Assignment 2 ST466

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02:49:56 PM 27 March, 2020

```
library(dplyr)
```

```
##
## Attaching package: 'dplyr'
```

```
## The following objects are masked from 'package:stats':
##
##     filter, lag
```

```
## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```
library(GGally)
```

```
## Loading required package: ggplot2
```

```
## Registered S3 method overwritten by 'GGally':
##   method from
##   +.gg   ggplot2
```

```
##
## Attaching package: 'GGally'
```

```
## The following object is masked from 'package:dplyr':
##
##     nasa
```

```
intensity <- c(0.0,0.5,1.0,1.5,2.0,2.5,3.0,3.5,4.0)
m <- c(40,40,40,40,40,40,40,40,40)
Y <- c(2,4,6,6,10,15,25,27,33)
current.data <- data.frame(intensity,m,Y)
current.data$p_yes <- current.data$Y/current.data$m
current.data$odds <- current.data$p_yes/(1-current.data$p_yes)
current.data$log_odds <- log(current.data$odds)
current.data$diff <- current.data$m - current.data$Y
current.data
```

```
##   intensity  m  Y p_yes       odds   log_odds diff
## 1       0.0 40  2 0.050 0.05263158 -2.9444390   38
## 2       0.5 40  4 0.100 0.11111111 -2.1972246   36
## 3       1.0 40  6 0.150 0.17647059 -1.7346011   34
## 4       1.5 40  6 0.150 0.17647059 -1.7346011   34
## 5       2.0 40 10 0.250 0.33333333 -1.0986123   30
## 6       2.5 40 15 0.375 0.60000000 -0.5108256   25
## 7       3.0 40 25 0.625 1.66666667  0.5108256   15
## 8       3.5 40 27 0.675 2.07692308  0.7308875   13
```

```
## 9       4.0 40 33 0.825 4.71428571  1.5505974    7
```

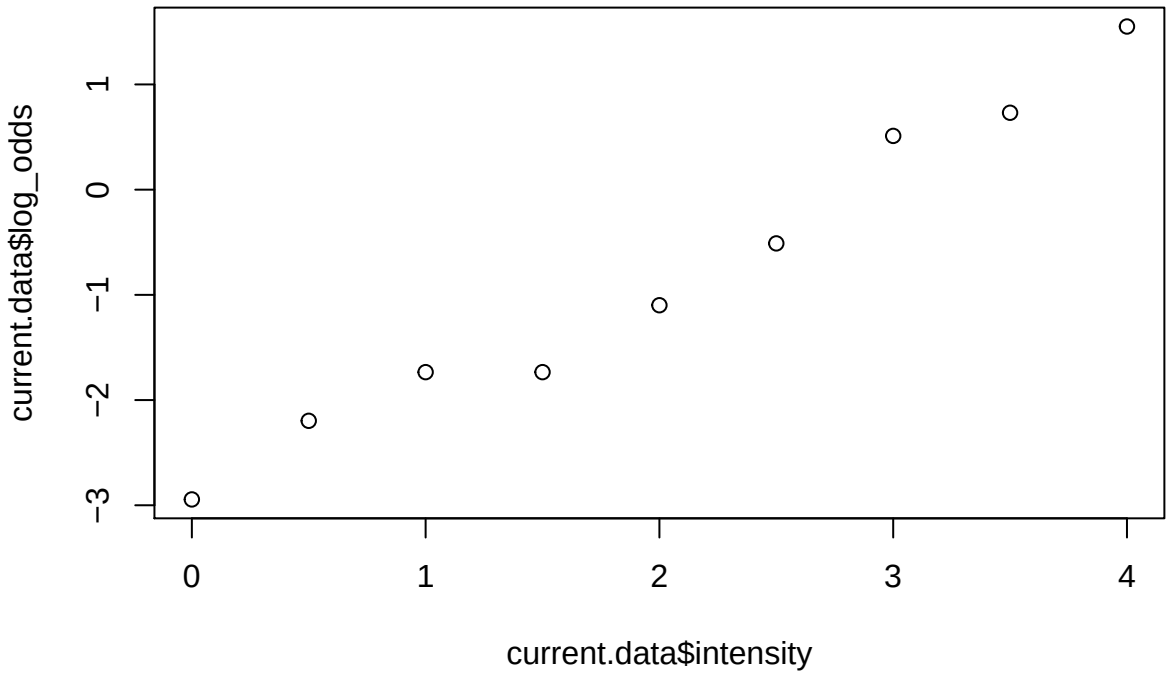
##Q1 ##(a) It was decided that a logistic regression model with intensity as the predictor would be appropriate for these data. Specify the model algebraically and explain your notation. Justify this choice of model over a simple linear regression model.

```
## logit(pi) = log(pi/1-pi) = B0 + B1X
## B0 is intercept
## B1 is slope
## X is intensity
## pi is probablity of success for mouth movement
## Y ~ binomial, # success out of n trials
## Y ~ B(pi,n)
## pi = Y/n

## The response is binomial variable which can be better explained by the logistic regression where as
```

