Artificial neural networks

Assignment 2: Bayesian learning in neural networks

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1 Context

Bayesian statistics offer a robust framework in which it is possible to build and assess models, and perform inference.

In this exercise, we were asked to explore bayesian learning applied to neural networks. Using the Bayes rule in the context of learning has several desirable properties related to the fact that one is not using point estimates in the search space of solutions (for example the weight space) but tries to obtain a distribution over the weight space. Hence, quantification of certainty of predictions is possible without the use of validation set or resampling.

2 BayesNN Demo

The figure 1, produced with the script [1] displays an example of classification of 4 labelled points. Starting from a gaussian, uninformative prior for the weights distribution. The algorithm computes first the posterior after having seen 2 datapoints $(-5, -5)$ and $(5, 5)$. The posterior distribution takes then the shape of a sigmoidal ridge, with half the space with weights for w_1 and w_2 close to 0. Those weights would create a classifier whose slope is positive, hence failing to classify the 2 points. After seeing the other points (which are impossible to classify linearly), we can see the posterior peaking a bit more.

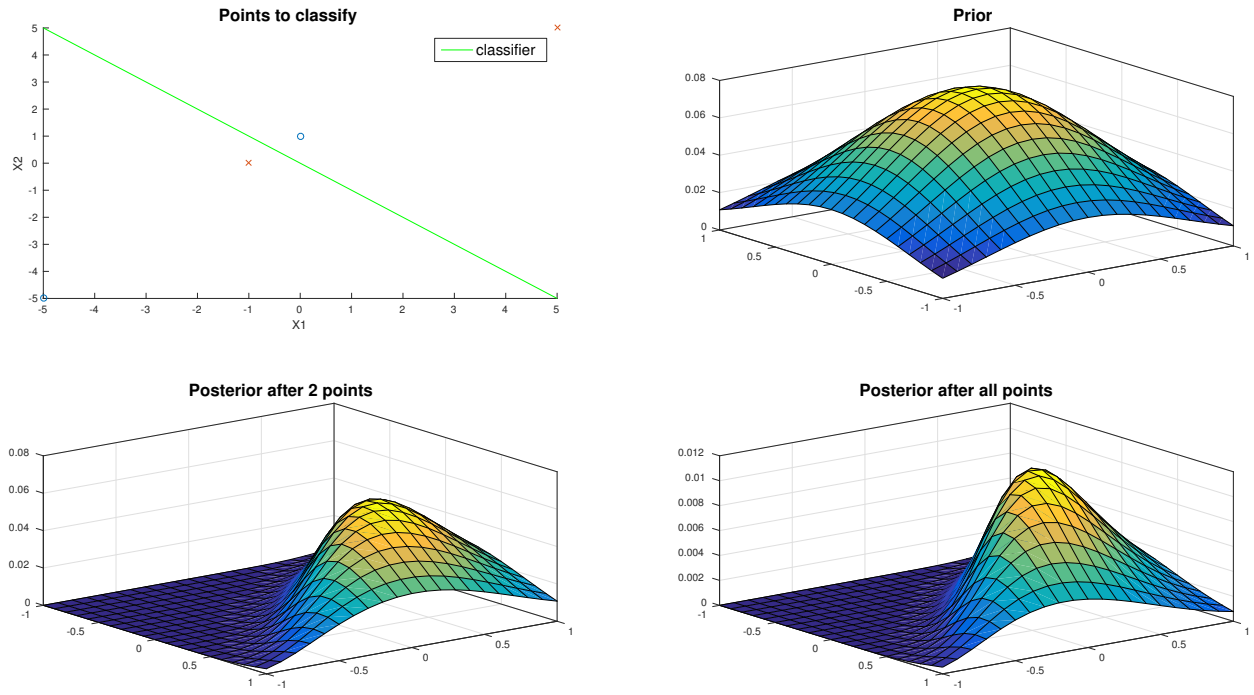

Figure 1: Bottom: evolution of the posterior through training. Top: in green, the classifier extracted using MAP on the weights' distribution

[1] https://github.com/milt0n/ANN-Experiments/bayesnn.m

3 Decision boundary of classifier

In this section, I investigated whether a simple bayesian approach could classify correctly data generated by a perceptron (hence linearly separable). In terms of architecture, the perceptron created consisted of 1 neuron with 2 inputs taking values in $[-1; 1]$, without bias term. The output of the perceptron is in $\{-1, 1\}$

4 Function approximation

References