Quiz #3

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1

For the 23 space shuttle flights before the Challenger mission disaster in 1986, the data set Oring.csv shows the temperature (∘ F) at the time of the flight and whether at least one primary O-ring suffered thermal distress.

```
oring <- read.csv("~/Downloads/Oring.csv")
head(oring) %>% tidy %>% kable
```

```
## Warning: 'tidy.data.frame' is deprecated.
## See help("Deprecated")
```

column	n	mean	sd	median	trimmed	mad	min	max	range	skew	kurtosis
Flight	6	3.5000000	1.8708287	3.5	3.5000000	1.5	1	6	5	0.0000000	1.731429
Tempeature	6	68.6666667	2.1602469	68.5	68.6666667	1.5	66	72	6	0.3380617	2.040000
TD	6	0.1666667	0.4082483	0.0	0.1666667	0.0	0	1	1	1.7888544	4.200000

a

Use logistic regression to model the effect of temperature on the probability of thermal distress. Interpret the effect.

```
oring.lrm <- glm(TD ~ Tempeature, family = "binomial", data = oring)
tidy(oring.lrm)
```

```
## # A tibble: 2 x 5
##   term        estimate std.error statistic p.value
##   <chr>          <dbl>     <dbl>     <dbl>   <dbl>
## 1 (Intercept)   15.0       7.38       2.04  0.0415
## 2 Tempeature    -0.232     0.108     -2.14  0.0320
```

There is moderate evidence that temperature is associated with thermal distress (Two-Tailed Wald Logistic Regression on a Single Variable. p-value = 0.032).

b

Estimate the probability of thermal distress at 31 ∘ F , the temperature at the time of the Challenger flight.

The estimated logit of failure probablitiy is 1.7164. The estimated failure probability is 0.9962.

```
eta <- predict(oring.lrm, newdata = data.frame(Tempeature=c(31)))
est.logit <- log(eta)
est.prob <- exp(eta) / (1 + exp(eta))

est.logit
```

```
##        1
## 2.059986
```

```r
est.prob
```

```
##         1
## 0.9996088
```

c

At what temperature does the estimated probability equal 0.50? At that temperature, give a linear approximation for the change in the estimated probability per degree increase in temperature. Use $\hat{\beta}_1\pi(1-\pi)$ for the second part of this problem.

$\hat{y} = 15.0429 - 0.2322 \times Temperature$

$logit(0.50) = 15.0429 - 0.2322 \times Temperature$

$\rightarrow logit(0.50 = log(0.5/0.5) = log(1) = 0$

$\rightarrow 0 = 15.0429 - 0.2322 \times Temperature \rightarrow Temperature = \frac{15.0429}{0.2322} = 64.7842$

Linear Approximation

$0.5 \times 0.5 \times -0.2322 = -0.0581$

d

Interpret the effect of temperature on the odds of thermal distress.

For every 1 degree increase in temperature, the odds of thermal distress vs non-thermal distress decrease by 0.0581.

e

Test the hypothesis that temperature has no effect using the Wald test and using the drop-in-deviance test.

There is convincing evidence that temperature has no effect on O-ring failure (Drop-in-deviance Test. p-value = 0.167).

There is moderate evidence that temperature has an effect on O-ring failure (Two-Tailed Wald Logistic Regression on a Single Variable. p-value = 0.032).

Given that the drop-in-deviance test more powerful than the Wald Test, the conclusions from the Drop-in-Deviance test are preferred.

```r
# Drop in Deviance Test
1 - pchisq(oring.lrm$null.deviance, oring.lrm$df.null)
```

```
## [1] 0.1669956
```