Assignment 8

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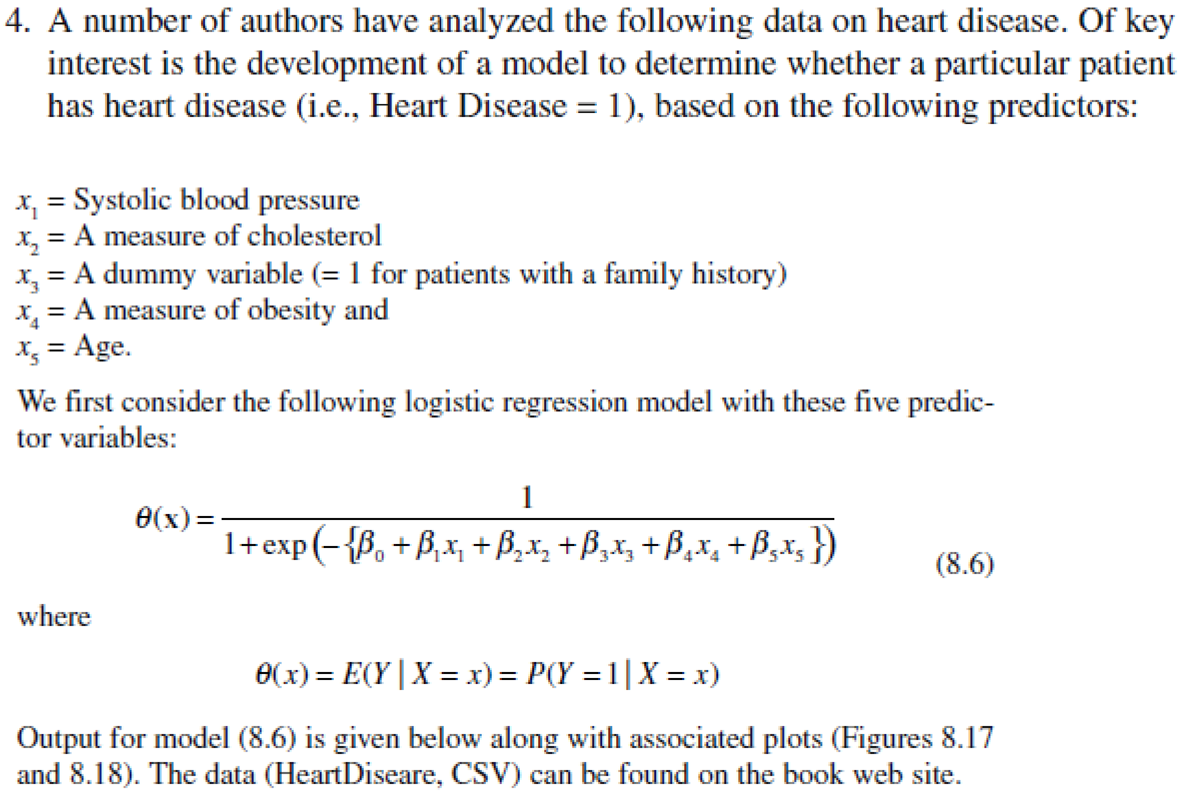
STAT 757 Applied Regression Analysis

Instructions [20 points]

Modify this file to provide responses to the Ch.8 Exercises in @sheather2009. You can find some helpful code here: http://www.stat. tamu.edu/~sheather/book/docs/rcode/Chapter8.R. Also address the project milestones indicated below. Please email **both** your .Rmd (or roxygen .R) and one of the following either .HTML, .PDF, or .DOCX using the format SURNAME-FIRSTNAME-Assignment8.Rmd and SURNAME-FIRSTNAME-Assignment8.pdf.

Exercise 8.3.4 [60 points]



4. A number of authors have analyzed the following data on heart disease. Of key interest is the development of a model to determine whether a particular patient has heart disease (i.e., Heart Disease = 1), based on the following predictors:

x_1 = Systolic blood pressure
x_2 = A measure of cholesterol
x_3 = A dummy variable (= 1 for patients with a family history)
x_4 = A measure of obesity and
x_5 = Age.

