STAT511HW5

Ben Straub

October 27, 2015

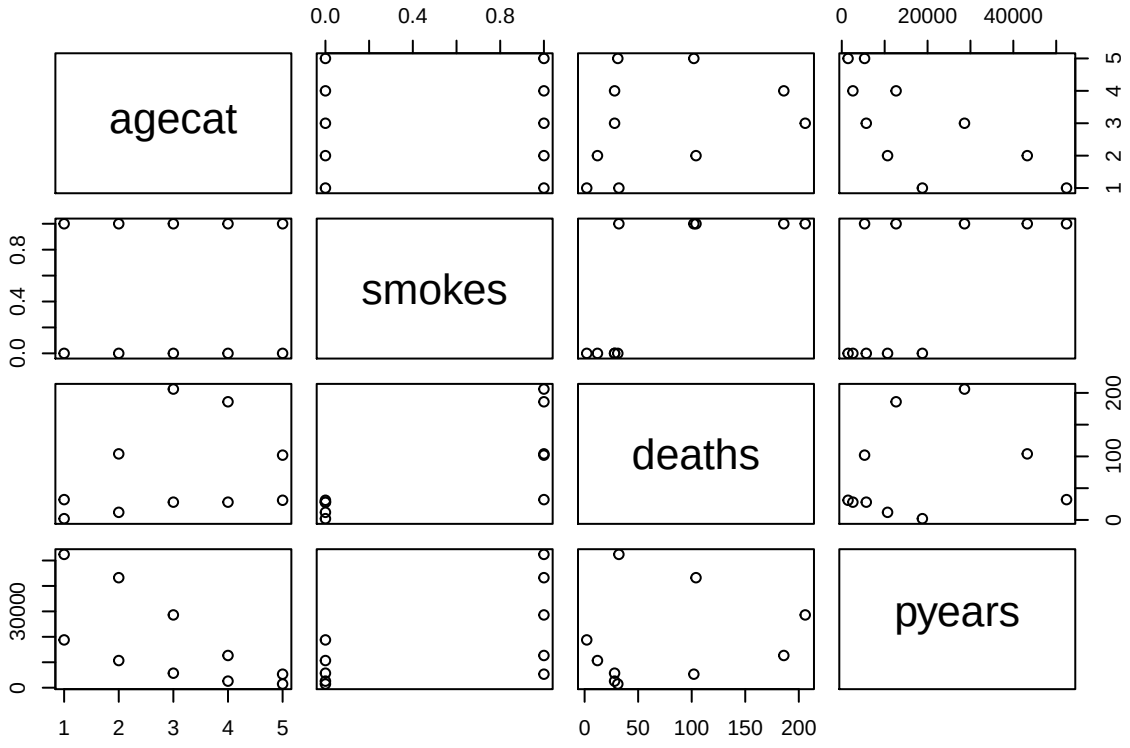
```
setwd("/Users/benStraub/Desktop/STAT511")
rm(list = ls())
smoking = read.csv("smoking.csv", sep=",")

library(knitr)
str(smoking)
```

```
## 'data.frame':    10 obs. of  4 variables:
##  $ agecat: int  1 2 3 4 5 1 2 3 4 5
##  $ smokes: int  1 1 1 1 1 0 0 0 0 0
##  $ deaths: int  32 104 206 186 102 2 12 28 28 31
##  $ pyears: int  52407 43248 28612 12663 5317 18790 10673 5710 2585 1462
```

```
attach(smoking)

pairs(smoking)
```




```
kable(summary(smoking), digits=2)
```

agecat	smokes	deaths	pyears
Min. :1	Min. :0.0	Min. : 2.0	Min. : 1462

agecat	smokes	deaths	pyears
1st Qu.:2	1st Qu.:0.0	1st Qu.: 28.0	1st Qu.: 5415
Median :3	Median :0.5	Median : 31.5	Median :11668
Mean :3	Mean :0.5	Mean : 73.1	Mean :18147
3rd Qu.:4	3rd Qu.:1.0	3rd Qu.:103.5	3rd Qu.:26156
Max. :5	Max. :1.0	Max. :206.0	Max. :52407

```
fit = lm(deaths~agecat+smokes+pyears, data=smoking)
summary(fit)
```

```
##
## Call:
## lm(formula = deaths ~ agecat + smokes + pyears, data = smoking)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -67.660  -4.563   1.482   6.225  80.358
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  48.442179  92.056399   0.526   0.6176
## agecat       -3.653275  23.792861  -0.154   0.8830
## smokes      151.199007  60.489437   2.500   0.0466 *
## pyears       -0.002203   0.002523  -0.873   0.4162
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 48.87 on 6 degrees of freedom
## Multiple R-squared:  0.7046, Adjusted R-squared:  0.5569
## F-statistic: 4.771 on 3 and 6 DF,  p-value: 0.04971
```

```
fit = lm(deaths~factor(agecat)+factor(smokes)+pyears, data=smoking)
summary(fit)
```

```
##
## Call:
## lm(formula = deaths ~ factor(agecat) + factor(smokes) + pyears,
##     data = smoking)
##
## Residuals:
##       1       2       3       4       5       6       7       8       9
## -29.165   1.135  37.642  19.033 -28.645  29.165  -1.135 -37.642 -19.033
##      10
##  28.645
##
## Coefficients:
##                   Estimate Std. Error t value Pr(>|t|)
## (Intercept)      -1.937030  74.381326  -0.026    0.981
## factor(agecat)2  29.402338  52.774959   0.557    0.616
## factor(agecat)3  75.245208  67.132795   1.121    0.344
## factor(agecat)4  52.440519  85.900531   0.610    0.585
```

```
## factor(agecat)5   6.255141  95.039571   0.066    0.952
## factor(smokes)1 133.465485  60.625030   2.201    0.115
## pyears           -0.001343   0.002547  -0.527    0.635
##
## Residual standard error: 47.97 on 3 degrees of freedom
## Multiple R-squared:  0.8577, Adjusted R-squared:  0.5732
## F-statistic: 3.014 on 6 and 3 DF,  p-value: 0.1968
```

```
fit = lm(deaths~factor(agecat)+smokes+pyears, data=smoking)
summary(fit)
```

```
##
## Call:
## lm(formula = deaths ~ factor(agecat) + smokes + pyears, data = smoking)
##
## Residuals:
##       1       2       3       4       5       6       7       8       9
## -29.165   1.135  37.642  19.033 -28.645  29.165  -1.135 -37.642 -19.033
##      10
##  28.645
##
## Coefficients:
##                   Estimate Std. Error t value Pr(>|t|)
## (Intercept)      -1.937030  74.381326  -0.026    0.981
## factor(agecat)2  29.402338  52.774959   0.557    0.616
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## pyears           -0.001343   0.002547  -0.527    0.635
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```

