

## Bayesian Filtering and Smoothing: Exercise Set 8

1. Show that the quadrature formula

$$\int_{-\infty}^{\infty} g(x) \mathcal{N}(x|m, \sigma^2) dx \approx \frac{2}{3}g(m) + \frac{1}{6}g(m + \sigma\sqrt{3}) + \frac{1}{6}g(m - \sigma\sqrt{3})$$

is exact when  $g$  is a polynomial of degree  $\leq 5$ .

2. Estimate the track from set 6 question 3 using a third-order Gauss-Hermite Kalman Filter.
3. Modify `pendulum_demo_PF.m` to use stratified resampling.
4. Estimate the track from set 6 question 3 using a bootstrap particle filter.
5. Estimate the track from set 6 question 5 using a bootstrap particle filter.
6. Modify set 6 questions 4–5 into a terrain navigation model by changing the measurement function to

$$h(\mathbf{x}) = 100 + 50 \sin\left(\frac{x^{[1]}}{7}\right) + 20 \sin\left(\frac{x^{[1]}}{5}\right) + 20 \cos\left(\frac{x^{[1]}}{4}\right) + 10 \sin(x^{[1]}).$$

Estimate the track using a bootstrap particle filter with  $N = 1000$  particles and the initial state distribution  $\mathbf{x}_0 \sim \mathcal{N}\left(\begin{bmatrix} 4 \\ 0 \end{bmatrix}, \begin{bmatrix} 400 & 0 \\ 0 & 1 \end{bmatrix}\right)$ .