We first consider the following logistic regression model with these five predictor variables:

$$\theta(\mathbf{x}) = \frac{1}{1+\exp\left(-\{\beta_0+\beta_1x_1+\beta_2x_2+\beta_3x_3+\beta_4x_4+\beta_5x_5\}\right)} \qquad (8.6)$$

where

$$\theta(x) = E(Y \mid X = x) = P(Y = 1 \mid X = x)$$

Output for model (8.6) is given below along with associated plots (Figures 8.17 and 8.18). The data (HeartDiseare, CSV) can be found on the book web site.

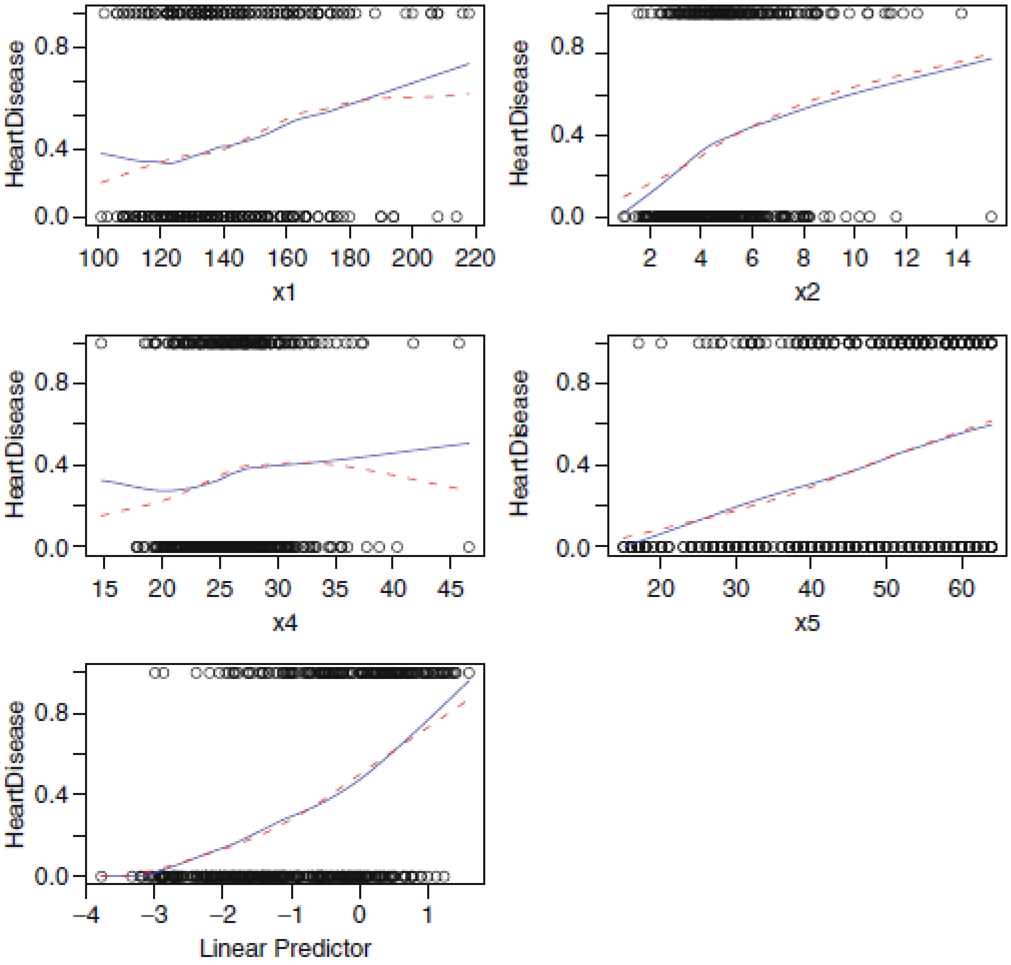
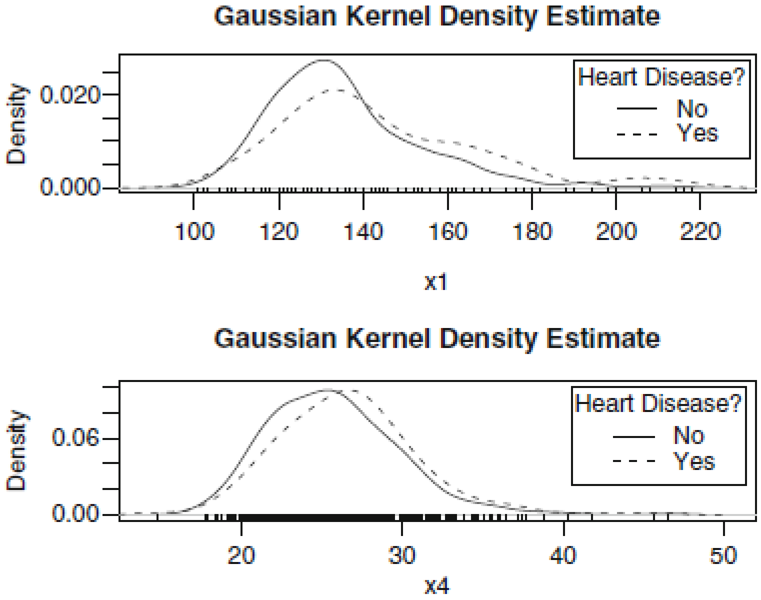


