CSE 397 Introduction to Computational Oncology
Homework 3 Part 2 - Model Calibration

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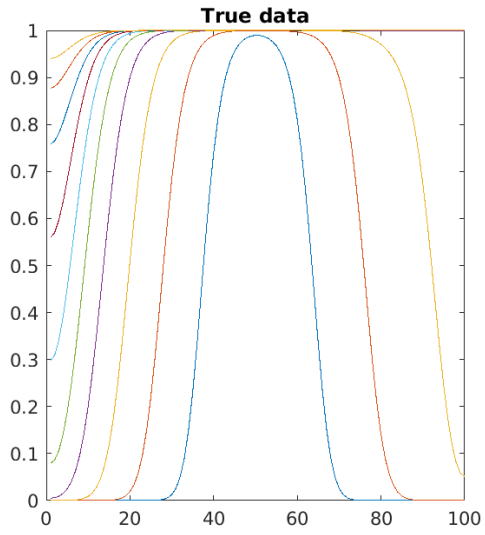
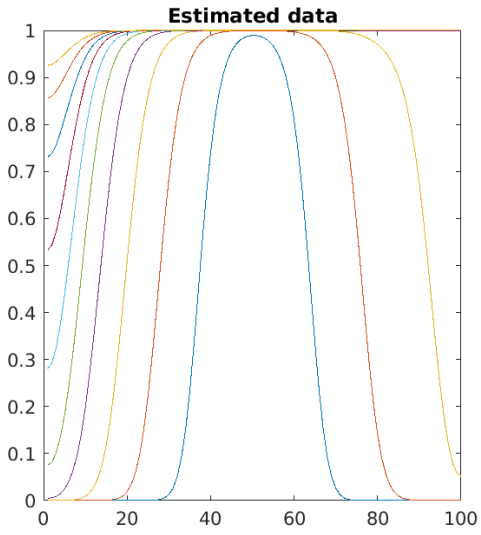
Part a: 1D optimization

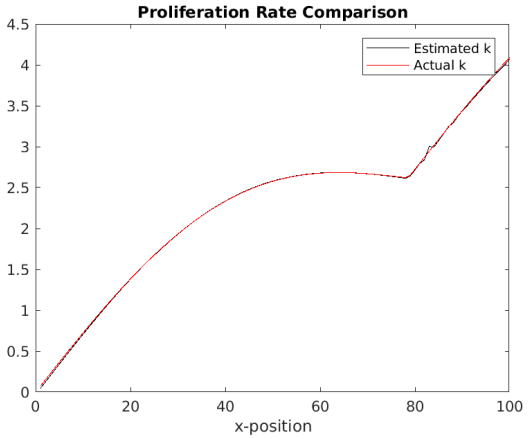
Please see attached Matlab code for details on the calculation of the following quantities, which include plots of estimated vs. actual tumor growth and estimated vs. actual proliferation rates and diffusion constants.

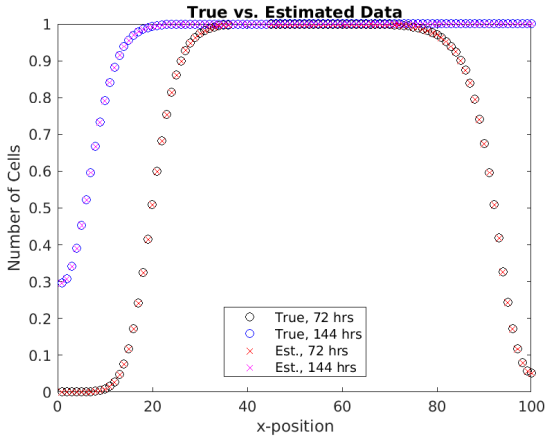
It can be seen that the algorithm works very well when there isn't any noise, does a bad but not terrible job when some noise is present, and is horrendous when the noise is significant. If we can assume k is continuous in real life, there could be some way to constrain the estimates with the algorithm with a different regularization term.