```
fit = lm(deaths~agecat+factor(smokes)+pyears, data=smoking)
summary(fit)
```

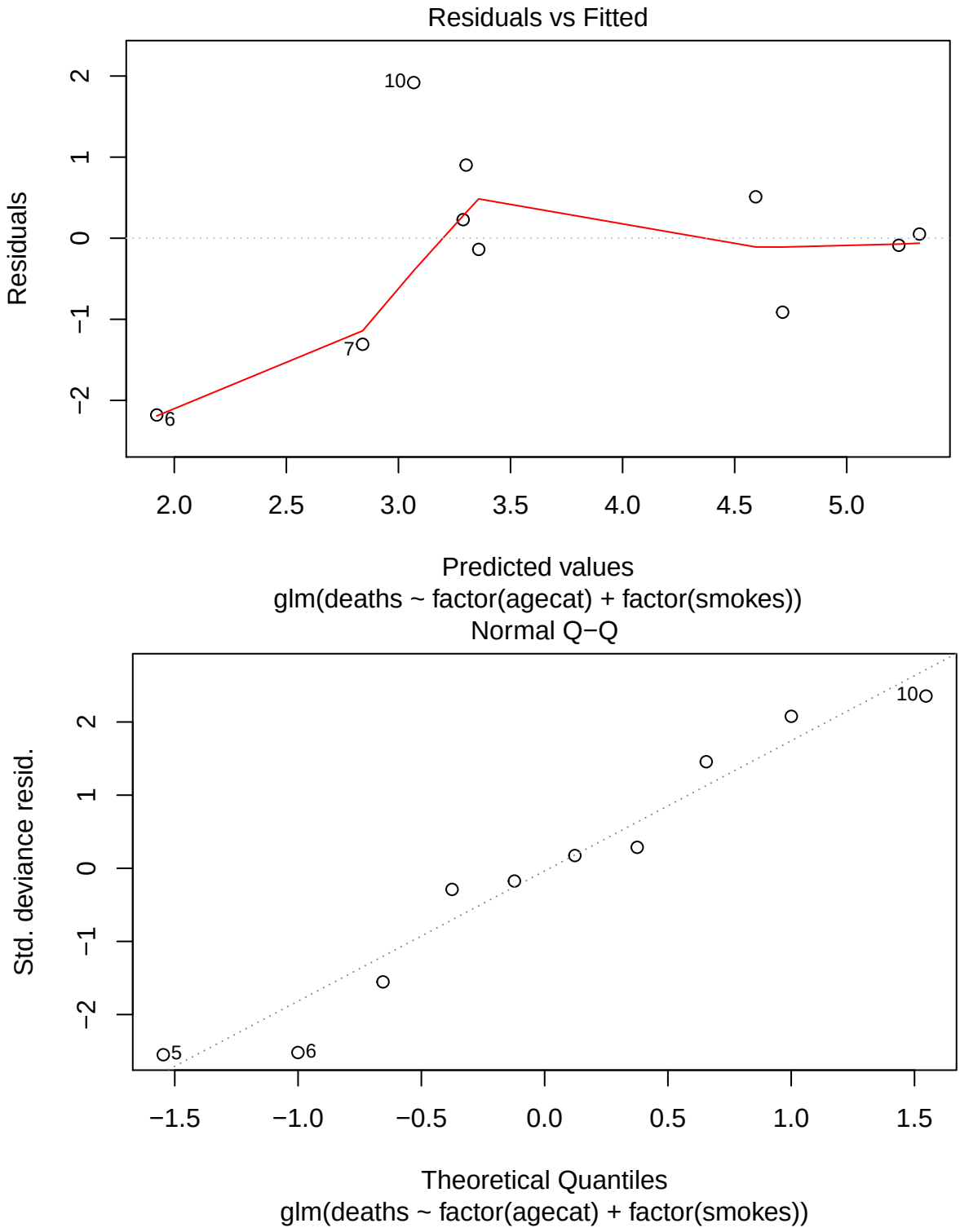
```
##
## Call:
## lm(formula = deaths ~ agecat + factor(smokes) + pyears, data = smoking)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -67.660  -4.563   1.482   6.225  80.358
##
## Coefficients:
##                   Estimate Std. Error t value Pr(>|t|)
## (Intercept)      48.442179  92.056399   0.526   0.6176
## agecat           -3.653275  23.792861  -0.154   0.8830
## factor(smokes)1 151.199007  60.489437   2.500   0.0466 *
## pyears           -0.002203   0.002523  -0.873   0.4162
## ---
```

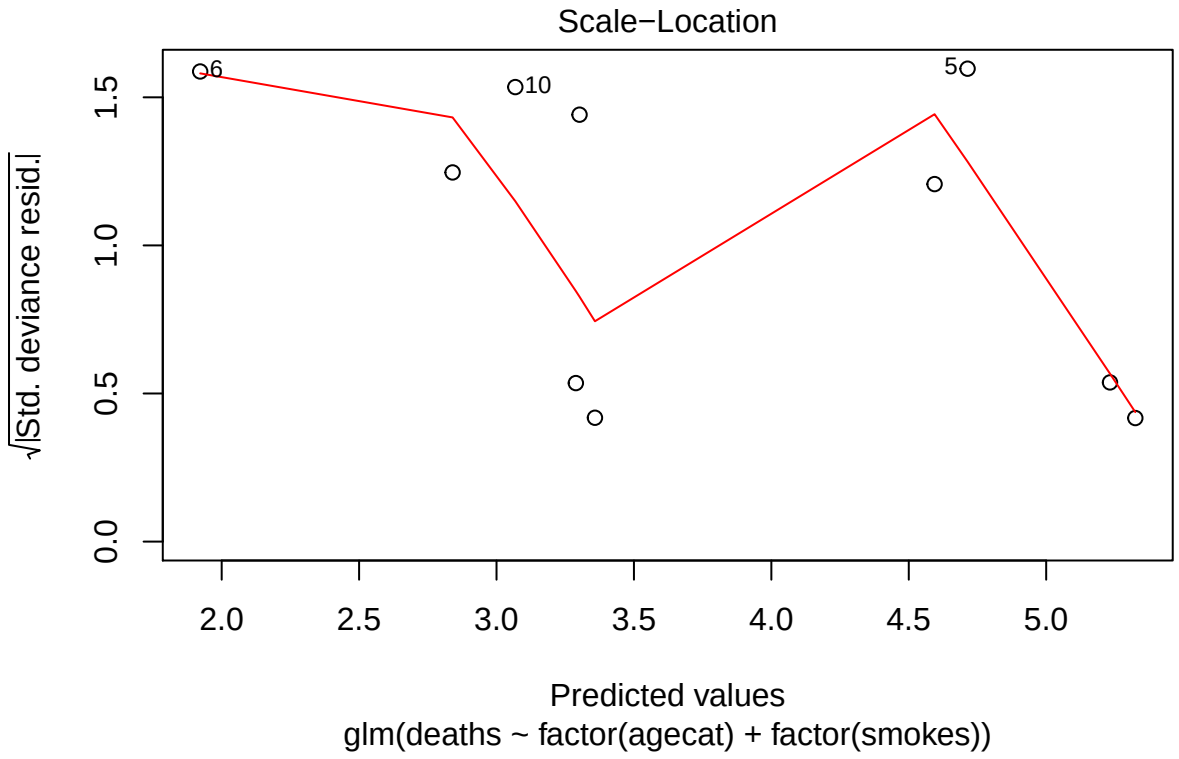
```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 48.87 on 6 degrees of freedom
## Multiple R-squared:  0.7046, Adjusted R-squared:  0.5569
## F-statistic: 4.771 on 3 and 6 DF,  p-value: 0.04971
```

