Empirical Bayes in Bayesian inference

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The Bayesian paradigm prescribes the specification of a prior distribution on the parameters of the statistical model. For complex models, the choice of prior hyper-parameters can be a delicate and difficult task. The empirical Bayes (EB) approach, suggesting a maximum marginal likelihood (MML) selection of prior hyper-parameters, is a popular alternative to orthodox prior specifications.Rigorous understanding of such a practice is surprisingly incomplete. This contribution aims to elicit the main dynamics that drive empirical Bayesian learning processes. We first show that, under regularity conditions, the MML selection approaches an oracle choice of the hyper-parameters, asymptotically minimizing the Kullback-Leibler divergence of the (frequentist) true data generating density to the (Bayesian) marginal likelihood. The traditional folklore of EB analysis, according to which it provides approximations to genuineBayesian inference, is then addressed via a higher-order asymptotic comparison. We show that, in regular setups, EB offers a closer approximation to the posterior and the predictive distributions obtained with an oracle selection of prior hyperparameters than with non-oracle choices. We conclude illustrating our findings with examples and outlining possible extensions. This is a joint work with Judith Rousseau (University of Oxford) and Sonia Petrone (Bocconi University).