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Combining Physics and Bayesian Statistics to Validate Models and Infer Their Parameters

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Physical models can suffer from systematic deficiencies due to omitted physics, which can bias parameter estimates and predictions. Such simplifications may be unavoidable, but physicists often have some idea of what is missing from their models. I discuss how physical knowledge of model discrepancy can be encoded into the language of Bayesian statistics, and how the inclusion of this uncertainty affects the parameter fitting protocol. Further benefits of this Bayesian formulation include the ability to (1) validate the model's performance and (2) make explicit all assumptions for reproducible research. Recent developments in probabilistic programming make it easier than ever before to provide a full accounting of uncertainty in the Bayesian paradigm. Applications are discussed.

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