```
fit=glm(deaths~factor(agecat)+factor(smokes),offset=log(pyears),family="poisson",data=smoking)
summary(fit)
```

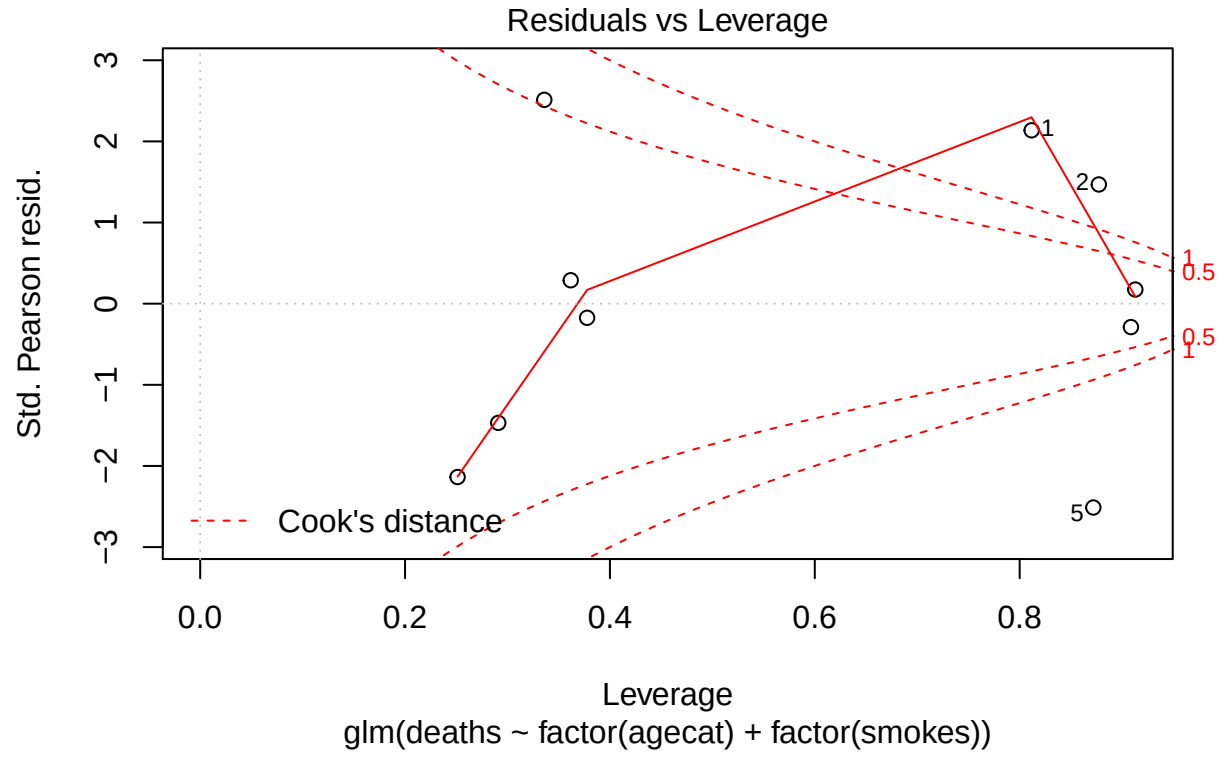
```
##
## Call:
## glm(formula = deaths ~ factor(agecat) + factor(smokes), family = "poisson",
##     data = smoking, offset = log(pyears))
##
## Deviance Residuals:
##        1         2         3         4         5         6         7
##  0.90160   0.51038   0.05135  -0.08732  -0.91237  -2.17978  -1.30800
##        8         9        10
## -0.13791   0.22882   1.91902
##
## Coefficients:
##                 Estimate Std. Error z value Pr(>|z|)
## (Intercept)      -7.9193     0.1918 -41.298  < 2e-16 ***
## factor(agecat)2   1.4840     0.1951   7.606 2.82e-14 ***
## factor(agecat)3   2.6275     0.1837  14.301  < 2e-16 ***
## factor(agecat)4   3.3505     0.1848  18.131  < 2e-16 ***
## factor(agecat)5   3.7001     0.1922  19.249  < 2e-16 ***
## factor(smokes)1   0.3545     0.1074   3.302  0.00096 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for poisson family taken to be 1)
##
##     Null deviance: 935.067  on 9  degrees of freedom
## Residual deviance:  12.132  on 4  degrees of freedom
## AIC: 79.2
##
## Number of Fisher Scoring iterations: 4
```

