

# Inleiding Machine Learning

## Exercises, Chapter 3

### Exercise 1

This exercise is to reproduce the full Bayesian solution for linear regression as shown in figures 3.8 and 3.9 in Bishop.

1. Generate  $N$  data samples (input and target output) according to fig 1.2 and further described in appendix A. Choose  $\sigma = 0.3$  and  $\beta = \frac{1}{\sigma^2}$ .
2. Choose  $M = 9$  basis functions according to Eq. 3.4 with means  $\mu = (0.1, \dots, 0.9)$  and standard deviation  $s = 0.1$ .
3. The Bayesian posterior in  $w$  is given by Eq. 3.49. Compute  $m_N$  and  $S_N$  from Eqs. 3.53 and 3.54. Choose  $\alpha = 0.1$ . Reproduce Figs. 3.8 and 3.9.
4. Study numerically the influence of the prior over  $w$  for low and high number of samples  $N$  relative to the number of free parameters  $M$ . Hint: fix the random seed generator, so that you can reproduce the solution for different  $\alpha$  for fixed data set. Try  $N = 100, M = 9, \alpha = 0$  and  $\alpha = 10$ . Try  $N = 3, M = 9, \alpha = 0, 0.1$  and  $\alpha = 10$ .
5. Show that when  $\alpha = 0$ , the mean  $m_N$  of the Bayesian solution coincides the with maximum likelihood solution of section 3.1.1. Show that for general  $\alpha$ , the mean  $m_N$  of the Bayesian solution coincides the with maximum a posteriori solution of section 3.1.4.