

**Syllabus for ST740**  
**Bayesian Inference, Fall 2023**

**Course:**

Meeting time: MW, 2102 SAS Hall, 1:30–2:45  
Course website: <https://st740.wordpress.ncsu.edu/>

**Instructor:** Brian Reich

Office: 5212 SAS Hall  
Email: [brian\\_reich@ncsu.edu](mailto:brian_reich@ncsu.edu)  
Office Hours: TuTh, 3:00–4:00 on zoom (link on the course website's notes page)

**Teaching Assistant:** Chenyin Gao

Email: [cgao6@ncsu.edu](mailto:cgao6@ncsu.edu)  
Office Hours: Mo, 10:00–11:00 on zoom (link on the course website's notes page)

**Prerequisites:** ST 702.

**Optional textbooks:** *Bayesian Statistical Methods* by Reich and Ghosh and *Bayesian Data Analysis 4* by Gelman et al.

**Computing:** The primary computing language will be R, which is freely available at <http://www.r-project.org/>. We will also use JAGS, which is freely available at <http://sourceforge.net/projects/mcmc-jags/files/>.

**Grading:** Final grade will be based on:

$$\text{Final Semester Score} = (20H + 30DA + 20P + 30F)/100,$$

where  $H$  is the homework average,  $DA$  is the data analysis project,  $P$  is a presentation of a foundational paper and  $F$  is the final project (all out of 100).

**Homework:** There will be three homework assignments. Problems and due dates will be posted on the course website. Students are encouraged to work in groups. All unexcused late homework will be given a 50% penalty.

**Data analysis project:** The take-home project will be a written report of a challenging data analysis. The project will be assigned on (tentatively) October 18 submitted approximately a week later.

**Presentation:** Students will prepare a short video presentation of a foundational Bayesian paper. The presentation is due Friday, November 24.

**Final project:** The final is a group research project due Dec 11 at noon.

The main topics are:

1. **Bayesian inference:** prior and posterior distributions, posterior predictive distribution
2. **Selecting priors:** conjugate priors, objective Bayesian priors, empirical Bayes, penalized complexity priors, prior sensitivity
3. **Bayesian theory:** De Finetti's Theorem, bias/variance tradeoff, Bernstein/Von Mises Theorem, posterior consistency
4. **Bayesian computing:** deterministic methods, Markov Chain Monte Carlo (Gibbs, Metropolis, slice and Hamiltonian), INLA, Approximate Bayesian Computation (ABC)
5. **Big data:** divide and conquer methods, stochastic gradient MCMC, variational Bayes
6. **Statistical models:** generalized linear mixed models, hierarchical models, missing data, censoring
7. **Model selection:** cross-validation, goodness-of-fit criteria; Bayes factors, model averaging, posterior predictive checks
8. **Machine learning:** high-dimensional models, Dirichlet process, BART, neural networks

**Policy on Academic Integrity:** The University policy on academic integrity is spelled out in Appendix L of the NCSU Code of Student Conduct. For a more details see the NCSU Office of Student Conduct website [http://www.ncsu.edu/student\\_conduct/](http://www.ncsu.edu/student_conduct/). For this course group work on homework is encouraged. However copying someone else's work and calling them your own is plagiarism, so the work you turn in should be your own.

**Students with Disabilities:** Reasonable accommodations will be made for students with verifiable disabilities. In order to take advantage of available accommodations, students must register with Disability Services for Students (DSS), 1900 Student Health Center, CB 7509, 515-7653.

**Tentative schedule:**

Data	Meetings	Assignment	Topic
8/21	MW		Bayes basics
8/28	MW		Priors
9/4	—W		
9/11	MW	H1	Theory
9/18	MW		
9/25	MW		Computing
10/2	MW	H2	
10/9	—W		
10/16	MW		
10/23	MW	DA	Big data
10/30	MW		Models
11/6	MW		
11/13	MW	H3	Model selection
11/20	M—		Machine learning
11/27	MW	P	
12/4	M—		
12/11	M—	F	Final exam (12:00-2:30)