```
plot(fit)
```

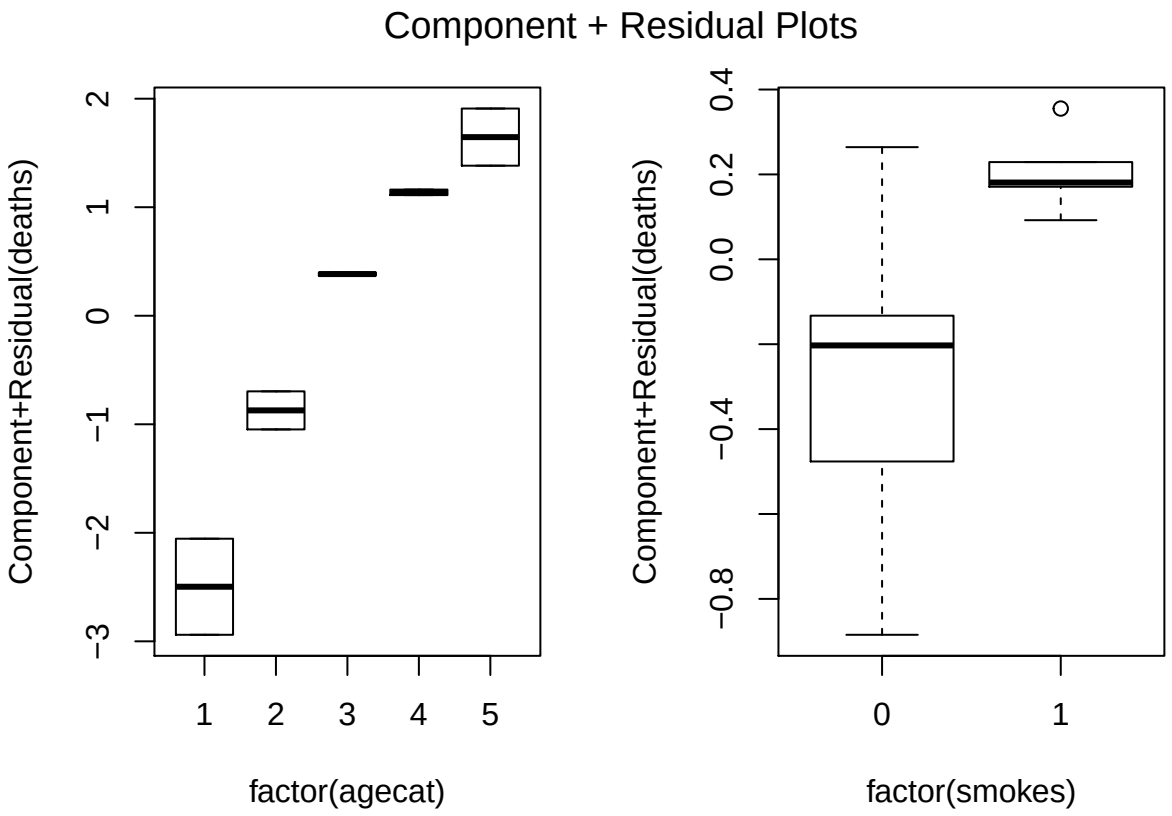

Residuals vs Fitted
Residuals
Predicted values
glm(deaths ~ factor(agecat) + factor(smokes))
Normal Q−Q
Std. deviance resid.
Theoretical Quantiles
glm(deaths ~ factor(agecat) + factor(smokes))




```
library(car)
```




```
crPlots(fit)
```




```
## Test for outliers
library(car)
outlierTest(fit)
```

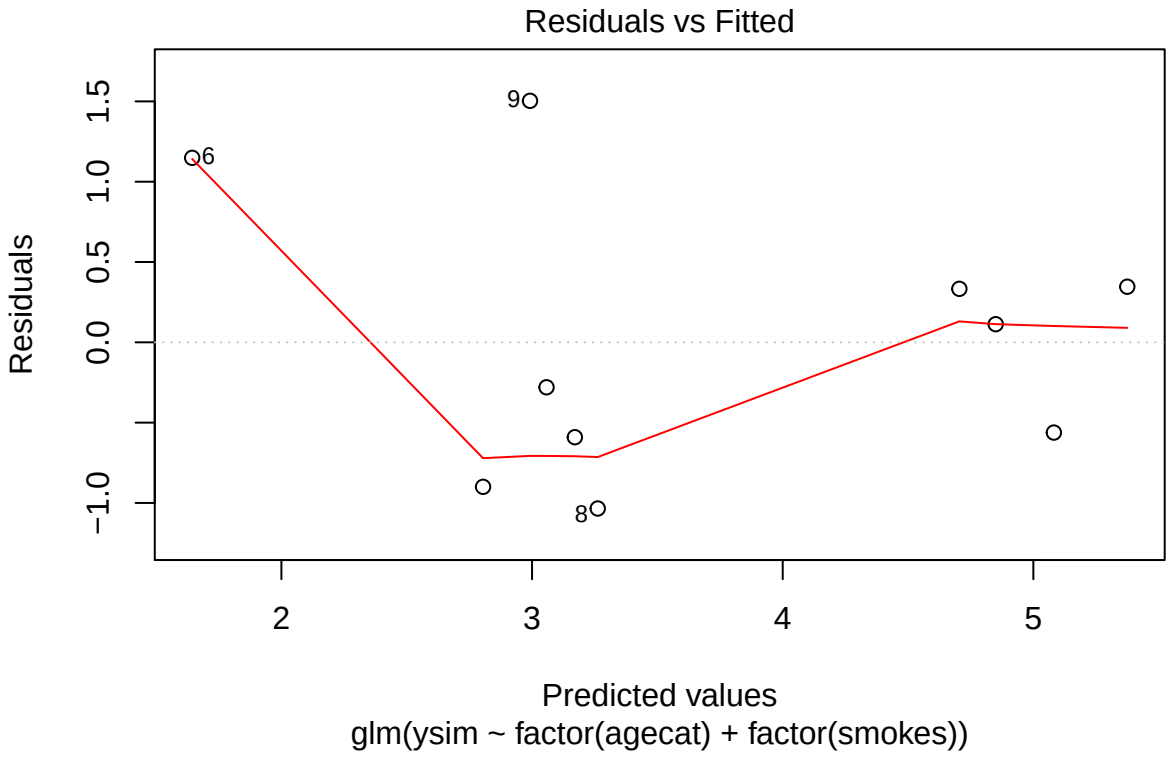
```
##
## No Studentized residuals with Bonferonni p < 0.05
## Largest |rstudent|:
##    rstudent unadjusted p-value Bonferonni p
## 5 -2.517043           0.011834      0.11834
```

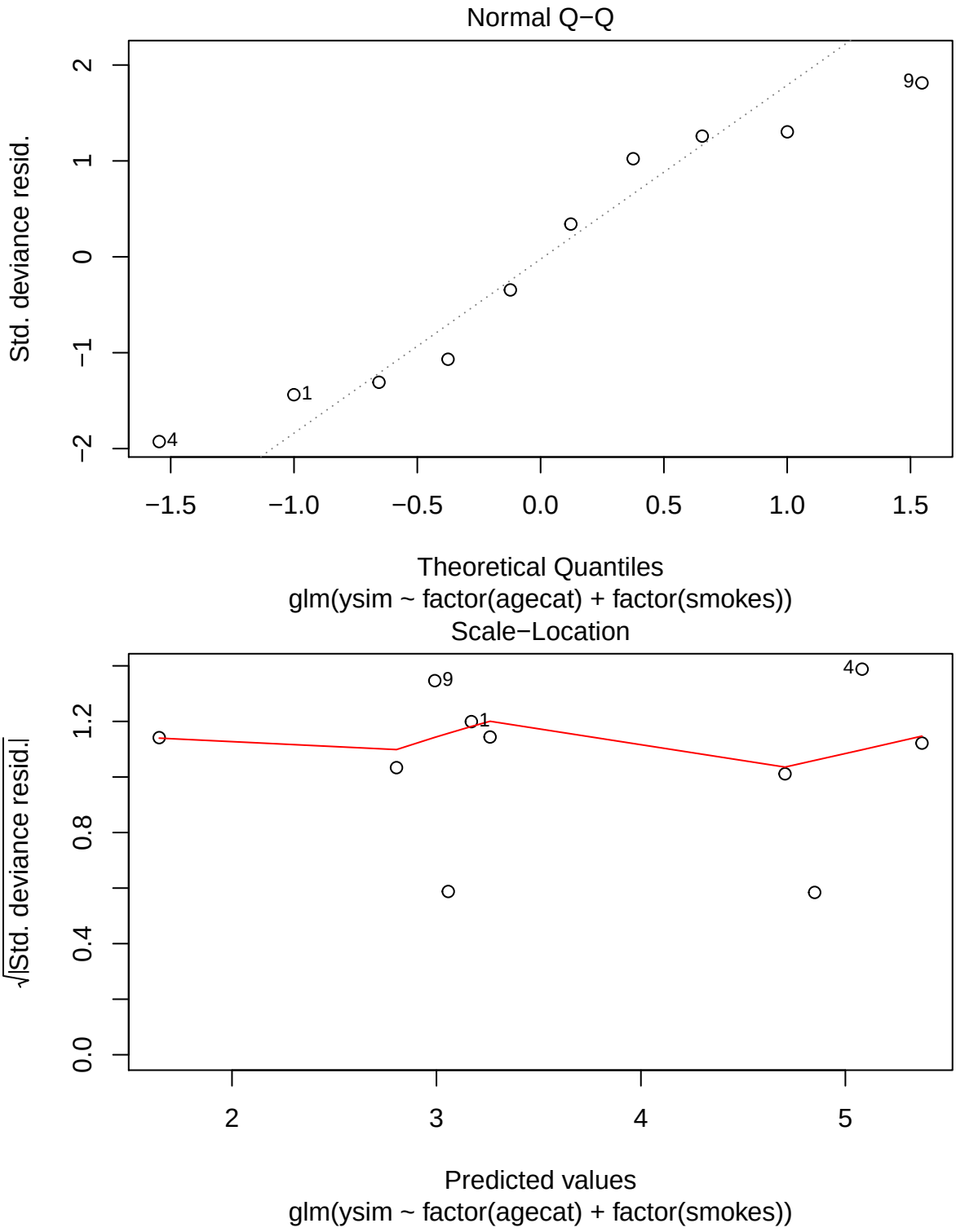
```
##
## simulation study to see if resids are acceptable
##

