

# Catalytic Prior Distributions for Bayesian Inference

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## Abstract

The prior distribution is an essential part of Bayesian statistics, and yet in practice, it is often challenging to quantify existing knowledge into pragmatic prior distributions. In this talk we will discuss a general method for constructing prior distributions that stabilize the estimation of complex target models, especially when the sample sizes are too small for standard statistical analysis, which is a common situation encountered by practitioners with real data. The key idea of our method is to supplement the observed data with a relatively small amount of “synthetic” data generated, for example, from the predictive distribution of a simpler, stably estimated model. This general class of prior distributions, called “catalytic prior distributions” is easy to use and allows direct statistical interpretation. In the numerical evaluations, the resulting posterior estimation using catalytic prior distribution outperforms the maximum likelihood estimate from the target model and is generally superior to or comparable in performance to competitive existing methods. We will illustrate the usefulness of the catalytic prior approach through real examples and explore the connection between the catalytic prior approach and a few popular regularization methods.