Figure 8.17 Marginal model plots for model (8.6)



Gaussian Kernel Density Estimate

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Figure 8.18 Kernel density estimates of x_1 and x_4

(a) Is model (8.6) a valid model for the data? Give reasons to support your answer.

(b) What extra predictor term or terms would you recommend be added to model (8.6) in order to improve it. Please give reasons to support each extra term.

(c) Following your advice in (b), extra predictor terms were added to model (8.6) to form model (8.7). We shall denote these extra predictors as $f_1(x_1)$ and $f_2(x_4)$ (so as not to give away the answer to (b)). Marginal model plots from model (8.7) are shown in Figure 8.19. Is model (8.7) a valid model for the data? Give reasons to support your answer.

(d) Interpret the estimated coefficient of x_3 in model (8.7).

Output from R for model (8.6)

```
Call:
glm(formula = HeartDisease ~ x1 + x2 + x3 + x4 + x5, family =
binomial(), data = HeartDisease)
Coefficients:
                 Estimate   Std. Error   z value    Pr(>|z|)
(Intercept) -4.313426     0.943928     -4.570    4.89e-06    ***
x1           0.006435     0.005503      1.169     0.24223
x2           0.186163     0.056325      3.305     0.00095    ***
x3           0.903863     0.221009      4.090    4.32e-05
x4          -0.035640     0.028833     -1.236     0.21643
x5           0.052780     0.009512      5.549    2.88e-08    ***
(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 596.11 on 461 degrees of freedom
Residual deviance: 493.62 on 456 degrees of freedom
AIC: 505.62
Number of Fisher Scoring iterations: 4
```

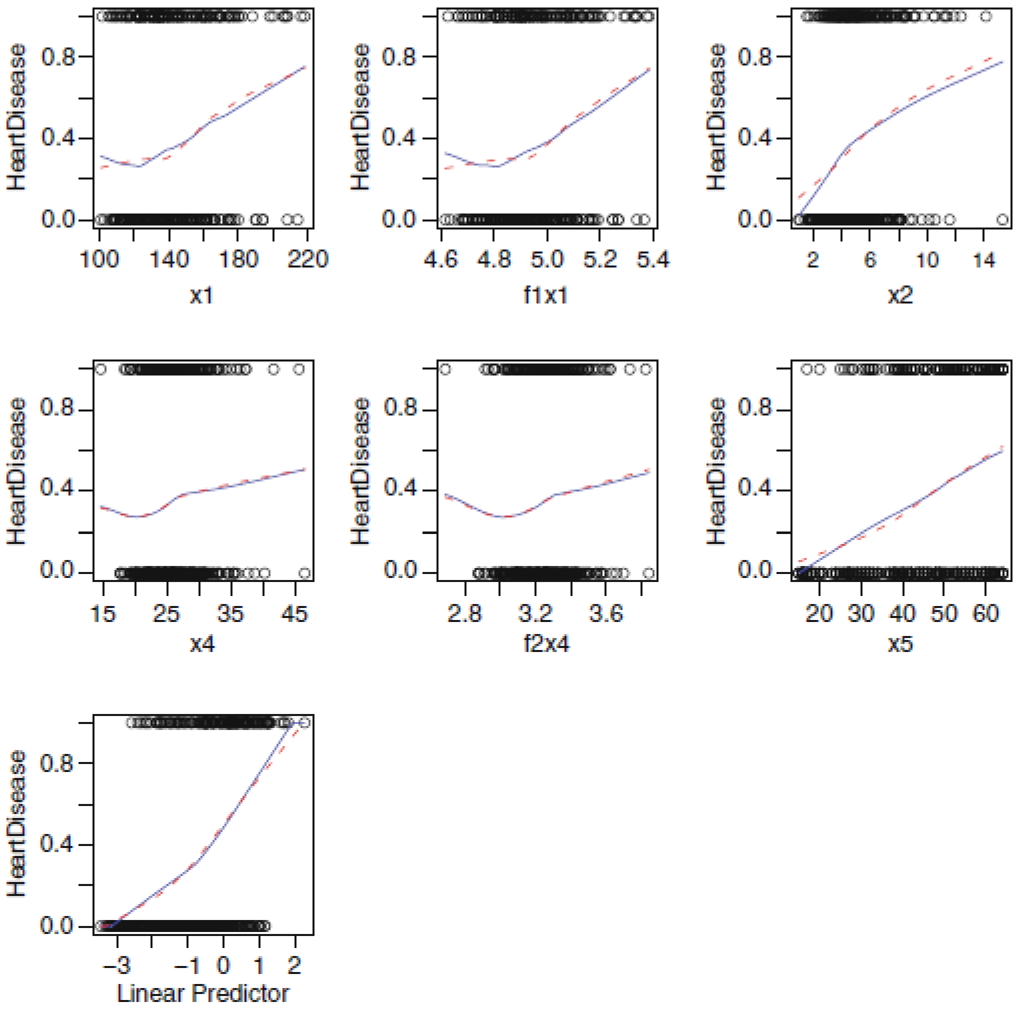
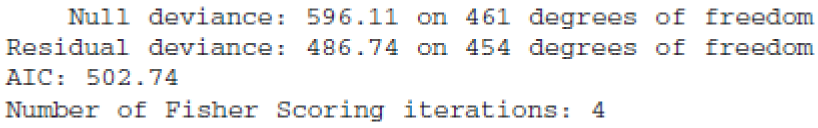


