Lab 9 Solutions

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We'll begin by loading some packages.

```
library(MASS)
library(plyr)
library(ggplot2)
library(reshape)
```

```
##
## Attaching package: 'reshape'

## The following objects are masked from 'package:plyr':
##
##     rename, round_any
```

Let's form our favourite birthwt data set.

```
# Rename the columns to have more descriptive names
colnames(birthwt) <- c("birthwt.below.2500", "mother.age", "mother.weight",
    "race", "mother.smokes", "previous.prem.labor", "hypertension", "uterine.irr",
    "physician.visits", "birthwt.grams")

# Transform variables to factors with descriptive levels
birthwt <- transform(birthwt,
            race = as.factor(mapvalues(race, c(1, 2, 3),
                            c("white","black", "other"))),
            mother.smokes = as.factor(mapvalues(mother.smokes,
                            c(0,1), c("no", "yes"))),
            hypertension = as.factor(mapvalues(hypertension,
                            c(0,1), c("no", "yes"))),
            uterine.irr = as.factor(mapvalues(uterine.irr,
                            c(0,1), c("no", "yes")))
            )
```

ANOVA with birthwt data

(a) Create a new factor that categorizes the number of physician visits into three levels: 0, 1, 2, 3 or more.

```
pvb <- unique(birthwt$physician.visits)
repvb <- as.character(pvb)
for (i in 4:length(repvb)) {
  repvb[i] = "3 or more"
}
birthwt <- transform(birthwt, phys.visit.binned1 = as.factor(mapvalues(physician.visits, pvb, repvb )))
birthwt$phys.visit.binned1
```

```
##  [1] 0         3         1         3 or more 0         0         1
##  [8] 1         1         0         0         1         0         3 or more
## [15] 0         0         0         3         0         1         3 or more
## [22] 3         1         0         3 or more 0         0         3 or more
## [29] 0         1         1         1         1         1         0
## [36] 3 or more 3 or more 0         3 or more 1         3 or more 3 or more
```

```
##  [43] 1         0         0         0         3 or more 0         3 or more
##  [50] 0         1         0         0         3 or more 0         0
##  [57] 0         0         0         0         0         3 or more 0
##  [64] 0         0         1         3 or more 3 or more 1         3 or more
##  [71] 0         3 or more 1         0         0         0         1
##  [78] 3 or more 0         0         1         0         0         0
##  [85] 0         0         0         0         0         1         0
##  [92] 3 or more 0         0         0         1         1         0
##  [99] 0         1         1         0         0         1         0
## [106] 0         1         0         3 or more 3 or more 3 or more 1
## [113] 3 or more 1         0         1         0         0         3 or more
## [120] 1         1         0         1         0         3 or more 3 or more
## [127] 1         0         1         1         0         3 or more 0
## [134] 0         0         0         1         1         0         1
## [141] 0         0         0         1         0         3 or more 3 or more
## [148] 0         0         0         1         3 or more 0         0
## [155] 0         0         3         1         0         0         0
## [162] 1         0         0         0         0         3 or more 0
## [169] 1         0         1         0         0         0         0
## [176] 0         1         3         0         3 or more 1         3
## [183] 0         0         3 or more 3 or more 0         0         3
## Levels: 0 1 3 3 or more
```

```
phys.visit.binned <- birthwt$physician.visits
phys.visit.binned[phys.visit.binned >= 3] <- "3.or.more"
birthwt <- transform(birthwt, phys.visit.binned = as.factor(phys.visit.binned))
birthwt$phys.visit.binned
```

```
##   [1] 0         3.or.more 1         2         0         0         1
##   [8] 1         1         0         0         1         0         2
##  [15] 0         0         0         3.or.more 0         1         2
##  [22] 3.or.more 1         0         2         0         0         2
##  [29] 0         1         1         1         1         1         0
##  [36] 2         2         0         2         1         2         2
##  [43] 1         0         0         0         3.or.more 0         2
##  [50] 0         1         0         0         2         0         0
##  [57] 0         0         0         0         0         2         0
##  [64] 0         0         1         2         3.or.more 1         2
##  [71] 0         2         1         0         0         0         1
##  [78] 3.or.more 0         0         1         0         0         0
##  [85] 0         0         0         0         0         1         0
##  [92] 2         0         0         0         1         1         0
##  [99] 0         1         1         0         0         1         0
## [106] 0         1         0         2         3.or.more 2         1
## [113] 2         1         0         1         0         0         2
## [120] 1         1         0         1         0         2         2
## [127] 1         0         1         1         0         2         0
## [134] 0         0         0         1         1         0         1
## [141] 0         0         0         1         0         2         2
## [148] 0         0         0         1         2         0         0
## [155] 0         0         3.or.more 1         0         0         0
## [162] 1         0         0         0         0         3.or.more 0
## [169] 1         0         1         0         0         0         0
## [176] 0         1         3.or.more 0         2         1         3.or.more
## [183] 0         0         2         2         0         0         3.or.more
```

```
## Levels: 0 1 2 3.or.more
```

