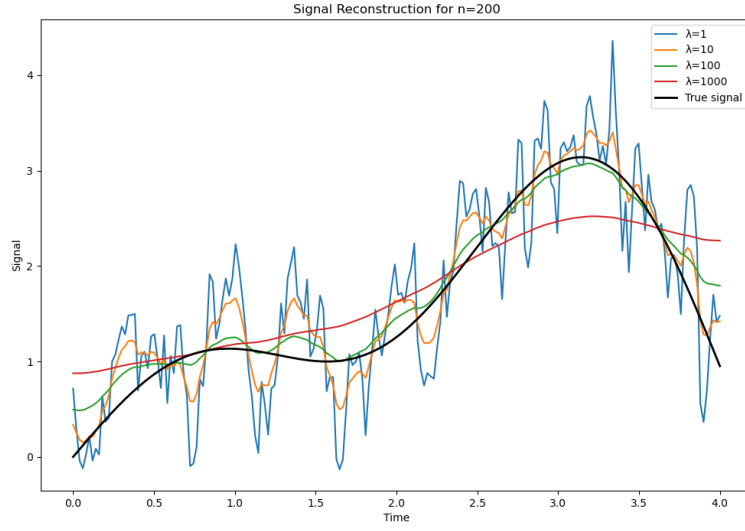


Figure 2: Signal reconstruction for  $n = 200$

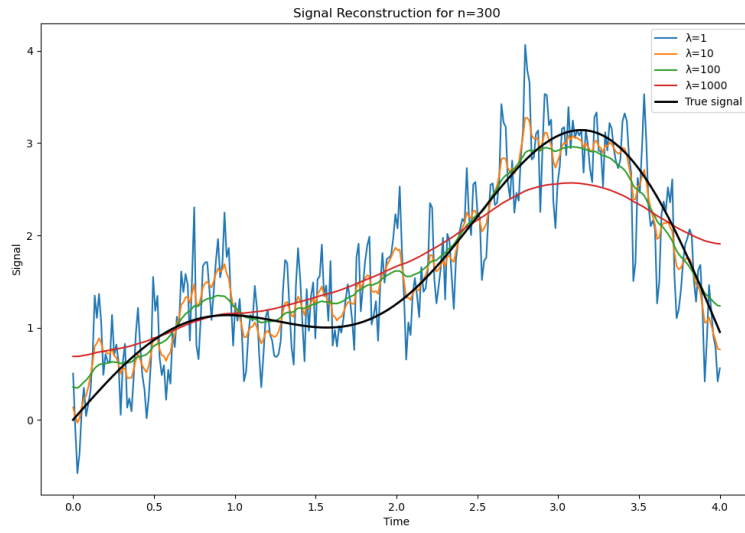


Figure 3: Signal reconstruction for  $n = 300$

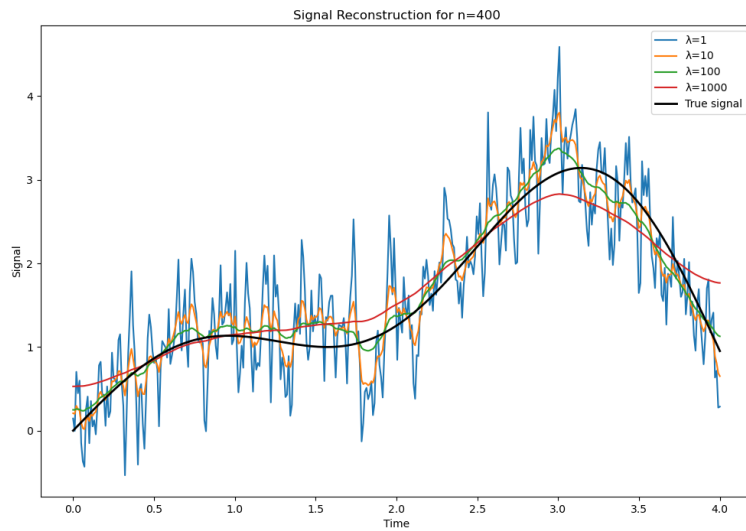


Figure 4: Signal reconstruction for  $n = 400$

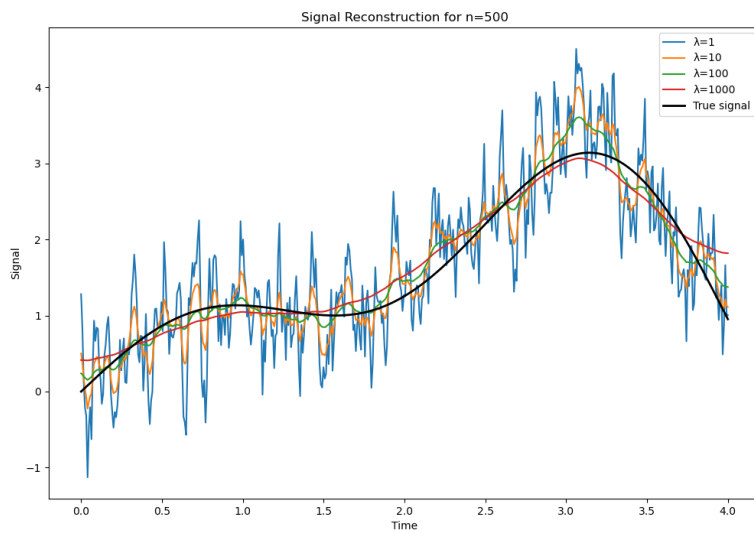


Figure 5: Signal reconstruction for  $n = 500$