BST 760: Advanced Regression
Breheny

Assignment 5
Due: Tuesday, March 5

1. Show that the updating step of the Newton-Raphson algorithm is equivalent to the updating step of the iteratively reweighted least squares algorithm. In other words, show that if each algorithm starts with the same $\widehat{\boldsymbol{\beta}}^{(m)}$, the next iteration will produce the same $\widehat{\boldsymbol{\beta}}^{(m+1)}$.

2. Write an `R` function (or a SAS macro, if you know how to do so) called `glm.poisson` that can fit GLMs based on the Poisson distribution with canonical link function. To clarify and provide some hints:

   - The function you're writing should have accept arguments (inputs) `X` and `y`, and return the standard estimate/SE/test statistic/p-value output. Specifically, it should look like:

     ```
     glm.poisson <- function(X,y)
       {
         ...
         return(data.frame(Estimate=b,SE=SE,z=z,p=p))
       }
     ```

     where of course you calculate `b`, `SE`, `z`, and `p` in place of the dots.
   - Please turn in the function electronically as well as print out the code. As part of the grading of the problem, I will check to see that the function actually works correctly when applied to a real data set.
   - It would be a good idea to check that your function works by generating an `X` and `y` and running your function (or using real data). You can then check your answers against those given by `glm(...,family=poisson)` or by SAS.

3. The course website contains a data set (`challenger.txt`) which contains information on the first 24 space shuttle launches of the National Aeronautics and Space Administration's Space Shuttle program. Information is recorded on two variables: `Temp`, the outside temperature (in degrees Fahrenheit) at the time of the launch, and `BadRings`, the number of O-rings that showed signs of thermal distress following the launch. An O-ring is a seal that separates the fuel supply from the combustible gases in the rocket's exhaust; if it fails to do so perfectly, it will show signs of thermal distress after the launch. In cold weather, O-rings are less resilient and may be more likely to fail.

   (a) Using logistic regression, model the way in which the probability of an O-ring failure depends on temperature. What is the coefficient for `Temp`?

   (b) Test the null hypothesis that O-ring failures are independent of temperature. Does this seem plausible given the data?

(c) Estimate the odds ratio for O-ring failure with a 10 degree decrease in the launch temperature.

(d) The 25th space shuttle launch, involving the space shuttle *Challenger*, took place on January 27, 1986. Seventy-three seconds into the flight, the fuel mixed with the rocket exhaust, resulting in an explosion which destroyed the shuttle and killed all seven astronauts on board. The launch temperature that day was 31 degrees. Based on data from the first 24 launches, estimate the probability of a O-ring failure on the *Challenger* flight.

(e) Provide a confidence interval for the probability in part (d).