



THE UNIVERSITY OF
CHICAGO

Computational and Applied Mathematics
&
Statistics Student Seminar

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Bayesian Compositional Data Analysis with the Reparametrized Libby-Novick
Beta Distribution

Wednesday, October 29, 2025

12:30 PM

DSI, 5460 S University Ave,
Room 105, Chicago, IL 60615

ABSTRACT

The beta distribution occupies a central role in Bayesian statistics, particularly as a conjugate prior for binomial and negative binomial models. Less common, however, is the use of the beta distribution as a likelihood for models of continuous and bounded data, largely due to the analytic intractability of learning beta shape parameters. We study the reparametrized Libby-Novick beta distribution, an overlooked generalization of the beta distribution which proves useful both as a likelihood and as a prior in Bayesian hierarchical models. We demonstrate that this distribution admits multiple latent-variable representations--such as formulations involving Pólya-gamma or negative binomial random variables---which enable efficient Bayesian inference. Empirically, Libby-Novick beta regression models often outperform standard approaches to beta regression in terms of sample efficiency, wall-clock time, and model fit. To investigate forest growth dynamics, we build a model with a Libby-Novick beta likelihood which naturally captures spatial and temporal patterns. Overall, our results substantially expand the class of compositional data models that can be fit efficiently using conditionally conjugate Bayesian inference.