STA 303 H1S / 1002 HS – Winter 2012 – Assignment 2

Due: Monday, March 26 at 14:00
No late assignments will be accepted without a valid reason.
Presentation of solutions is important. It particular, it is inappropriate to hand in pages of SAS output without explanation or interpretation. The only SAS output you need to submit with assignments is relevant plots. Quote relevant numbers from your SAS output as part of your solutions. You don't need to hand in your SAS code.

The Data:
The data to be considered in this assignment were first published in the article
C.R. Charig, D.R. Webb, S.R. Payne, and J.E.A. Wickham (1986). Comparison of treatment of renal calculi by open surgery, percutaneous nephrolithotomy, and extracorporeal shockwave lithotripsy. *British Medical Journal* **292**, 879-882.
The authors compared the success rates of different methods of treating kidney stones. We will look at the data comparing open surgery to extracorporeal shockwave lithotripsy (ESWL). Patients were classified into two groups by the size of their kidney stones.

The variables in the dataset are:
• `count` – the number of patients in each category
• `surgery` – the surgical method used to treat the kidney stones (`open` or `ESWL`)
• `size` – whether the kidney stones had a mean diameter < 2cm (`small`) or ≥ 2cm (`large`)
• `outcome` – `success` or `failure`. A surgery was considered successful if the kidney stones were eliminated or reduced in size to less than 2 mm after three months.

The SAS file on the assignment web page
(`http://www.utstat.utoronto.ca/alisong/Teaching/1112/Sta303/assignments.html`)
includes code to read in the data in a suitable format for questions 1 and 3 and code to manipulate it into a suitable format for question 2.
Use SAS to do the analysis for the following questions.

1. *Analysis using contingency tables:*

   (a) Use `proc freq` to construct a 2×2 table of `surgery` by `outcome`. The paper claims that ESWL surgery works better than the traditional open surgery. What numbers from the SAS output support this claim? Based on this output, do you think the paper's claim is reasonable?

   (b) The paper also examines how the surgical methods work for kidney stones of various sizes. Examine the `surgery` and `outcome` relationship separately for each size classification. SAS will do this if you specify a three-dimensional contingency table in `proc freq`, that is
   `tables size*surgery*outcome;`
   How does the evidence for ESWL versus open surgery compare to what you observed and concluded in part (a)?

   (c) These data have been used as an illustration of "Simpson's Paradox". In the article "When Combined Data Reveal the Flaw of Averages" (*The Wall Street Journal*, December 2, 2009, Cari Tuna defines Simpson's Paradox in the following way

Simpson's Paradox reveals that aggregated data can appear to reverse important trends in the numbers being combined.

Her article quotes Harvard statistics professor Xiao-Li Meng who illustrates his point with this example. Explain why the paradox occurred for these data. (*Hint*: Consider whether there are any evidence of lack of randomization in the assignment of surgeries to patients.)

The article is available at
`http://online.wsj.com/article/SB125970744553071829.html`.

2. *Analysis using Logisitic Regression:*
Since we are interested in whether or not a surgery is successful, `outcome` could be considered a response variable for these data and a logistic regression analysis could be carried out to determine the effect of `surgery` and `size` on the odds of the surgery being successful.

   Fit two logistic regression models to these data with both `surgery` and `size` as predictor variables where one model has the interaction between `surgery` and `size` and the other does not.

   (a) Is the coefficient of the interaction term statistically significantly different from 0? How is this consistent with your answers to question 1?

   (b) Which of `surgery` and `size` have coefficients that are statistically significantly different from 0? How is this consistent with your answers to question 1?

   (c) Estimate the odds ratio with their 95% confidence intervals for the odds of having a successful surgery for (1) ESWL versus open surgery and for (2) large versus small kidney stones. Give practical interpretations of these odds ratios and confidence intervals.

3. *Analysis using Poisson Regression:*
Since the data are counts of independent patients, we can use Poisson regression. Fit two models: (1) a model with explanatory variables `outcome`, `surgery`, `size`, the three two-way interactions and the three-way interaction, and (2) a model with the three-way interaction removed. The deviances for these models should coincide with the deviances for the logistic regression models in question 2. For each coincident pair of models:

   (a) Explain how the deviance is calculated.

   (b) Explain in practical terms how the inferences from the Wald tests for the logistic regression models and the corresponding Wald tests for the Poisson regression models agree.

Marking scheme:
Each of the questions is worth 3 marks (for a total of 24). 3 marks will be awarded for complete, correct answers, or answers with only very minor problems. Good answers that are unclear or have some mistakes or are missing some aspects of the solution will be awarded 2 marks. Poor answers that have some value will be awarded one mark. Note that sometimes an answer awarded 3 marks will not be perfect. You should always look at the solutions.