STAT 207, Spring 2026
Homework # 1
Released March 31. Due April 13 on Canvas

Instructions: You may discuss the homework problems in small groups, but you must write up the final solutions and codes yourself. You can either type your work in LaTeX or write down on papers and scan. Please make sure that all handwriting are visible and please combine all pages into a single PDF file (in the correct order).

For any problems that involve coding, you must provide written answers and also include your codes. You can either include your codes at the end of the homework and label which questions they correspond to, or include as part of the answer (e.g., in the R Markdown style). You will receive no credit if you submit only codes or only written answers.

1. BDA3 Problem 2.1
2. BDA3 Problem 2.2
3. BDA3 Problem 2.5
4. BDA3 Problem 2.7
5. BDA3 Problem 2.11
6. Consider a distribution with p.d.f

$$p(x, y) \propto \mathbf{1}(|x - y| < c)\mathbf{1}(x, y \in (0, 1))$$

   (a) Derive a Gibbs sampler to sample from this distribution.
   (b) Implement the Gibbs sampler for 1000 iterations for each of the following: $c = 0.3, c = 0.05$ and $c = 0.01$.
   (c) For each value of the c make a traceplot of x and a scatter plot of (x, y).
   (d) What do you see as c gets smaller?

7. BDA3 Problem 3.1
8. BDA3 Problem 3.4. Also compute the following two quantities for the problem: (1) Posterior probabilities of $p_0 > p_0^{(MLE)}$ and $p_1 > p_1^{(MLE)}$ respectively; (2) Posterior probability of the odds ratio being smaller than 1. Also repeat the problem with the modified sample size so that 34 patients were assigned to each group with 2 died in the control and 1 died in the treatment group.
9. BDA3 Problem 10.4. Hint: show that if $\theta \sim h(\theta)$ and $u \sim Unif[0, 1]$, then $P(\theta < a \mid u < \frac{p^\star(\theta|y)}{Mh(\theta)})$ is the same as the posterior CDF of θ.
10. Let $Y \sim N(\theta, 1)$ and $\theta \sim$ Cauchy$(0, 1)$. Derive the posterior of $\theta|y$ up to a proportional constant. Describe and implement a Metropolis-Hastings sampler to generate posterior draws of $\theta|y$ for $y = 1.5$.