##(b) Using the raw data construct an appropriate graph to justify the assumed relationship (under this model) between the log odds of mouth movement and intensity.

```
plot(current.data$log_odds ~ current.data$intensity)
```



##(c) Fit the logistic regression model using R. Provide the logistic regression equation based on the model output.

```
glm_data <- current.data %>% mutate(failure = m - Y) %>% select(Y,failure)%>% as.matrix()
fit_logreg <- glm(glm_data ~ intensity ,data = current.data,family = binomial())
summary(fit_logreg)
```

```
##
## Call:
## glm(formula = glm_data ~ intensity, family = binomial(), data = current.data)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
```

```
## -0.7099  -0.6231   0.2283   0.5643   0.7993
##
## Coefficients:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept)   -3.114      0.333  -9.353   <2e-16 ***
## intensity      1.122      0.125   8.979   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 120.6862  on 8  degrees of freedom
## Residual deviance:   2.9689  on 7  degrees of freedom
## AIC: 39.374
##
## Number of Fisher Scoring iterations: 4
```

fitted model-

fitted model:- intercept = -3.114 slope = 1.122 log(pi/1-pi) = -3.114 +1.122intensity

(d) Provide an interpretation of the intensity coefficient. Use a Wald test to determine if the intensity coefficient is significant.

```
## Interpretation:-
## coef of intensity:- 1.122
## by increasing intensity by one unit changes the odds of mouth movement by a factor of 3.071
## B1 = 1.122
## sd error:- 0.125
## wald test
## Ho: B1 = 0
## Ha: B1 != 0
wald_test <- 1.122/0.125
wald_test
```

```
## [1] 8.976
```

since test statistics is greater than 1.96 so we reject the null hypothesis and conclude that the term intensity is significant.

(e) Use a likelihood ratio test to test the hypothesis that the odds of mouth movement is independent of intensity. State the null and alternative hypothesis. Provide the test statistic for the hypothesis test.Provide the critical value under the null hypothesis. Provide justification for the conclusions of your test.

```
## Ho: odds of mouth movement is independent of intensity(B1 = 0)
## Ha: odds of mouth movement and intensity are dependent (B1 != 0)
## degrees of freedom = 1.
## 95% significant level critical value = 3.84
## 99% significant level critical value = 6.634
```

```
## the test stats = 120.686 - 2.969
                ##  = 117.72
## the statistics is greter then the critical value under Ho so we reject and we can say B1 != 0
```

(f) Produce an appropriate plot to assess if the model is doing a good job of capturing the observed relationship between the proportion of mouth movement and intensity.

```
fit0 <- glm(Y ~ 1, data = current.data)
fit0
```