## simulate data from the fitted model
muhat=predict(fit,type="response")

ysim=rpois(length(muhat),lambda=muhat)

## fit the simulated data
fit.sim=glm(ysim~factor(agecat)+factor(smokes),offset=log(pyears),family="poisson",data=smoking)
summary(fit.sim)
```

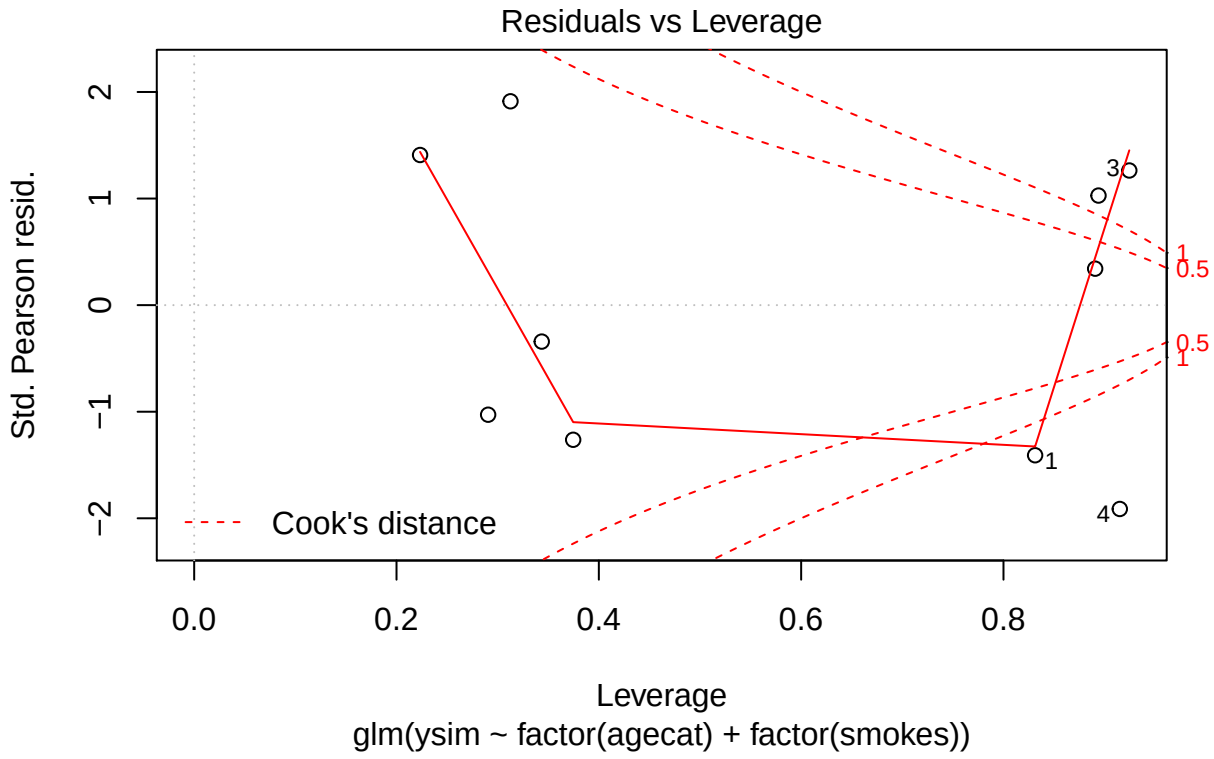
```
##
## Call:
## glm(formula = ysim ~ factor(agecat) + factor(smokes), family = "poisson",
##     data = smoking, offset = log(pyears))
```

```
##
## Deviance Residuals:
##       1        2        3        4        5        6        7        8
## -0.5907   0.3331   0.3461  -0.5618   0.1129   1.1485  -0.8997  -1.0346
##       9       10
##  1.5034  -0.2799
##
## Coefficients:
##                  Estimate Std. Error z value Pr(>|z|)
## (Intercept)      -8.1972     0.2077 -39.462  < 2e-16 ***
## factor(agecat)2   1.7262     0.2059   8.385  < 2e-16 ***
## factor(agecat)3   2.8093     0.1967  14.284  < 2e-16 ***
## factor(agecat)4   3.3315     0.2002  16.644  < 2e-16 ***
## factor(agecat)5   3.9673     0.2030  19.543  < 2e-16 ***
## factor(smokes)1   0.5011     0.1133   4.422 9.78e-06 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for poisson family taken to be 1)
##
##     Null deviance: 933.1539  on 9  degrees of freedom
## Residual deviance:   6.4458  on 4  degrees of freedom
## AIC: 73.949
##
## Number of Fisher Scoring iterations: 4
```