Figure 8.19 Marginal model plots for model (8.7)

Output from R for model (8.7)

```
Call:
glm(formula = HeartDisease ~ x1 + f1x1 + x2 + x3 + x4 + f2x4 +
x5, family = binomial(), data = HeartDisease)
Coefficients:
                Estimate   Std. Error  z value    Pr(>|z|)
(Intercept)    75.204768    33.830217    2.223    0.026215   *
x1              0.096894     0.052664    1.840    0.065792   .
f1x1          -13.426632     7.778559   -1.726    0.084328   .
x2              0.201285     0.057220    3.518    0.000435   ***
x3              0.941056     0.224274    4.196    2.72e-05   ***
x4              0.384608     0.208016    1.849    0.064467   .
f2x4          -11.443233     5.706058   -2.005    0.044915   *
x5              0.056111     0.009675    5.800    6.64e-09   ***
(Dispersion parameter for binomial family taken to be 1)
```



```
    Null deviance: 596.11  on 461  degrees of freedom
Residual deviance: 486.74  on 454  degrees of freedom
AIC: 502.74

Number of Fisher Scoring iterations: 4
```

Ans: a)

When we observe the model 8.6 from the plots, we see that: 1) the plot of HeartDisease Vs x1 and HeartDisease Vs x4 are not adequately fit, and 2) The variates x1 and x4 can be observed to be skewed from the Gaussian Kernel Density estimate plot. Hence, we need to address these issues in the current model.

Therefore, we could say that the model is not valid.

b) Ans:

As already mentioned from a, systolic blood pressure and obesity are skewed in our dataset. Thus we shall add log(x1) and log(x4) in our model.

c) Ans:

After the addition of the new variables in the model, we observe that the marginal model plots of HeartDisease vs x1 and x4 have improved and are not much accurately fit. Also, the log(x1) and log(x4) are also accurately fit with each their corresponding marginals. Apart from these, all other variable are fit. Also, Linear predictor is also fit properly. Hence, we can say that this model is valid. Going a step further, we could infact analyse the interaction term between x1 and x4. ALso we could perform analysis of deviance to remove redundant term(x1 and logx1) and improve the model.

d) Ans:

The coefficient of x3 is 0.941 in model 8.7. It can be interpreted as, the patients with family history of heart disease is e(0.941)=2.563 times more prone to heart disease compared to those patients with no history of heart disease in their family.

Project milestones [20 points]

Done with Dhurba Neupane.