

# Homework 9 - Logistic Regression Stats 230

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date

**PROBLEMS TO TURN IN: #9.4, #9.6, #9.19, #9.22**

**Exercise 9.4**

$$odds = \frac{Probability}{1 - Probability}$$

9.4 part a:

SOLUTION:  $odds = 0.8/(1-0.8) = 4 = 4:1$

9.4 part b:

SOLUTION:  $odds = 0.25/(1-0.25) = 1/3 = 1:3$

9.4 part c:

SOLUTION:  $odds = 0.6/(1-0.6) = 3/2 = 3:2$

**Exercise 9.6**

$$Probability = \frac{odds}{1 + odds}$$

9.6 part a:

SOLUTION:  $Probability = (1/3)/(4/3) = 1/4 = 0.25$

9.7 part b:

SOLUTION:  $Probability = (5/2)/(7/2) = 5/7$

9.8 part c:

SOLUTION:  $Probability = (1/9)/(10/9) = 1/10 = 0.10$

```
data("MedGPA")
summary(MedGPA)
```

### Exercise 9.19

```
## Accept Acceptance Sex BCPM GPA VR
## A:30 Min. :0.000 F:28 Min. :2.41 Min. :2.72 Min. : 6.00
## D:25 1st Qu.:0.000 M:27 1st Qu.:3.26 1st Qu.:3.38 1st Qu.: 8.00
## Median :1.000 Median :3.53 Median :3.58 Median :10.00
## Mean :0.545 Mean :3.50 Mean :3.55 Mean : 9.76
## 3rd Qu.:1.000 3rd Qu.:3.75 3rd Qu.:3.77 3rd Qu.:11.00
## Max. :1.000 Max. :4.00 Max. :3.97 Max. :13.00
##
## PS WS BS MCAT Apps
## Min. : 5.00 Min. : 4.00 Min. : 6.00 Min. :18.0 Min. : 1.00
## 1st Qu.: 9.00 1st Qu.: 6.00 1st Qu.: 9.00 1st Qu.:34.0 1st Qu.: 5.00
## Median :10.00 Median : 8.00 Median :10.00 Median :36.0 Median : 7.00
## Mean : 9.71 Mean : 7.15 Mean : 9.78 Mean :36.3 Mean : 8.36
## 3rd Qu.:10.50 3rd Qu.: 8.00 3rd Qu.:11.00 3rd Qu.:39.0 3rd Qu.:11.00
## Max. :14.00 Max. :10.00 Max. :14.00 Max. :48.0 Max. :24.00
## NA's :1
```

9.19 part a:

```
model <- glm(Acceptance ~ MCAT, data = MedGPA, family = binomial(logit))
msummary(model)
```

```
## Coefficients:
## Estimate Std. Error z value Pr(>|z|)
## (Intercept) -8.7125 3.2365 -2.69 0.0071 **
## MCAT 0.2460 0.0894 2.75 0.0059 **
##
## (Dispersion parameter for binomial family taken to be 1)
##
## Null deviance: 75.791 on 54 degrees of freedom
## Residual deviance: 64.697 on 53 degrees of freedom
## AIC: 68.7
##
## Number of Fisher Scoring iterations: 4
```

SOLUTION:

$$\text{logit}(P(\text{Accept})) = -8.7125 + 0.2460(\text{MCAT})$$

$$P(\text{Accept}) = \frac{e^{-8.7125+0.2460(\text{MCAT})}}{1 + e^{-8.7125+0.2460(\text{MCAT})}}$$

9.19 part b:

SOLUTION:  $e^{0.2460} = 1.2789$  (rounded to 4 dp) The odds of acceptance are 1.2789 times higher for per unit increase in the MCAT score.

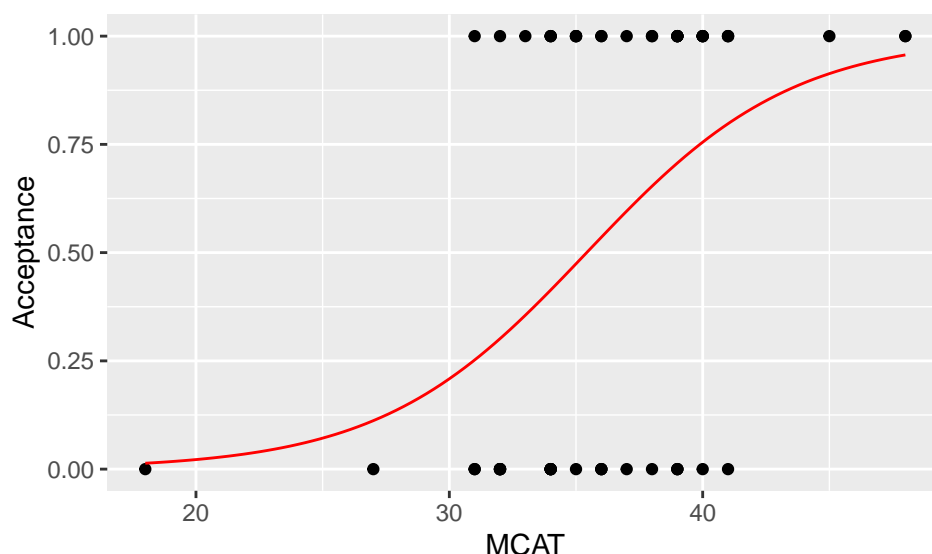
9.19 part c:

SOLUTION:  $P(\text{Accept}) = \hat{\pi}(\text{MCAT} = 40) = \frac{e^{-8.7125+0.2460(40)}}{1+e^{-8.7125+0.2460(40)}} = 0.7554$  (rounded to 4 dp) The estimated model indicates that the probability that a student with MCAT = 40 is accepted to medical school is around 0.7554.

9.19 part d:

SOLUTION: A student has around a 50-50 chance of being accepted to medical school for an MCAT score of approximately 35.

```
myfun <- makeFun(model)
gf_point(Acceptance ~ MCAT, data = MedGPA) %>%
  gf_fun(myfun(MCAT = x) ~ x, color = "red")
```



## Exercise 9.22

9.22 part a:

SOLUTION:  $\widehat{odds}(MMSE = -4) = e^{-0.742-0.294(-4)} = 1.5434$  (rounded to 4 dp) The estimated odds of Alzheimer's disease for a patient with MMSE of -4 is 1.5434:1.

9.22 part b:

SOLUTION:  $\hat{\pi}(MMSE = -4) = \frac{e^{-0.742-0.294(-4)}}{1+e^{-0.742-0.294(-4)}} = 0.6068$  (rounded to 4 dp) The estimated probability of Alzheimer's disease for a patient with MMSE of -4 is 0.6068.

9.22 part c:

SOLUTION:  $\widehat{odds}(MMSE = -3) - \widehat{odds}(MMSE = -4) = e^{-0.742-0.294(-3)} - e^{-0.742-0.294(-4)} = -0.3931$  (rounded to 4 dp) If the MMSE changes from -4 to -3, then the estimated odds of Alzheimer's disease for a patient decreases by 0.3931 on average.

9.22 part d:

SOLUTION:  $\hat{\pi}(MMSE = -3) - \hat{\pi}(MMSE = -4) = \frac{e^{-0.742-0.294(-3)}}{1+e^{-0.742-0.294(-3)}} - \frac{e^{-0.742-0.294(-4)}}{1+e^{-0.742-0.294(-4)}} = -0.0719$   
(rounded to 4 dp) If the MMSE changes from -4 to -3, then the estimated probability of Alzheimer's disease for a patient decreases by 0.0719 on average.