

# State Estimation for Robotics

## Exercise 1

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1. (30 pts) *Exercise 2.16 in the book (2nd Ed).*
2. (30 pts) *Exercise 3.8 in the book (2nd Ed).* 1D SLAM problem, batch solution.
3. (40 pts) *Exercise 3.9 in the book (2nd Ed).* 1D SLAM problem, recursive solution.
4. (10 pts) **Bonus points:** Figure 2.6 in the book. Consider the uncertainty ellipsoid inside the set of points  $\mathbf{x}$  given by equation (2.100):

$$(\mathbf{x} - \boldsymbol{\mu})^\top \boldsymbol{\Sigma}^{-1} (\mathbf{x} - \boldsymbol{\mu}) = M^2.$$

- (a) ( $\dim = 2$ ) Show that the area inside the uncertainty ellipse defined is  $A = M^2 \pi \sqrt{\det \boldsymbol{\Sigma}}$ .
- (b) ( $\dim = N$ ) Show that the volume inside the uncertainty hyper-ellipsoid is

$$V = \frac{M^N \pi^{N/2} \sqrt{\det \boldsymbol{\Sigma}}}{\Gamma(\frac{N}{2} + 1)},$$

where  $\Gamma$  is the Gamma function (the generalization of the factorial function for real numbers).

Observe that  $N = 2$  gives the above formula for  $A$ .