Noiseless Data:

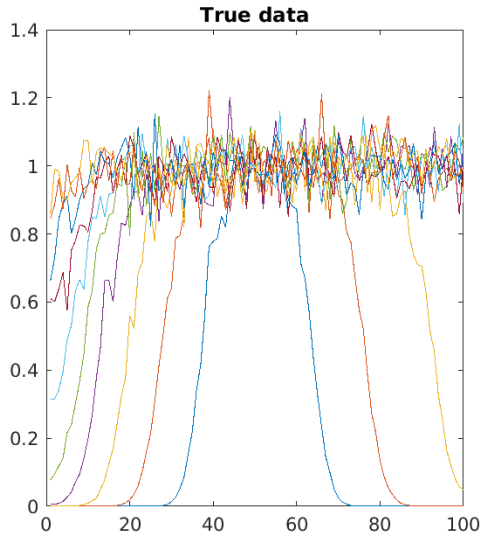


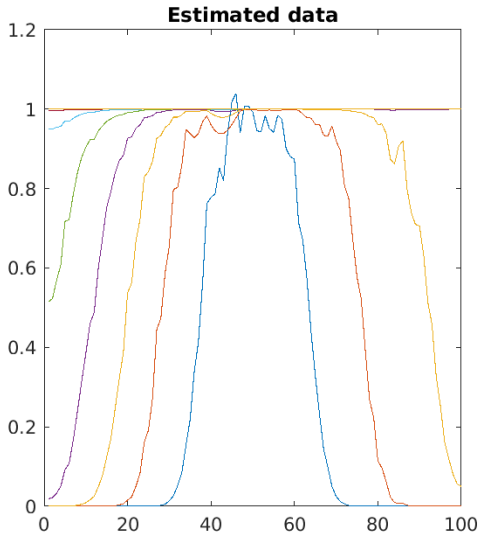


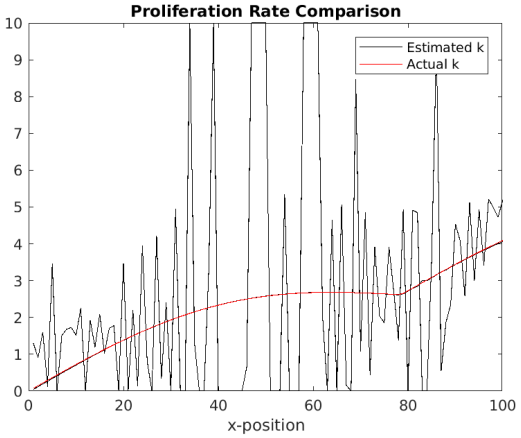


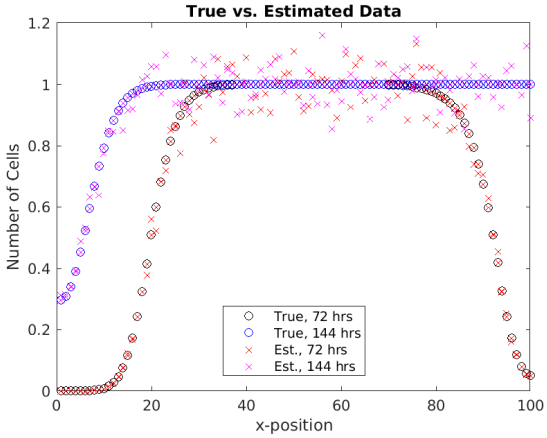


SNR = 16:

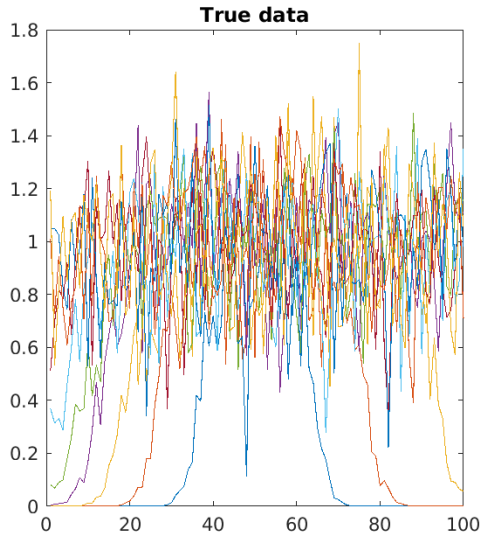

True data

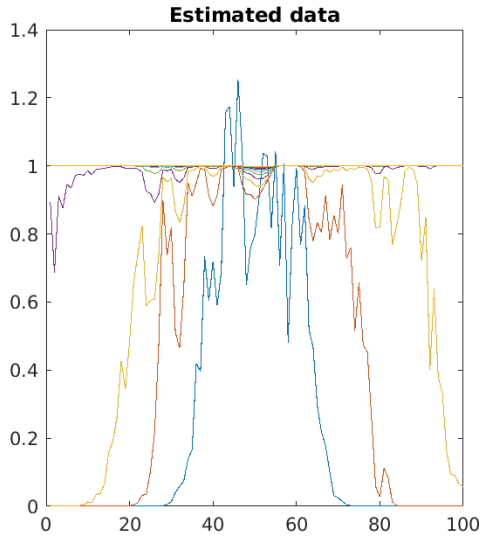

Estimated data

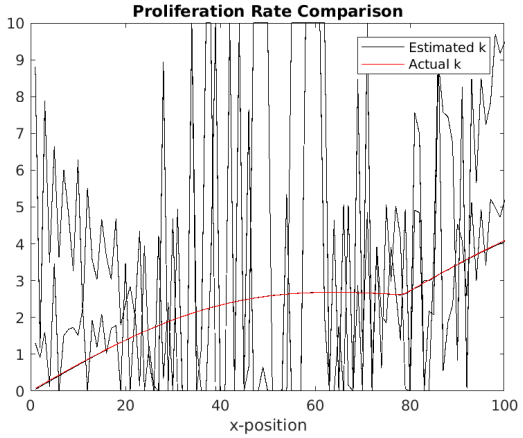

Proliferation Rate Comparison
Estimated k
Actual k
x-position

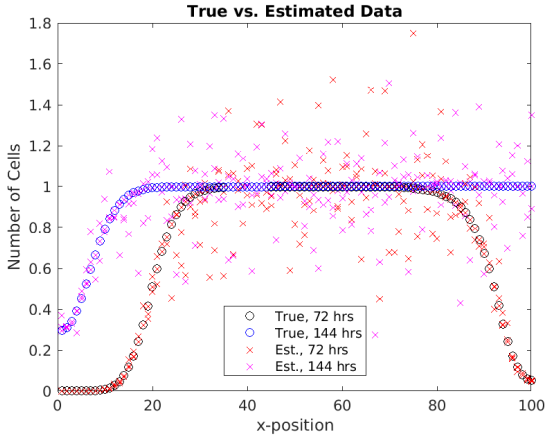

True vs. Estimated Data
Number of Cells
True, 72 hrs
True, 144 hrs
Est., 72 hrs
Est., 144 hrs
x-position

SNR = 4:









Parameter error:

L_2^2 Error in k		
Exact data	SNR = 16	SNR = 4
0.0159	875	1919

L_2^2 Error in D0		
Exact data	SNR = 16	SNR = 4
4e-8	2e-5	.0021

1 Part b: 2D Parameter Optimization

Please see attached Matlab code for details. Matlab function "lsqnonlin" was used to estimate the parameters. lsqnonlin requires an input function to minimize. In this case the function was:

$$f = N_{estimate}(k_{guess}, D_{guess}) - N_{true}$$

lsqnonlin requires the function input to be a vector of size greater than the number of parameters, so the resulting matrix was reshaped into a vector of size 10000x1. This was done for time points two and three and the vectors were concatenated.

Although the estimated parameters for SNR = 4 had the least error, they produced poor estimates of tumor growth. Overall, the general shape of the k field is similar which is interesting. The error amounts seem large but the resulting tumor growth at day 10 is actually not too far off.

