BM2_HW2

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Problem_1

(a)

```
# load data
dose=c(0, 1, 2, 3, 4)## x_i
num=c(30, 30, 30, 30, 30) ## m_i
killed=c(2, 8, 15, 23, 27) ## y_i
data=data.frame(dose,num,killed) ## (x_i, m_i, y_i)
```

```
# data preparation
x=data$dose
y=data$killed
m=data$num
resp=cbind(y,m-y)   #### counts of success (death=1), failure (surv=0)
```

```
glm_logit=glm(resp~x, family=binomial(link='logit'))
glm_probit=glm(resp~x, family=binomial(link='probit'))
glm_clog=glm(resp~x, family=binomial(link='cloglog')) # asymmetric

confint.default(glm_logit) [2,2]
```

```
## [1] 1.517463
```

```
confint.default(glm_probit) [2,2]
```

```
## [1] 0.8760393
```

```
confint.default(glm_clog)[2,2]
```

```
## [1] 0.9613187
```

```
summary(glm_logit)$deviance
```

```
## [1] 0.3787483
```

```
summary(glm_probit)$deviance
```

```
## [1] 0.3136684
```

```
summary(glm_clog)$deviance
```

```
## [1] 2.230479
```

```
pred_1 = predict(glm_logit, newdata = data.frame(x = 0.01), type = "response")
pred_2 = predict(glm_probit, newdata = data.frame(x = 0.01), type = "response")
pred_3 = predict(glm_clog, newdata = data.frame(x = 0.01), type = "response")
```

```r
data.frame(
    estimate_of_beta = c(summary(glm_logit)$coeff[2,1], summary(glm_probit)$coeff[2,1],
                         summary(glm_clog)$coeff[2,1]),
    ci_lower = c(confint.default(glm_logit) [2,1], confint(glm_probit) [2,1],
                 confint.default(glm_clog)[2,1]),
    ci_upper = c(confint.default(glm_logit) [2,2], confint.default(glm_probit) [2,2],
                 confint.default(glm_clog)[2,2]),
    deviance = c(summary(glm_logit)$deviance, summary(glm_probit)$deviance,
                 summary(glm_clog)$deviance),
    estimated_probability = c(pred_1, pred_2, pred_3))|>
  knitr::kable(digits = 4)
```

```
## Waiting for profiling to be done...
```

estimate_of_beta	ci_lower	ci_upper	deviance	estimated_probability
1.1619	0.8063	1.5175	0.3787	0.0901
0.6864	0.5034	0.8760	0.3137	0.0853
0.7468	0.5323	0.9613	2.2305	0.1282

(b)

```r
dose=c(0, 1, 2, 3, 4)## x_i
num=c(30, 30, 30, 30, 30) ## m_i
killed=c(2, 8, 15, 23, 27) ## y_i
data=data.frame(dose,num,killed) ## (x_i, m_i, y_i)

# data preparation
x=data$dose
y=data$killed
m=data$num
resp=cbind(y,m-y)   #### counts of success (death=1), failure (surv=0)
glm_logit=glm(resp~x, family=binomial(link='logit'))
glm_probit=glm(resp~x, family=binomial(link='probit'))
glm_clog=glm(resp~x, family=binomial(link='cloglog')) # asymmetric
summary(glm_logit) # Wald test of coefficients
```

```
##
## Call:
## glm(formula = resp ~ x, family = binomial(link = "logit"))
##
## Coefficients:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept)  -2.3238     0.4179  -5.561 2.69e-08 ***
## x             1.1619     0.1814   6.405 1.51e-10 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 64.76327  on 4  degrees of freedom
## Residual deviance:  0.37875  on 3  degrees of freedom
## AIC: 20.854
##
```

```
## Number of Fisher Scoring iterations: 4
```

```
summary(glm_probit)
```

```
##
## Call:
## glm(formula = resp ~ x, family = binomial(link = "probit"))
##
## Coefficients:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept) -1.37709    0.22781  -6.045 1.49e-09 ***
## x            0.68638    0.09677   7.093 1.31e-12 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 64.76327  on 4  degrees of freedom
## Residual deviance:  0.31367  on 3  degrees of freedom
## AIC: 20.789
##
## Number of Fisher Scoring iterations: 4
```

```
summary(glm_clog)
```

```
##
## Call:
## glm(formula = resp ~ x, family = binomial(link = "cloglog"))
##
## Coefficients:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept)  -1.9942     0.3126  -6.378 1.79e-10 ***
## x             0.7468     0.1094   6.824 8.86e-12 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 64.7633  on 4  degrees of freedom
## Residual deviance:  2.2305  on 3  degrees of freedom
## AIC: 22.706
##
## Number of Fisher Scoring iterations: 5
```

```
beta0=glm_logit$coefficients[1]
beta1=glm_logit$coefficients[2]
betacov=vcov(glm_logit) # inverse fisher information
x0fit=-beta0/beta1
10^x0fit # point estimate of LD50
```

```
## (Intercept)
##         100
```

```
varx0=betacov[1,1]/(beta1^2)+betacov[2,2]*(beta0^2)/(beta1^4)-2*betacov[1,2]*beta0/(beta1^3)
c(x0fit,sqrt(varx0)) # point est and se
```

```
## (Intercept)           x
```

```
##   2.0000000   0.1784367
```

```
10^(x0fit+c(qnorm(0.05),-qnorm(0.05))*sqrt(varx0)) # 90% CI for LD50
```

```
## [1]  50.87422 196.56322
```