Homework 8

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Problem 1

```
##              Estimate Std. Error  z value     Pr(>|z|)
## (Intercept) 1.4880771  0.1702530 8.740387 2.323123e-18
## x           0.5877867  0.1763832 3.332441 8.608783e-04
## z           0.2295744  0.1701455 1.349283 1.772460e-01
```

The effect of treatment type is significant and it is about $e^{0.59} = 1.80$ times in treatment B as in treatment A when fixing thickness of coating.

However, thickness of coating does not have a significant effect on imperfection rates.

Problem 2

(a)

```
##               Estimate Std. Error   z value   Pr(>|z|)
## (Intercept) 13.8504290  7.5086497  1.844597 0.06509626
## Temp        -0.2158586  0.1093794 -1.973484 0.04844044
```

The coefficient of temperature is negative, which means probability of primary O-ring suffered thermal distress decreases when temperature goes up.

(b)

$$\frac{exp(-0.22 * 31 + 13.85)}{1 + exp(-0.22 * 31 + 13.85)} = 0.999.$$

(c)

$$Temp = \frac{13.85}{0.22} = 64.15$$

It is asking the derivative of $\pi(x)$ and the result is $0.25\hat{\beta} = -0.05$.

(d)

The odds ratio is $\hat{\theta} = exp(-0.22) = 0.81$. So the odds of O-ring failure decreases by about 20% when temperature rises 1 degree.

(e)

```
## Likelihood ratio test
##
## Model 1: TD ~ Temp
## Model 2: TD ~ 1
##   #Df  LogLik Df  Chisq Pr(>Chisq)
## 1   2 -10.022
## 2   1 -13.201 -1 6.3592    0.01168 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

The code above shows that likelihood-ratio test. Wald test is show in (a). According to these two tests, effect of temperature is significant.

Problem 3

(a)

The odds ratio is $\hat{\theta} = exp(0.0532) = 1.055$. So the odds of possessing a credit card is 5.5% higher when income increases by 1 unit.

(b)

We are going to test $Income = 0$. The test statistics is

$$\hat{\beta}/SE = 0.0532/0.0131 = 4.061.$$

with the p-value $p = 2.442427 * 10^{-5}$.

Therefore, the income effect is significant.

(c)

$CI = \hat{\beta} \pm z_{\alpha/2} SE = 0.0532 \pm 1.96 * 0.0131 = (0.0275, 0.0789)$.

Problem 4

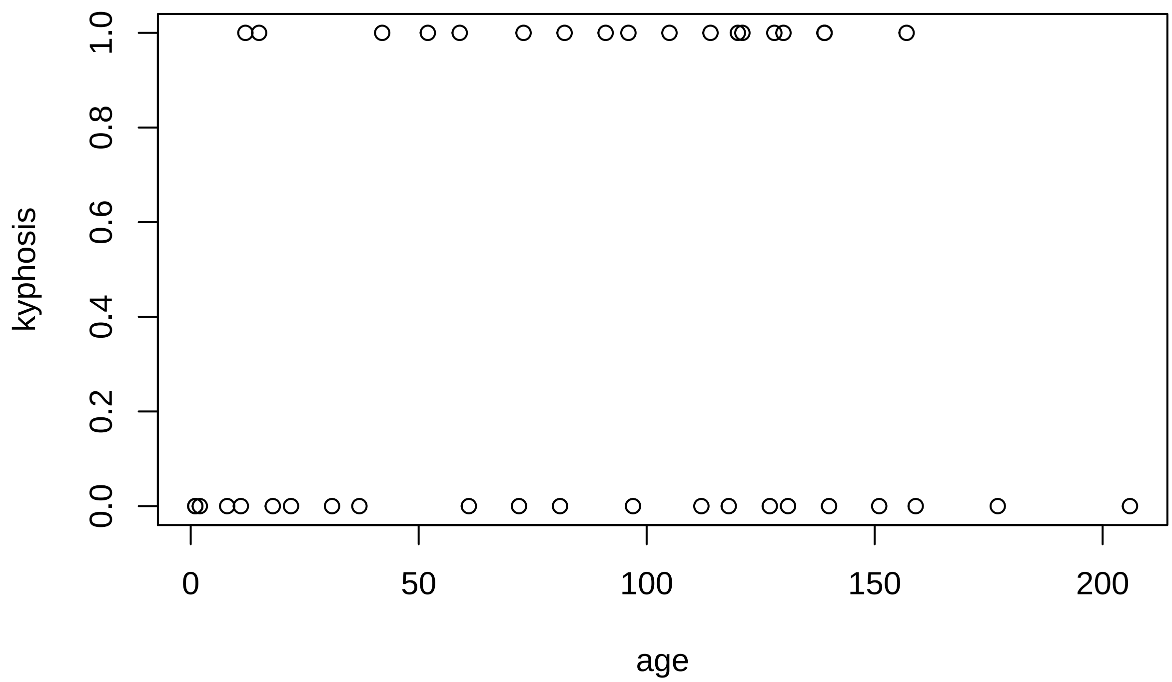
(a)

