Chambre de Commerce et d'Industrie de Paris ———— E.S.I.E.E.	IMC4-2IT Lab on Estimation	Classe IMC4-2IT

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The goal of this lab is to illustrate and consolidate some concepts in estimation theory. We consider the problem of estimating a speed from records of the noisy positions of a vehicle. First, we study the problem analytically, then we experiment and study the methods and their performances through simulations.

Matlab files:
In order to load the matlab files, you must connect to
http://www.esiee.fr/~bercherj/New/TP/LabEstimation and download the files in a local directory. Then you start matlab and choose as current directory the local directory where you downloaded the distribution.

1 Theoretical study

The problem at hands is the estimation of the speed of a vehicle from noisy measurements of its positions (in the monodimensional case), according to

$$y(t) = st + yo + w(t),$$

with $w(t)$ a white gaussian noise with variance σ_b^2. We use N measures. Give the estimators of the different parameters $\theta = \{s, yo, \sigma_b^2\}$ according to maximum likelihood and maximum a posteriori (in the second case, take a gaussian prior on s, a gamma prior on σ_b^2 and suppose that $yo = 0$).

2 Practical work

The goal of the experimentations is now to implement the two estimators and study their behaviour with respect to the signal to noise ratio, to the number of data and to the priors.
A file esti_speed_tocomplete.m is offered, which as the name suggests, has to be completed.
The script uses several flags that enable to execute only a part of the code. For instance, the flags ML and MAP, when equal to 1, enable the computations of the ML and MAP estimators, FIGS=1 enable the display of figures while FIGS=0 forbid this display, display_results=1 enable to print the numerical results.
You have to

1. analyze and understand the program,
2. complete the script at indicated places (and test your additions),
3. experiment, analyse the results for different values for N and for the signal to noise ratio.

For instance, you may test $\{N = 5, 10, 15 \;\; \text{RSB} = -10, -5, 0, 5....\}$
In order to find the whole set of unknown parameters, $\theta = [v, yo, \sigma_b^2]$, when it is not possible to obtain an analytical solution, it is still possible to maximize numerically the ML or MAP criterion (or minimize the opposite of its logarithm). The script apost_en.m computes the posterior distribution $p_{\theta|\boldsymbol{Y}}(\theta|\boldsymbol{y})$ for a vector of data $\boldsymbol{y}$, and opt_apost_en.m implements the optimization. You may edit the two scripts so as to understand how one can deal with such a problem under Matlab, then you will experiment, at least so as to acknowledge that it is indeed possible to estimate the whole set of unknown parameters by numerical methods.