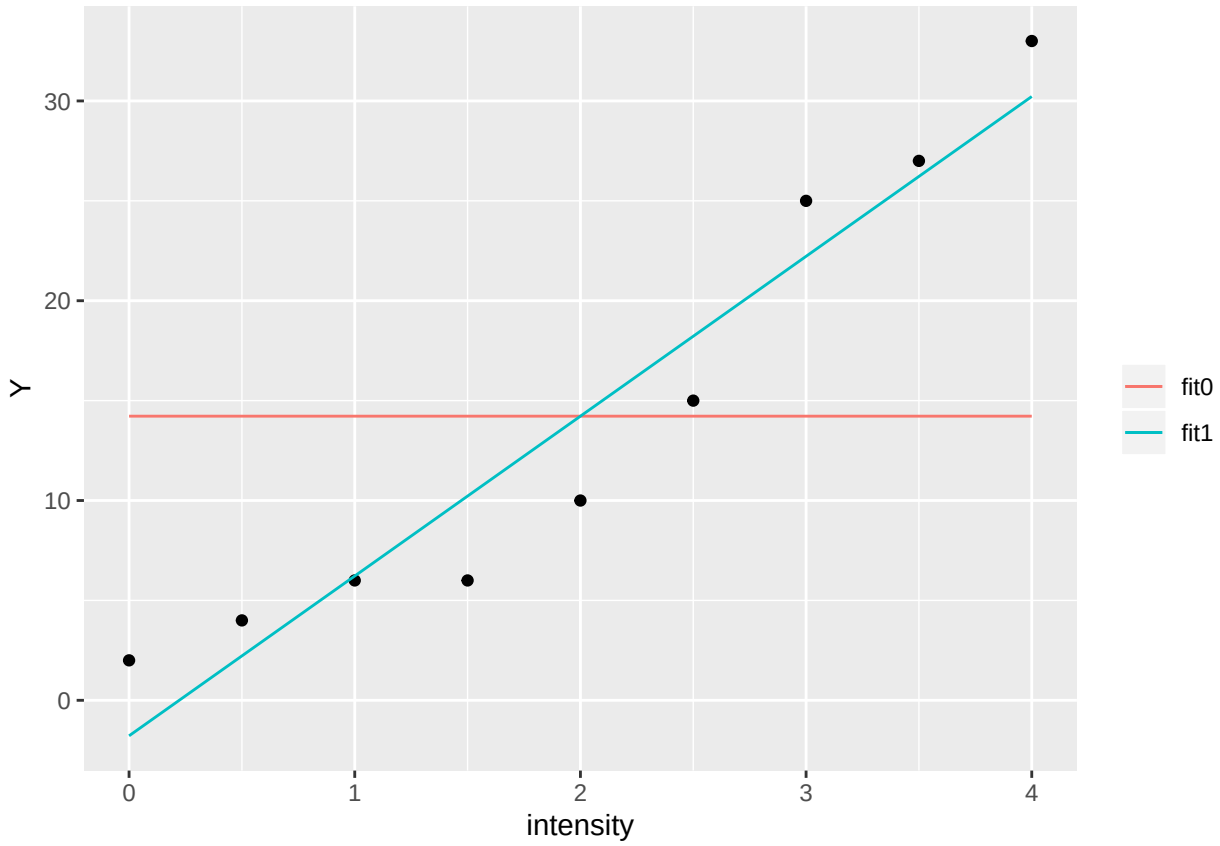
```
##
## Call:  glm(formula = Y ~ 1, data = current.data)
##
## Coefficients:
## (Intercept)
##       14.22
##
## Degrees of Freedom: 8 Total (i.e. Null);  8 Residual
## Null Deviance:       1040
## Residual Deviance: 1040  AIC: 72.28
```

```
fit1 <- glm(Y ~ intensity, data = current.data)
fit1
```

```
##
## Call:  glm(formula = Y ~ intensity, data = current.data)
##
## Coefficients:
## (Intercept)    intensity
##      -1.778        8.000
##
## Degrees of Freedom: 8 Total (i.e. Null);  7 Residual
## Null Deviance:       1040
## Residual Deviance: 79.56     AIC: 51.15
```

```
current_res <- current.data %>%
mutate(pred_fit0 = predict(fit0, type = "response"),
pred_fit1 = predict(fit1, type = "response"))

ggplot(current_res, aes(x = intensity, y = Y)) +
geom_point()+
geom_line(aes(x = intensity, pred_fit0, colour = "fit0")) +
geom_line(aes(x = intensity, pred_fit1, colour = "fit1")) +
labs(colour = "")
```


30
20
10
0
Y
0
1
2
3
4
intensity
fit0
fit1