```
## residual plots
plot(fit.sim)
```




Normal Q−Q
Std. deviance resid.
Theoretical Quantiles
glm(ysim ~ factor(agecat) + factor(smokes))
Scale−Location
√|Std. deviance resid.|
Predicted values
glm(ysim ~ factor(agecat) + factor(smokes))




```
################################################
##
## Predictions
##
################################################

## predicted mean # of resp.deaths per year for 1000 people in a particular group
##  by setting "arsenic=1:4" I am jointly calculating everything for all 4 arsenic groups
##  This allows us to compare predicted respitory death rates across arsenic exposure levels

## make a data frame with the desired predictor variables
data=data.frame(pyears=1000,agegr=2,period=1,arsenic=1:4,start=1)
data
```

```
##   pyears agegr period arsenic start
## 1   1000     2      1       1     1
## 2   1000     2      1       2     1
## 3   1000     2      1       3     1
## 4   1000     2      1       4     1
```

```
## get the mean and sd of the linear predictor eta for those predictor variables
pred.mean=predict(fit,newdata=data,type="response",se=T)
```

```
## Warning: 'newdata' had 4 rows but variables found have 10 rows

## Warning in offset + eval(object$call$offset, newdata): longer object length
## is not a multiple of shorter object length
```

```
mu.hat=pred.mean$fit

## CI bounds on linear predictor
CI.up=mu.hat+1.96*pred.mean$se.fit
CI.down=mu.hat-1.96*pred.mean$se.fit

## CI on LINEAR PREDICTOR in table form
cbind(CI.down,CI.up)
```

```
##       CI.down      CI.up
## 1   0.3427640  0.6940084
## 2   1.8642902  2.7084809
## 3   6.2363318  8.1117678
## 4  12.7641022 16.8013100
## 5  17.3347917 24.6039002
## 6   0.2269698  0.5003251
## 7   1.1940391  2.0137558
## 8   3.9016843  6.1634949
## 9   8.0089409 12.7311696
## 10 11.1065051 18.3134503
```

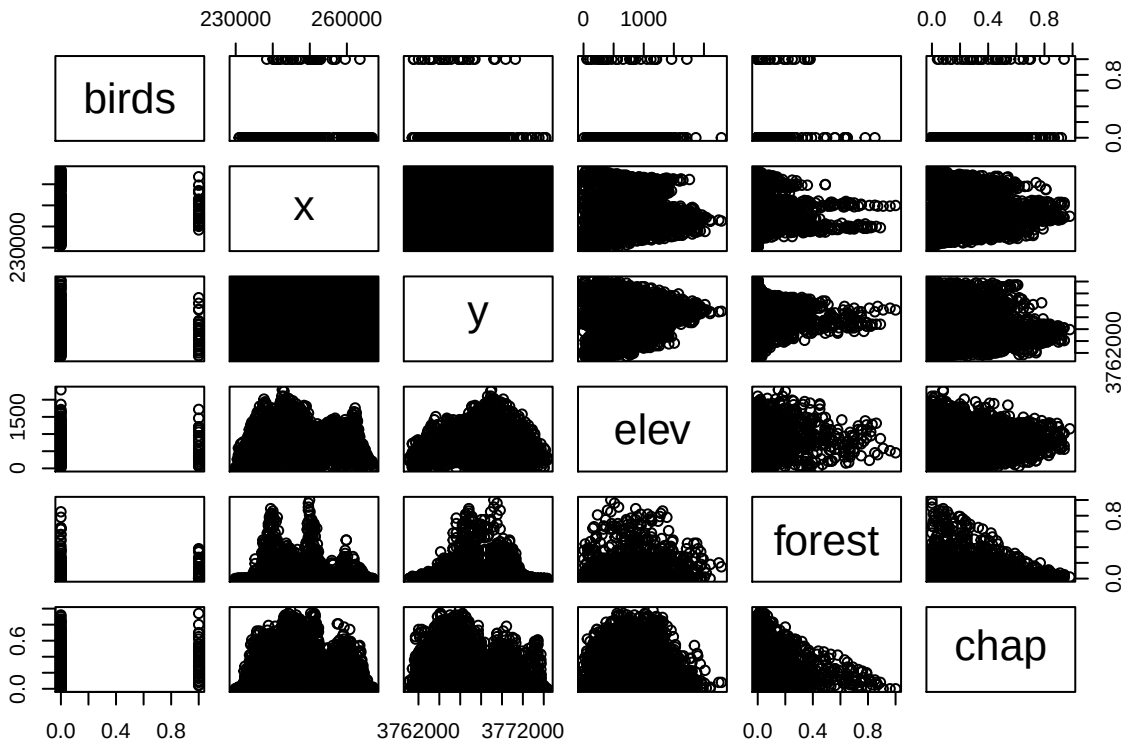
```
## CI on MEAN # of resp.deaqths per year for 1000 people
## Note: for Poisson regression, response function is mu=exp(eta)
exp(cbind(CI.down,CI.up))
```

```
##         CI.down        CI.up
## 1  1.408836e+00 2.001723e+00
## 2  6.451355e+00 1.500646e+01
## 3  5.109807e+02 3.333466e+03
## 4  3.494452e+05 1.980233e+07
## 5  3.376015e+07 4.845494e+10
## 6  1.254792e+00 1.649257e+00
## 7  3.300385e+00 7.491401e+00
## 8  4.948573e+01 4.750856e+02
## 9  3.007730e+03 3.381246e+05
## 10 6.660301e+04 8.983187e+07
```

```
setwd("/Users/benStraub/Desktop/STAT511")
rm(list = ls())
load("isj.Rdata")
names(isj)[names(isj)=="isj"] <- "birds"
library(knitr)
str(isj)
```

```
## 'data.frame':    5625 obs. of  6 variables:
##  $ birds : num  0 0 0 0 0 0 0 0 0 0 ...
##  $ x     : num  234870 237083 235732 237605 234239 ...
##  $ y     : num  3767154 3766804 3766717 3766719 3766570 ...
##  $ elev  : num  151 562 407 563 440 582 586 285 795 671 ...
##  $ forest: num  0.02 0 0 0.26 0.01 0.1 0.12 0 0.17 0 ...
##  $ chap  : num  0.29 0.49 0.72 0.25 0.01 0.48 0.57 0.03 0.12 0 ...
```

