

# Bayesian (Multilevel) Modeling in Stata

## QIPSR Summer Workshop Series

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**Description:** Stata has recently made great strides in allowing users to employ Bayesian models. However, these techniques are very different from the traditional frequentist approaches that are familiar to Stata users. This workshop will walk participants through some of the primary differences between frequentist and Bayesian models, the underlying techniques used to solve Bayesian problems, how to specify models in Stata, and how to run and interpret diagnostics for these models. While we will focus on multilevel modelling applications this workshop will be generally useful for anyone interested in understanding the Bayesian options in Stata 15.

**Software:** We will use the canned ‘bayes’ suite of commands as well as the StataStan program. Registered participants will be provided with a temporary license for Stata 15 MP and links to files for Stan. Users will need to have both programs pre-installed on their machines before the workshop begins or will otherwise be able to check out a laptop while they last.

**Background:** Prior exposure to Bayesian methods is useful but not expected. The minimum requirement to find this workshop useful is a background in linear modeling and some exposure to maximum likelihood. We will focus on multilevel modeling in particular so some background exposure to mixed effects or multilevel models would also be beneficial. A set of optional background readings and resources is provided at the end of this syllabus.

## **DAY 1: BASICS OF BAYESIAN MODELING**

9:00-10:15	Bayesian Models from a Non-Bayesian Perspective
10:15-10:30	Break
10:30-12:00	Bayesian Models from a Bayesian Perspective
12:00-1:15	Lunch
1:15-2:30	The Basics of MCMC
2:30-2:45	Break
2:45-4:00	Specifying a (Generalized) Linear Model in Stata

## **DAY 2: BAYESIAN MULTILEVEL MODELING**

9:00-10:15	Review of Basic Bayesian Models
10:15-10:30	Break
10:30-12:00	The Basics of Bayesian Hierarchical Modeling
12:00-1:15	Lunch
1:15-2:30	Some Differences between Bayesian and Likelihood-Based Multilevel Models
2:30-2:45	Break
2:45-4:00	Specifying a Bayesian Hierarchical Model in Stata

## **DAY 3: DIAGNOSTICS AND HARD MODELS**

9:00-10:15	Review of Basic Bayesian Models
10:15-10:30	Break
10:30-12:00	Bayesian Model Diagnostics in Stata
12:00-1:15	Lunch
1:15-2:30	StataStan for Harder Problems
2:30-2:45	Break
2:45-4:00	Fitting a Multilevel Model with StataStan

## Suggested Readings and Resources

Perezgonzalez, J. D. (2015). "Fisher, Neyman-Pearson or NHST? A tutorial for teaching data testing." Frontiers in Psychology, **6**: 223

The Bayesian Manual for Stata 15

Grant, R. L., et al. (2017). "Introducing the StataStan interface for fast, complex Bayesian modeling using Stan." Stata Journal **17**(2): 330-342.

Gill, J. and A. J. Womack (2013). The Multilevel Model Framework. The SAGE handbook of multilevel modeling. M. A. Scott, J. S. Simonoff and B. D. Marx, Sage.

Enders, C. K. (2013). Centering predictors and contextual effects. SAGE Handbook of Multilevel Modeling. M. A. Scott, J. S. Simonoff and B. D. Marx.

McElreath, Richard. (2017) Bayesian Statistics without Frequentist Language. Recorded Talk.

Gelman, A., et al. (2017). "The prior can often only be understood in the context of the likelihood." Entropy **19**(10): 555.

### Stan Prior Choice Recommendations

Gill, J. (2014). The Bayesian Prior. Bayesian methods: A social and behavioral sciences approach, CRC press

Clark, Michael (2017). A Great Directory of MCMC Algorithms.

Feng, Chi. (2018). A Great Visual Demonstration of Different MCMC Algorithms.

Betancourt, M. and M. Girolami (2015). "Hamiltonian Monte Carlo for hierarchical models." Current trends in Bayesian methodology with applications **79**: 30.

Betancourt, M. (2017). "A Conceptual Introduction to Hamiltonian Monte Carlo." arXiv preprint arXiv:1701.02434.