```
##                 Estimate Std. Error    z value  Pr(>|z|)
## (Intercept) -0.572693106 0.60239457 -0.9506943 0.3417596
## age          0.004295787 0.00584936  0.7344029 0.4627032
```

Non-significance of the effect of age.

(b)

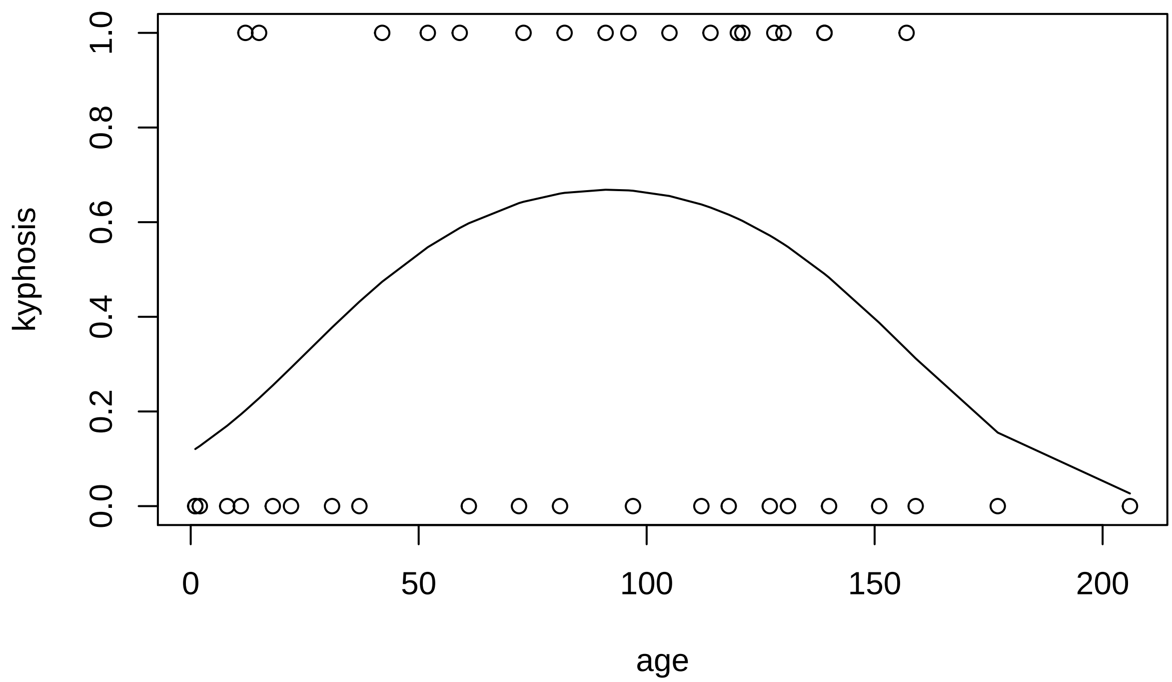
The plot is below:



The kyphosis-absent group shows a wider spread in ages than the kyphosis-present group.

(c)

```
##                  Estimate   Std. Error   z value   Pr(>|z|)
## (Intercept) -2.0462546726 0.9943478097 -2.057886 0.03960106
## age          0.0600397937 0.0267808473  2.241893 0.02496829
## agesq       -0.0003279439 0.0001564095 -2.096700 0.03602012
```



All parameters are significant. The new model seems fit better than previous one.

Problem 5

(a)

The logistic model is

$$logit(\hat{\pi}) = -3.6947264 + 0.0018151 * weight.$$

(b)

$\hat{\pi}$ at the weight values 1.20kg: $logit(\hat{\pi}) = -3.6947264 + 0.0018151 * 1200 = -1.52$.

$\hat{\pi}$ at the weight values 2.44kg: $logit(\hat{\pi}) = -3.6947264 + 0.0018151 * 2440 = 0.73$.

$\hat{\pi}$ at the weight values 5.20kg: $logit(\hat{\pi}) = -3.6947264 + 0.0018151 * 5200 = 5.74$.

So $\hat{\pi}$ are 0.18, 0.68 and 1.00 respectively.

(c)

$El_{50} = 3.6947/0.0018151 = 2040$.

(d)

i $0.25\hat{\beta} * 1000 = 0.45$.

ii $0.25\hat{\beta} * 100 = 0.045$.

iii $0.25\hat{\beta} * 580 = 0.26$.

(e)

```
##                 2.5 %   97.5 %
## b$weight 2.935372 12.85143
```

So an increase of 1 kg in weight is associated with increasing the odds of a satellite by a multiplicative factor between about 3 and 13.

(f)

```
## Likelihood ratio test
##
## Model 1: b$y ~ b$weight
## Model 2: b$y ~ 1
##   #Df   LogLik Df  Chisq Pr(>Chisq)
## 1   2  -97.869
## 2   1 -112.879 -1 30.021  4.273e-08 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

The likelihhod ratio test reports p-value is $4.273 * 10^{-8}$, which is really small. Therefore we reject the null hypothesis and conclude that weight has highly significant effect. Heavier crabs are significantly associated with increased probability of having a satellite.