STA 365: Applied Bayesian Statistics

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Week 8B: Bayesian Regression

Bayesian Regression

- Linear regression is the most common statistical model.
- The multiple linear regression model is

$$Y_i \sim \mathrm{N}\left(\beta_0 + \sum_{j=1}^{p} X_{i,j}\beta_j, \sigma^2\right),$$

  for $i = 1, \ldots, n$. Y_i are independently across the n observations.
- Bayesian and classical linear regression are similar if $n >> p$ and the priors are uninformative

Bayesian Regression

- The likelihood remains

$$Y_i \mid \boldsymbol{\beta}, \sigma^2 \sim \mathrm{N}\left(\beta_0 + X_{i,1}\beta_1 + \ldots + X_{i,p}\beta_p, \sigma^2\right)$$

  independent for $i = 1, \ldots, n$ observations.
- A Bayesian analysis also requires priors for $\boldsymbol{\beta}$ and σ.
- We will focus on prior specification since this piece is uniquely Bayeisan.

Bayesian Regression

- For the purpose of setting priors, it is helpful to standardize both the response and each covariate to have mean zero and variance one.
- Many priors for β have been considered:
  - Improper priors
  - Gaussian priors
  - Double exponential priors
  - Many, many more ...

Bayesian Regression

- The standard summary is a table with marginal means and 95% intervals for each β_j.
- This becomes unwieldy for large p
- Picking a subset of covariates is a crucial step in a linear regression analysis
- Common methods include cross-validation and information criteria.