```
attach(isj)
pairs(isj)
```




```
kable(summary(isj), digits=2)
```

birds	x	y	elev	forest	chap
Min. :0.000	Min. :229837	Min. :3761124	Min. : 0.0	Min. :0.000	Min. :0.0000
1st Qu.:0.000	1st Qu.:239137	1st Qu.:3764424	1st Qu.: 375.5	1st Qu.:0.000	1st Qu.:0.0600
Median :0.000	Median :248437	Median :3767724	Median : 655.0	Median :0.000	Median :0.2000
Mean :0.124	Mean :248437	Mean :3767725	Mean : 717.8	Mean :0.064	Mean :0.2469
3rd Qu.:0.000	3rd Qu.:257737	3rd Qu.:3771024	3rd Qu.:1004.5	3rd Qu.:0.060	3rd Qu.:0.3900
Max. :1.000	Max. :267037	Max. :3774324	Max. :2289.0	Max. :1.000	Max. :0.9800
NA's :5318	NA	NA	NA's :2838	NA's :2838	NA's :2838

Exploratory Data Analysis

- The Island Scrub Jay Data Set has 5,265 observations and 6 Variables
- I renamed the Variable isj as birds.
- Variables: birds, x, y, elev, forest, chap
- The birds Variable is a coded as 0 for abscence of birds and 1 for presence of birds.
- There appears to be a lot of NAs in the data set!!

```
head(isj)
```

```
##   birds        x       y elev forest chap
```

```
## 1     0 234870.1 3767154  151   0.02 0.29
## 2     0 237083.0 3766804  562   0.00 0.49
## 3     0 235732.0 3766717  407   0.00 0.72
## 4     0 237605.0 3766719  563   0.26 0.25
## 5     0 234239.1 3766570  440   0.01 0.01
## 6     0 235005.1 3766420  582   0.10 0.48
```

```
tail(isj, n= 10)
```

```
##      birds        x       y elev forest chap
## 5616    NA 264336.7 3761124   NA     NA   NA
## 5617    NA 264636.7 3761124   NA     NA   NA
## 5618    NA 264936.7 3761124   NA     NA   NA
## 5619    NA 265236.7 3761124   NA     NA   NA
## 5620    NA 265536.7 3761124   NA     NA   NA
## 5621    NA 265836.7 3761124   NA     NA   NA
## 5622    NA 266136.7 3761124   NA     NA   NA
## 5623    NA 266436.7 3761124   NA     NA   NA
## 5624    NA 266736.7 3761124   NA     NA   NA
## 5625    NA 267036.7 3761124   NA     NA   NA
```

```
# Subsetting data on presence of birds
isj.sub_1 <- subset(isj, birds == 1)
# Subsetting data on absence of birds
isj.sub_0 <- subset(isj, birds == 0)
isj.sub_0_1 <- isj[complete.cases(isj),]
```

- Upon further examination of the data set I found that there was only 303 complete cases of Data.
- The Data has 38 entries for the presences of birds
- The Data has 265 entries for the absence of birds.

```
fit=lm(birds~x+y+elev+forest+chap, data=isj.sub_1)
kable(summary(fit)$coef, digits=15)
```

```
## Warning in summary.lm(fit): essentially perfect fit: summary may be
## unreliable
```

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	1e+00	2.59e-13	3.862513e+12	0.0000000000
x	0e+00	0.00e+00	-2.226244e-01	0.8252427536
y	0e+00	0.00e+00	4.012019e+00	0.0003385996
elev	0e+00	0.00e+00	-2.480884e+00	0.0185513693
forest	-3e-15	1.00e-15	-2.291693e+00	0.0286505658
chap	0e+00	1.00e-15	1.601071e-01	0.8738030739

```
fit=lm(birds~x+y+elev+forest+chap, data=isj.sub_1)
kable(summary(fit)$coef, digits=15)
```

```
## Warning in summary.lm(fit): essentially perfect fit: summary may be
```

unreliable

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	1e+00	2.59e-13	3.862513e+12	0.0000000000
x	0e+00	0.00e+00	-2.226244e-01	0.8252427536
y	0e+00	0.00e+00	4.012019e+00	0.0003385996
elev	0e+00	0.00e+00	-2.480884e+00	0.0185513693
forest	-3e-15	1.00e-15	-2.291693e+00	0.0286505658
chap	0e+00	1.00e-15	1.601071e-01	0.8738030739

```
fit=glm(birds~.,family=binomial(link="probit"),data=isj.sub_0_1)
summary(fit)
```

```
##
## Call:
## glm(formula = birds ~ ., family = binomial(link = "probit"),
##     data = isj.sub_0_1)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -0.9255  -0.5834  -0.4082  -0.2470   2.4854
##
## Coefficients:
##               Estimate Std. Error z value Pr(>|z|)
## (Intercept)  4.309e+02  1.763e+02   2.445  0.01450 *
## x            2.508e-06  1.164e-05   0.215  0.82945
## y           -1.150e-04  4.690e-05  -2.451  0.01423 *
## elev        -1.945e-04  2.756e-04  -0.706  0.48025
## forest       1.248e+00  6.622e-01   1.885  0.05940 .
## chap         1.073e+00  4.135e-01   2.596  0.00944 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 228.81  on 302  degrees of freedom
## Residual deviance: 209.07  on 297  degrees of freedom
## AIC: 221.07
##
## Number of Fisher Scoring iterations: 6
```

```
fit=glm(birds~.,family=binomial(link="logit"),data=isj.sub_0_1)
summary(fit)
```

```
##
## Call:
## glm(formula = birds ~ ., family = binomial(link = "logit"), data = isj.sub_0_1)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -0.9467  -0.5698  -0.4119  -0.2748   2.4981
```

```
##
## Coefficients:
##               Estimate Std. Error z value Pr(>|z|)
## (Intercept)  8.202e+02  3.438e+02   2.385   0.0171 *
## x            7.773e-06  2.270e-05   0.342   0.7320
## y           -2.189e-04  9.154e-05  -2.392   0.0168 *
## elev        -4.303e-04  5.347e-04  -0.805   0.4210
## forest       2.202e+00  1.206e+00   1.827   0.0677 .
## chap         1.839e+00  7.535e-01   2.440   0.0147 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 228.81  on 302  degrees of freedom
## Residual deviance: 209.85  on 297  degrees of freedom
## AIC: 221.85
##
## Number of Fisher Scoring iterations: 5
```

```
fit=glm(birds~.,family=poisson(link="log"),data=isj.sub_0_1)
summary(fit)
```

