

**Introduction to Bayesian Inference with R**

**Course Number:** RPROG-108
**Duration:** 3 days

**Overview**

Accelebrate's Introduction to Bayesian Inference with R course teaches attendees the Bayesian approach to inference using the R language as the applied tool. After a quick review of importing and managing data with R as well as base R commands, students learn the theoretical underpinnings of inference (with a focus on Bayesian statistics), along with applied examples of Bayesian approaches to statistical models.

**Prerequisites**

Students should have a basic background in R programming including importing and manipulating data, and an understanding of base R data structures such as vectors, matrices, lists, and dataframes. Students should also have a basic background in frequentist statistics to include hypothesis testing (p-values and null hypotheses), and statistical tests such as t-tests and chi-square tests. An understanding of the general linear modeling framework will be helpful, but is not required for this course.

**Materials**

All R training attendees receive comprehensive courseware covering all topics in the course.

**Software Needed on Each Student PC**

* A recent release of R 4.x
* IDE or text editor of your choice (RStudio recommended)

**Objectives**

* Understand how to import data to R for use in statistical modeling
* Review the frequentist approach to making inference on populations, using samples of data
* Non-comprehensive review of probability theory
* Understand maximum likelihood and restricted maximum likelihood
* Contrast frequentist approaches to inference with Bayesian approaches to inference
* Understand how prior distributions affect posterior distributions
* Review the difference between proper and improper priors
* Understand how to implement and explain an MCMC algorithm for obtaining empirical prior distributions
* Fit Bayesian modeling approaches to the general linear modeling framework
* Account for clustering and repeated events over time using Bayesian inference (generalized linear models)
* Make inference on functions of parameters
* Properly interpret Bayesian posterior density intervals
* Develop awareness of different modern software approaches to making Bayesian inference (with a focus on R)

**Outline**

* Introduction to Software Environment (R and RStudio)
* Review of Base R
	+ Data import
	+ Creating new variables
	+ Basic summaries
	+ Plotting with R
* Probability Theory and Notation with Applied Examples
* Bayesian Models Versus Traditional Models
	+ The difference between a frequentist approach and a Bayesian approach
	+ Estimating cluster offsets
	+ Shrinkage
* Estimating a Single Parameter
	+ Combing the prior and observed data
	+ The notion of a non-informative prior
	+ Summarizing the posterior
	+ Implementing MCMC algorithms
	+ Diagnosing MCMC chain output
	+ Checking posterior output
* Applied Bayesian Regression Modelling: Normal Linear Regression
	+ Contrasting the Bayesian approach to linear regression
	+ Establishing model and data matrices
	+ Dimensionality reduction in the context of linear modeling
	+ Penalized models (shrinkage)
	+ Appropriate priors for beta and covariance parameters
	+ Diagnosing MCMC chain output
	+ Checking posterior output
	+ Non-linear terms
	+ Seasonal terms
	+ Extending this framework to clustered data
	+ Extensions to repeated measurements
* Applied Bayesian Regression Modelling: Logistic Regression
	+ Extending Bayesian models to binary outcomes
	+ Accounting for over and under dispersion in a binomial model
	+ Extensions to clustered data
	+ Extensions to repeated measurements
* Applied Bayesian Regression Modelling: Time to Event Models
	+ Extending Bayesian approaches to proportional hazards modeling
* Review of Other Software Approaches to Performing Bayesian Inference
	+ INLA
	+ WINBUGS/OPENBUGS
	+ JAGS
	+ STAN
* Conclusion