Homework 5
ISyE 6420: Fall 2024

Question 1

Despite advances over the past decade, including the advent of 5-HT_3 receptor antagonists, combination therapy, and multimodal strategies, **post-operative nausea and vomiting** (PONV) remains serious and frequent adverse event associated with surgery and anæsthesia. PONV can be very distressing for patients, can lead to medical complications and impose economic burdens. A meta analysis of several studies give rates of 37% for nausea and 20% for vomiting in patients undergoing general anæsthesia. However, indiscriminate prophylaxis is not recommended (the 'prevent-or-cure' dilemma).

There are considerable variations in the reported incidence of PONV, which can be attributed to a number of factors. Risk factors for PONV can be divided into patient risk factors, procedural risk factors, anæsthetic risk factors and post-operative risk factors. Main and well understood risk factors are gender, history of motion sickness/PONV, smoking status, and duration of anæsthesia.

A data set (courtesy of Dr. Jelena Velickovic, MD anesthesiologist, Belgrade University), is given in `ponv0.odc` or `ponv0.csv`. The `SinclairScore` (propensity to PONV) is to be predicted by variables `Gender` (0-male; 1-female), `Anaesthesiaduration` (duration of anæsthesia in minutes), `Smoking` (smoking status 0-nonsmoker; 1-smoker), and `PONVhist` (history of PONV 0-no; 1-yes) via Bayesian linear regression. Use normal noninformative priors on the beta coefficients and a gamma prior on the precision parameter (reciprocal of variance).

(a) Find the 95% CS for parameter `beta2`, the coefficient for `Anaesthesiaduration`? Does the credible set contain 0? If not, what does it mean?

(b) Find the 95% CS for an individual prediction of `SinclairScore` if `Gender = 1`, `Anaesthesiaduration = 55`, `Smoking=0`, and `PONVhist=1`.

(c) Find the Bayesian R^2.

Question 2

Some colors are more attractive to insects than others. Wilson and Shade (1967)[1] conducted an experiment aimed at determining the best color for attracting cereal leaf beetles (Oulema melanopus). Six boards in each of four selected colors (lemon yellow, white, green, and blue) were placed in a field of oats during summer time. The following table (modified from Wilson and Shade, 1967) gives data on the number of cereal leaf beetles trapped:

Board color	Insects trapped					
Lemon yellow	45	59	48	46	38	47
White	21	12	14	17	13	17
Green	16	11	20	21	14	7
Blue	37	32	15	25	39	41

(a) Use a PPL to conduct ANOVA analysis of the color "treatments." Use STZ constraints.
(b) Based on your output, state your conclusions about the attractiveness of these colors to the beetles.

Question 3

The dataset `iris.csv` gives Fisher's famous Iris dataset after removing one of the three flower species. Answer the following.

1. Fit a frequentist logistic regression on `Species` against the four predictors and show the summary output (estimate of coefficients, standard errors, etc.) if possible. What do you observe? Do you see any problems?

2. Fit a Bayesian logistic regression on `Species` against the four predictors using vague priors (say, $\beta_i \sim N(0, \sigma^2 = 1000)$ for $i = 0, 1, 2, 3, 4$). Provide a summary of the coefficients along with their 95% credible intervals.

3. Re-run the Bayesian LR model with $\beta_i \sim N(0, 1)$ priors. Compare the answers of the 3 parts. Are the Bayesian solutions more meaningful? If so, why?

[01] C. M. Wilson and R. E. Shade (1967). Relative Attractiveness of Various Luminescent Colors to the Cereal Leaf Beetle and the Meadow Spittlebug. Journal of Economic Entomology, 60, 578-580.