```
##
## Call:
## glm(formula = birds ~ ., family = poisson(link = "log"), data = isj.sub_0_1)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -0.8882  -0.5402  -0.4004  -0.2794   2.0618
##
## Coefficients:
##               Estimate Std. Error z value Pr(>|z|)
## (Intercept)  7.191e+02  3.178e+02   2.263   0.0236 *
## x            6.927e-06  2.131e-05   0.325   0.7451
## y           -1.921e-04  8.461e-05  -2.270   0.0232 *
## elev        -3.548e-04  4.941e-04  -0.718   0.4727
## forest       1.922e+00  1.079e+00   1.781   0.0749 .
## chap         1.539e+00  6.718e-01   2.291   0.0219 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for poisson family taken to be 1)
##
##     Null deviance: 157.79  on 302  degrees of freedom
## Residual deviance: 141.31  on 297  degrees of freedom
## AIC: 229.31
##
## Number of Fisher Scoring iterations: 6
```

```
fit=glm(birds~.,family=binomial(link="log"),data=isj.sub_0_1)
summary(fit)
```

```
##
## Call:
## glm(formula = birds ~ ., family = binomial(link = "log"), data = isj.sub_0_1)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -0.9761  -0.5609  -0.4107  -0.2899   2.4961
##
## Coefficients:
##               Estimate Std. Error z value Pr(>|z|)
## (Intercept)  7.060e+02  2.935e+02   2.405   0.0162 *
## x            9.308e-06  1.982e-05   0.470   0.6386
## y           -1.887e-04  7.818e-05  -2.414   0.0158 *
## elev        -3.913e-04  4.602e-04  -0.850   0.3951
## forest       1.805e+00  9.891e-01   1.825   0.0680 .
## chap         1.399e+00  6.059e-01   2.309   0.0209 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 228.81  on 302  degrees of freedom
## Residual deviance: 210.56  on 297  degrees of freedom
## AIC: 222.56
##
## Number of Fisher Scoring iterations: 7
```

```
fit=glm(birds~.,family=binomial(link="log"),data=isj.sub_0_1)
summary(fit)
```

```
##
## Call:
## glm(formula = birds ~ ., family = binomial(link = "log"), data = isj.sub_0_1)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -0.9761  -0.5609  -0.4107  -0.2899   2.4961
##
## Coefficients:
##               Estimate Std. Error z value Pr(>|z|)
## (Intercept)  7.060e+02  2.935e+02   2.405   0.0162 *
## x            9.308e-06  1.982e-05   0.470   0.6386
## y           -1.887e-04  7.818e-05  -2.414   0.0158 *
## elev        -3.913e-04  4.602e-04  -0.850   0.3951
## forest       1.805e+00  9.891e-01   1.825   0.0680 .
## chap         1.399e+00  6.059e-01   2.309   0.0209 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 228.81  on 302  degrees of freedom
## Residual deviance: 210.56  on 297  degrees of freedom
## AIC: 222.56
```

```
##
## Number of Fisher Scoring iterations: 7
```

```
fit=glm(birds~elev+forest+chap,family=binomial(link="log"),data=isj.sub_0_1)
summary(fit)
```

```
##
## Call:
## glm(formula = birds ~ elev + forest + chap, family = binomial(link = "log"),
##     data = isj.sub_0_1)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -0.9691  -0.5557  -0.4350  -0.3616   2.4357
##
## Coefficients:
##               Estimate Std. Error z value Pr(>|z|)
## (Intercept) -2.3353867  0.3563568  -6.554 5.62e-11 ***
## elev        -0.0007002  0.0004329  -1.618  0.10574
## forest       1.1967861  0.9532819   1.255  0.20932
## chap         1.8762731  0.5799870   3.235  0.00122 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 228.81  on 302  degrees of freedom
## Residual deviance: 216.85  on 299  degrees of freedom
## AIC: 224.85
##
## Number of Fisher Scoring iterations: 6
```

```
fit=glm(birds~forest+chap,family=binomial(link="log"),data=isj.sub_0_1)
summary(fit)
```

```
##
## Call:
## glm(formula = birds ~ forest + chap, family = binomial(link = "log"),
##     data = isj.sub_0_1)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -0.8701  -0.5498  -0.4375  -0.3812   2.2983
##
## Coefficients:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept)  -2.7086     0.2942  -9.207  < 2e-16 ***
## forest        1.0641     0.9650   1.103  0.27017
## chap          1.6890     0.5733   2.946  0.00322 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
```

```
##
##     Null deviance: 228.81  on 302  degrees of freedom
## Residual deviance: 219.59  on 300  degrees of freedom
## AIC: 225.59
##
## Number of Fisher Scoring iterations: 6
```

```
fit=glm(birds~forest,family=binomial(link="log"),data=isj.sub_0_1)
summary(fit)
```

```
##
## Call:
## glm(formula = birds ~ forest, family = binomial(link = "log"),
##     data = isj.sub_0_1)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -0.7353  -0.5118  -0.5007  -0.5007   2.0682
##
## Coefficients:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept)  -2.1386     0.1718 -12.447   <2e-16 ***
## forest        0.8216     0.9151   0.898    0.369
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 228.81  on 302  degrees of freedom
## Residual deviance: 228.04  on 301  degrees of freedom
## AIC: 232.04
##
## Number of Fisher Scoring iterations: 6
```

```
fit=glm(birds~chap,family=binomial(link="log"),data=isj.sub_0_1)
summary(fit)
```

```
##
## Call:
## glm(formula = birds ~ chap, family = binomial(link = "log"),
##     data = isj.sub_0_1)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -0.8934  -0.5335  -0.4415  -0.3987   2.2535
##
## Coefficients:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept)  -2.6040     0.2673  -9.740  < 2e-16 ***
## chap          1.6222     0.5599   2.897  0.00376 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
```

```
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 228.81  on 302  degrees of freedom
## Residual deviance: 220.70  on 301  degrees of freedom
## AIC: 224.7
##
## Number of Fisher Scoring iterations: 6
```

```
fit=glm(birds~chap+x+y,family=binomial(link="log"),data=isj.sub_0_1)
summary(fit)
```

```
##
## Call:
## glm(formula = birds ~ chap + x + y, family = binomial(link = "log"),
##     data = isj.sub_0_1)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -0.9334  -0.5593  -0.4335  -0.3185   2.4411
##
## Coefficients:
##               Estimate Std. Error z value Pr(>|z|)
## (Intercept)  6.537e+02  2.554e+02   2.559   0.0105 *
## chap         1.208e+00  5.723e-01   2.111   0.0348 *
## x            5.680e-06  1.926e-05   0.295   0.7681
## y           -1.746e-04  6.799e-05  -2.568   0.0102 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 228.81  on 302  degrees of freedom
## Residual deviance: 214.09  on 299  degrees of freedom
## AIC: 222.09
##
## Number of Fisher Scoring iterations: 7
```

Creates the Map