R Notebook

On January 28, 1986, a routine launch was anticipated for the Challenger space shuttle. Seventy-three seconds into the flight, disaster happened: the shuttle broke apart, killing all seven crew members on board. An investigation into the cause of the disaster focused on a critical seal called an O-ring, and it is believed that damage to O-rings during shuttle launches may have been related to the ambient temperature at the time of the launch. Using data from 24 shuttle missions, we fit a simple logistic regression model. Here, Temperature is the temperature in Fahrenheit at launch time and the response variable, Failure, is an indicator of O-rings failures (Failure = 1 if there was at least O-ring that failed. Here is a summary of the logistic regression model fit to these data:

```
Estimate Std. Error z value Pr(> |z|)
```

(Intercept) 10.88 5.70 1.91 0.06 Temperature -0.17 0.08 -2.05 0.04

1. Find a 90% confidence interval and a 95% confidence interval for the coefficient on Temperature. Which one of the intervals is wider? Can you provide some intuition on why?

```r
estimate <- -0.17
zval_90 <- qnorm(0.95) # 90% two-tailed confidence interval
zval_95 <- qnorm(0.975)
stdError <- 0.08

confLower_90 <- estimate - zval_90*0.08
confUpper_90 <- estimate + zval_90*0.08

confLower_95 <- estimate - zval_95*0.08
confUpper_95 <- estimate + zval_95*0.08

print(paste('90%:', confLower_90, confUpper_90))
```

```
## [1] "90%: -0.301588290156118 -0.0384117098438823"
```

```r
print(paste('95%:', confLower_95, confUpper_95))
```

```
## [1] "95%: -0.326797118763204 -0.0132028812367957"
```

The 95% confidence interval is wider because we are casting a larger statistical net. We are saying "We are 95% confident the paramenter of interest is in this range" VS 90% confident. As we become more confident, we increase the range.

2. In the context of the problem, interpret the 90% confidence interval you found in question 1, on the log-odds scale.

```r
logodds_lower <- exp(confLower_90)
logodds_Upper <- exp(confUpper_90)
print(paste('log odds',logodds_lower,logodds_Upper ))
```

```
## [1] "log odds 0.739642520318152 0.962316664077732"
```

Here we would still reject the null hypothesis that the estimate of temperature is different than zero.

3. Find a 90% confidence interval for the effect of a one-degree increase in temperature on the odds of O-ring failure and interpret your result.

```r
#Exp of the estimate value to find the odds odds
change <- exp(-0.17)

conflower_90 <- change - zval_90*0.08
confupper_90 <- change + zval_90*0.08

print(paste('90%:', conflower_90, confupper_90))
```

```
## [1] "90%: 0.712076526440266 0.975253106752501"
```

We are 90% confident that the effect of a one-degree increase of temperature on the odds of o-ring failure will be between 71.2% and 97.5%

4. Find the probability of O-ring failure when the ambient temperature is 52 ∘ F and when the ambient temperature is 72 ∘ F. Which temperature seems more favorable for a successful launch?

```r
probFail_52 = exp(10.88 -0.17*52)

probFail_72 = exp(10.88 -0.17*72)

print(paste('failure probability for 52 and 72 degrees F:', probFail_52, probFail_72))
```

```
## [1] "failure probability for 52 and 72 degrees F: 7.69060919887901 0.256660776953556"
```

The probability of failure at 52 degrees F is over 1, therefore is much less favorable than the 26% of 72 degrees F.

5. Can you find the coldest temperature so that the probability of O-ring failure is less than 10%?

```r
for (i in 60:100){

  val = exp(10.88 -0.17*i)
  print(paste('Temp, Percent:', i, round(val,3)))
}
```

```
## [1] "Temp, Percent: 60 1.974"
## [1] "Temp, Percent: 61 1.665"
## [1] "Temp, Percent: 62 1.405"
## [1] "Temp, Percent: 63 1.185"
## [1] "Temp, Percent: 64 1"
## [1] "Temp, Percent: 65 0.844"
## [1] "Temp, Percent: 66 0.712"
## [1] "Temp, Percent: 67 0.6"
## [1] "Temp, Percent: 68 0.507"
## [1] "Temp, Percent: 69 0.427"
## [1] "Temp, Percent: 70 0.361"
## [1] "Temp, Percent: 71 0.304"
## [1] "Temp, Percent: 72 0.257"
## [1] "Temp, Percent: 73 0.217"
## [1] "Temp, Percent: 74 0.183"
## [1] "Temp, Percent: 75 0.154"
## [1] "Temp, Percent: 76 0.13"
## [1] "Temp, Percent: 77 0.11"
## [1] "Temp, Percent: 78 0.093"
## [1] "Temp, Percent: 79 0.078"
## [1] "Temp, Percent: 80 0.066"
## [1] "Temp, Percent: 81 0.056"
## [1] "Temp, Percent: 82 0.047"
## [1] "Temp, Percent: 83 0.04"
## [1] "Temp, Percent: 84 0.033"
## [1] "Temp, Percent: 85 0.028"
## [1] "Temp, Percent: 86 0.024"
## [1] "Temp, Percent: 87 0.02"
## [1] "Temp, Percent: 88 0.017"
## [1] "Temp, Percent: 89 0.014"
## [1] "Temp, Percent: 90 0.012"
## [1] "Temp, Percent: 91 0.01"
## [1] "Temp, Percent: 92 0.009"
## [1] "Temp, Percent: 93 0.007"
## [1] "Temp, Percent: 94 0.006"
## [1] "Temp, Percent: 95 0.005"
## [1] "Temp, Percent: 96 0.004"
## [1] "Temp, Percent: 97 0.004"
## [1] "Temp, Percent: 98 0.003"
## [1] "Temp, Percent: 99 0.003"
## [1] "Temp, Percent: 100 0.002"
```

```
#print(paste('failure probability for 52 and 72 degrees F:', probFail_52, probFail_72))
```

The first temperature with less than 10% failure rate is 78 degrees F