Parameter error:

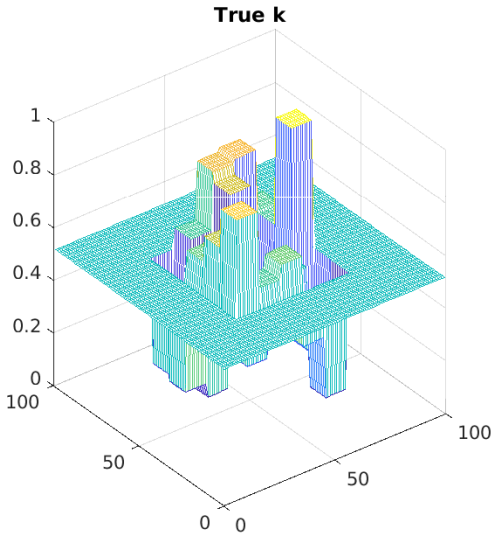
L_2^2 Error in k

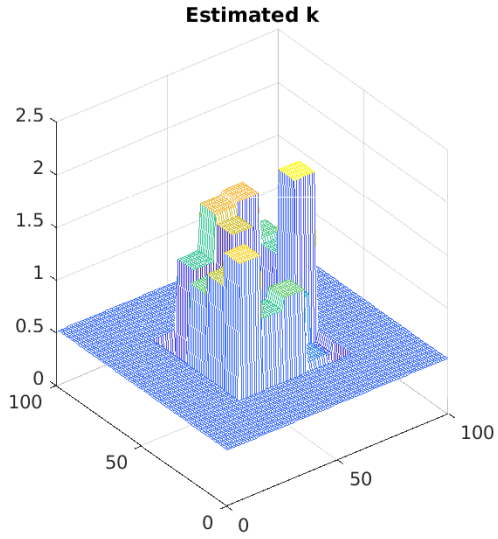
Exact data	SNR = 16	SNR = 4
800	820	661

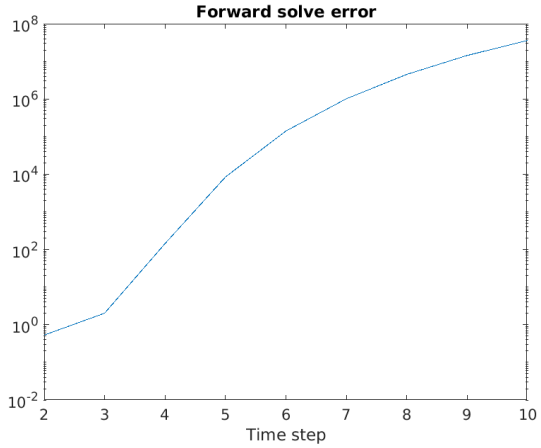
L_2^2 Error in D

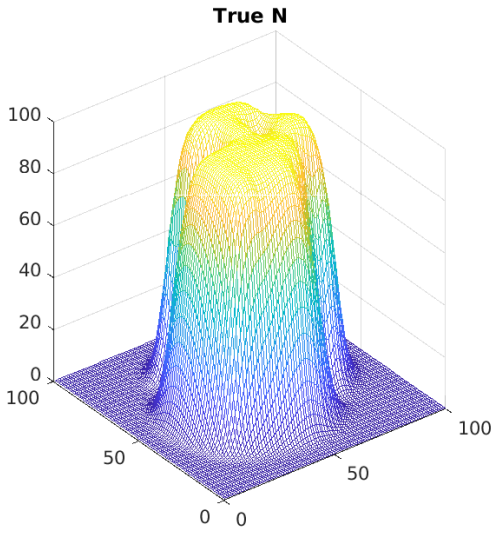
Exact data	SNR = 16	SNR = 4
9e-4	9e-4	7e-4

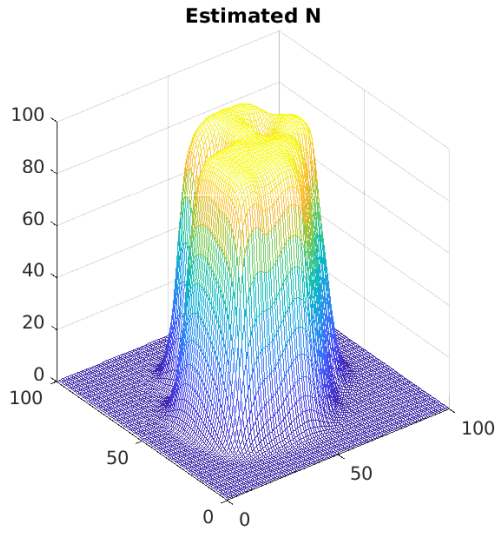
Noiseless Data:



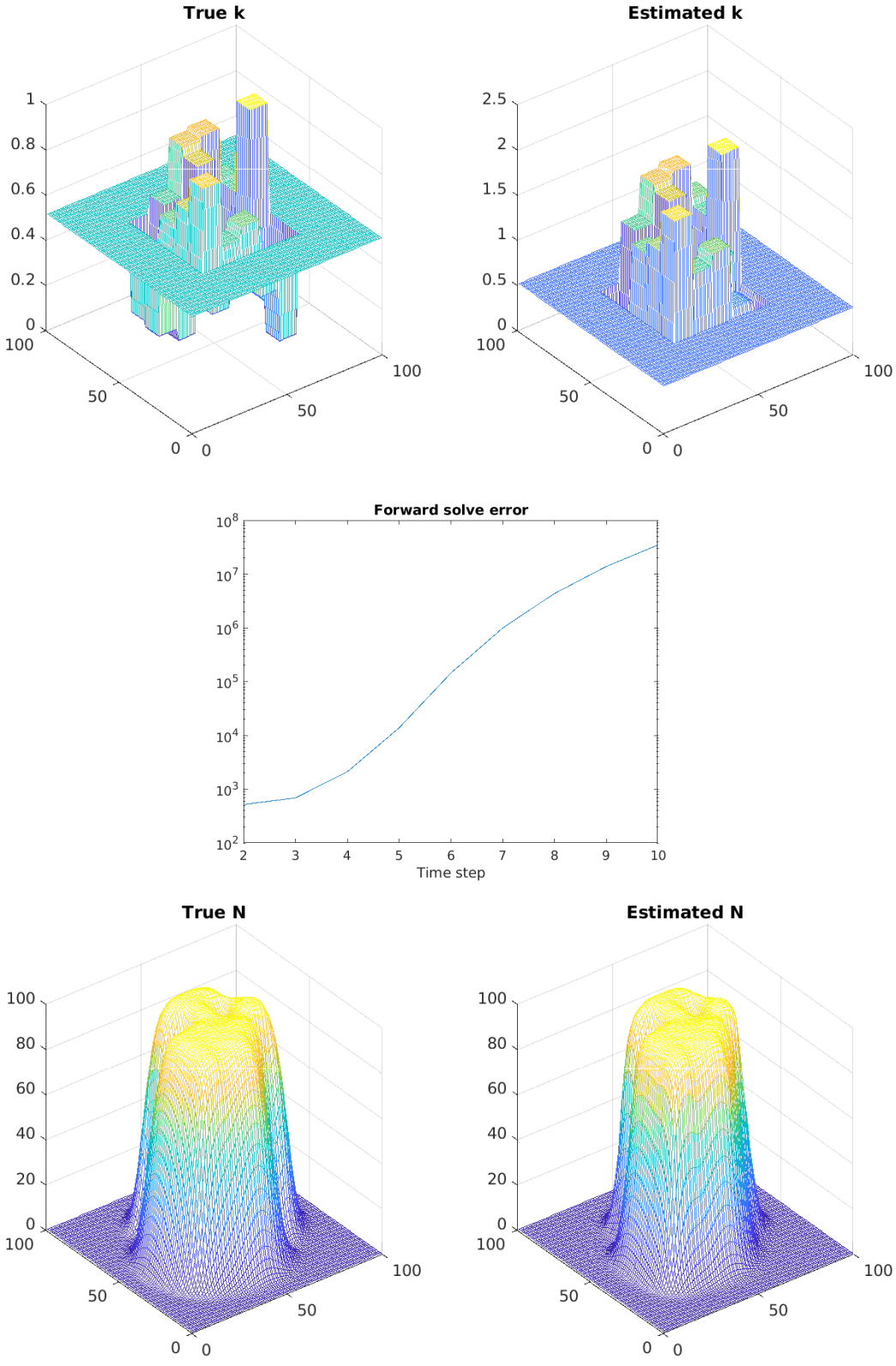




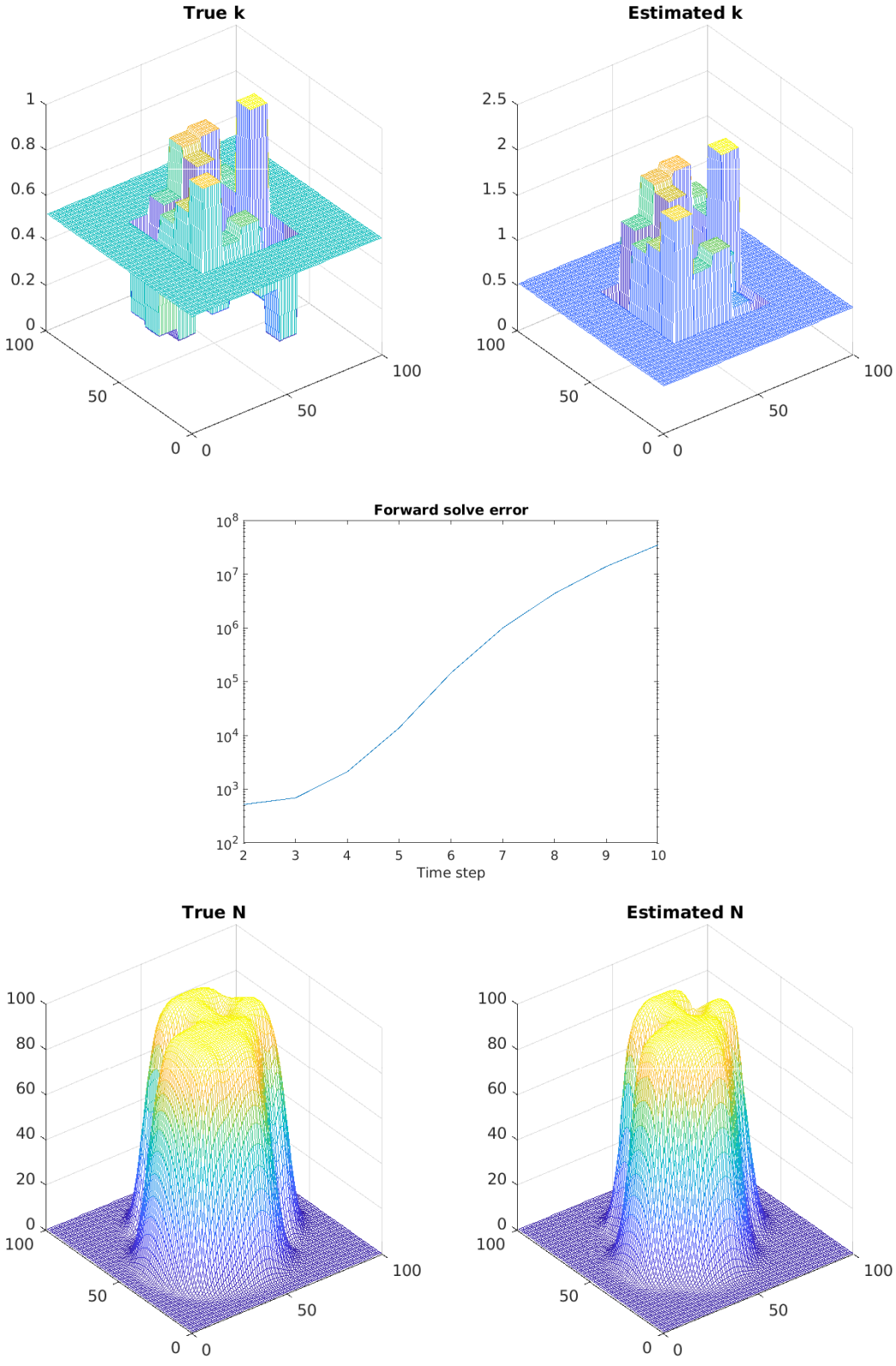




SNR = 16:


True k
Estimated k
Forward solve error
Time step
True N
Estimated N

SNR = 4:


True k
Estimated k
Forward solve error
Time step
True N
Estimated N