Hint: One way of doing this is with mapvalues, by mapping all instances of 3, 4,... etc, to "3 or more".

(b) Run an ANOVA to determine whether the average birth weight varies across number of physician visits.

```
aov.birthwt <- aov(birthwt.grams ~ phys.visit.binned, data = birthwt)
summary(aov.birthwt)
```

```
##                    Df   Sum Sq Mean Sq F value Pr(>F)
## phys.visit.binned   3  2259057  753019   1.426  0.237
## Residuals         185 97710599  528165
```

The p-value is greater than 0.05, so the variation in birthweight across number of physician visits is not statistically significant.

```
plot(aov.birthwt)
```


Residuals vs Fitted

aov(birthwt.grams ~ phys.visit.binned)

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Normal Q–Q

aov(birthwt.grams ~ phys.visit.binned)

Scale–Location

aov(birthwt.grams ~ phys.visit.binned)

Residuals vs Leverage

aov(birthwt.grams ~ phys.visit.binned)
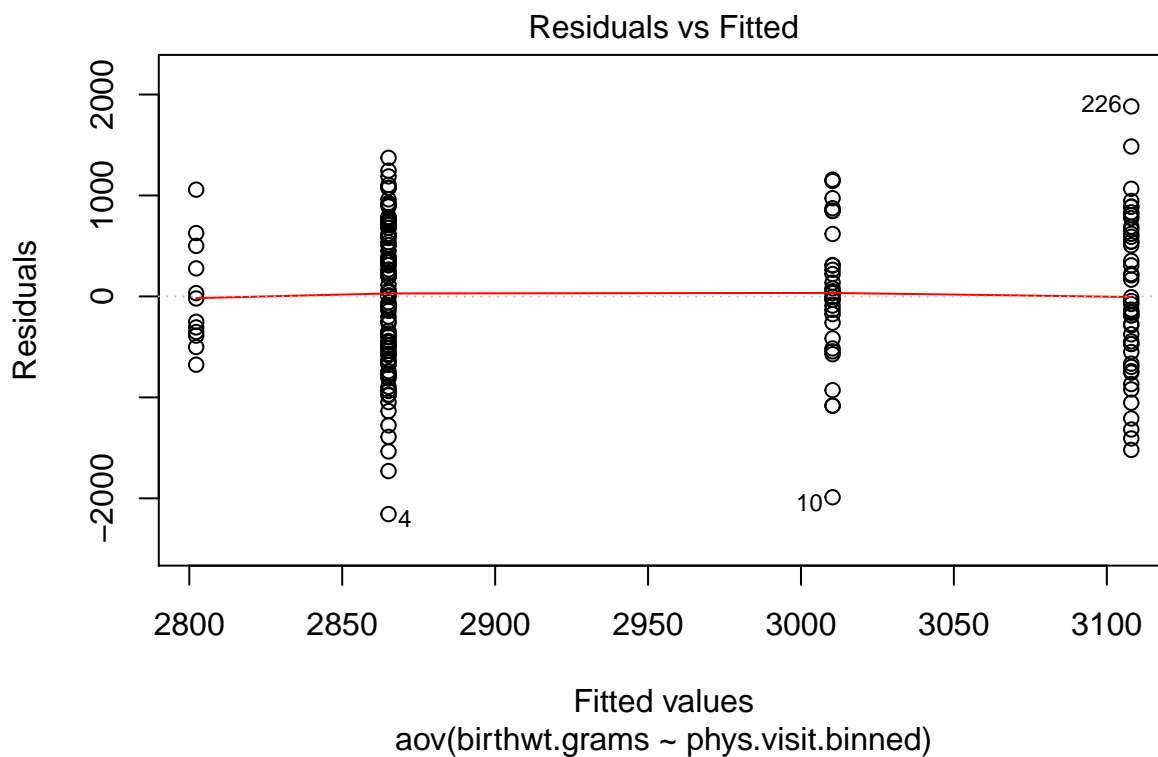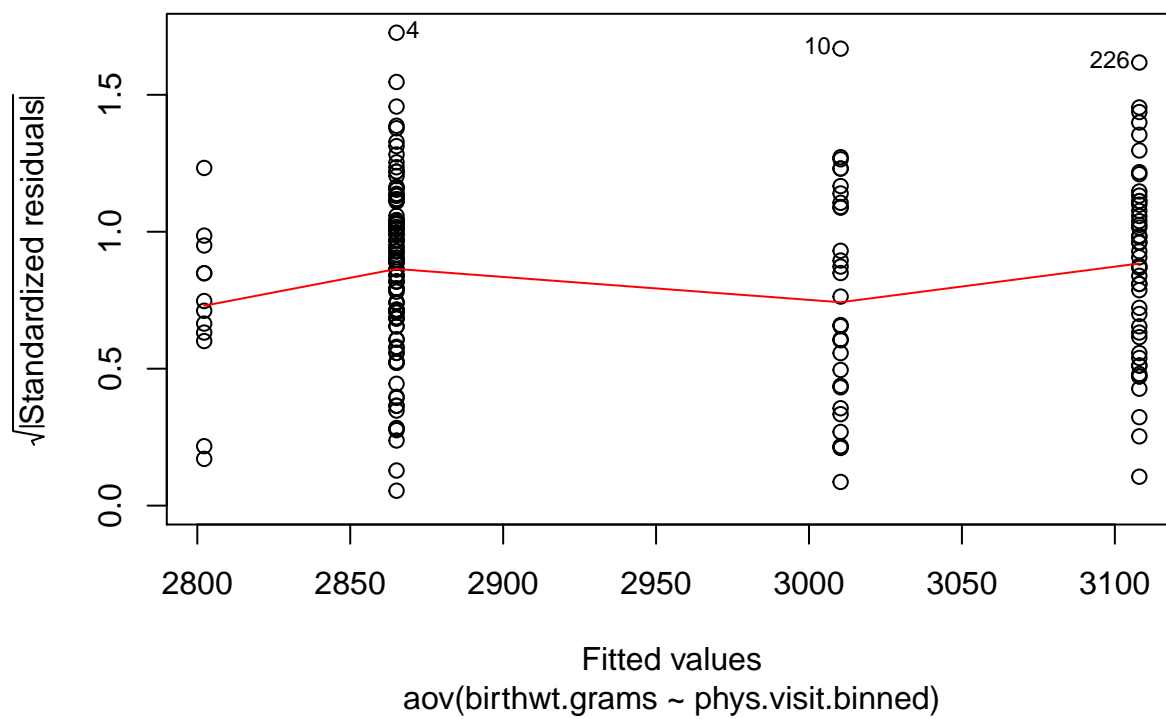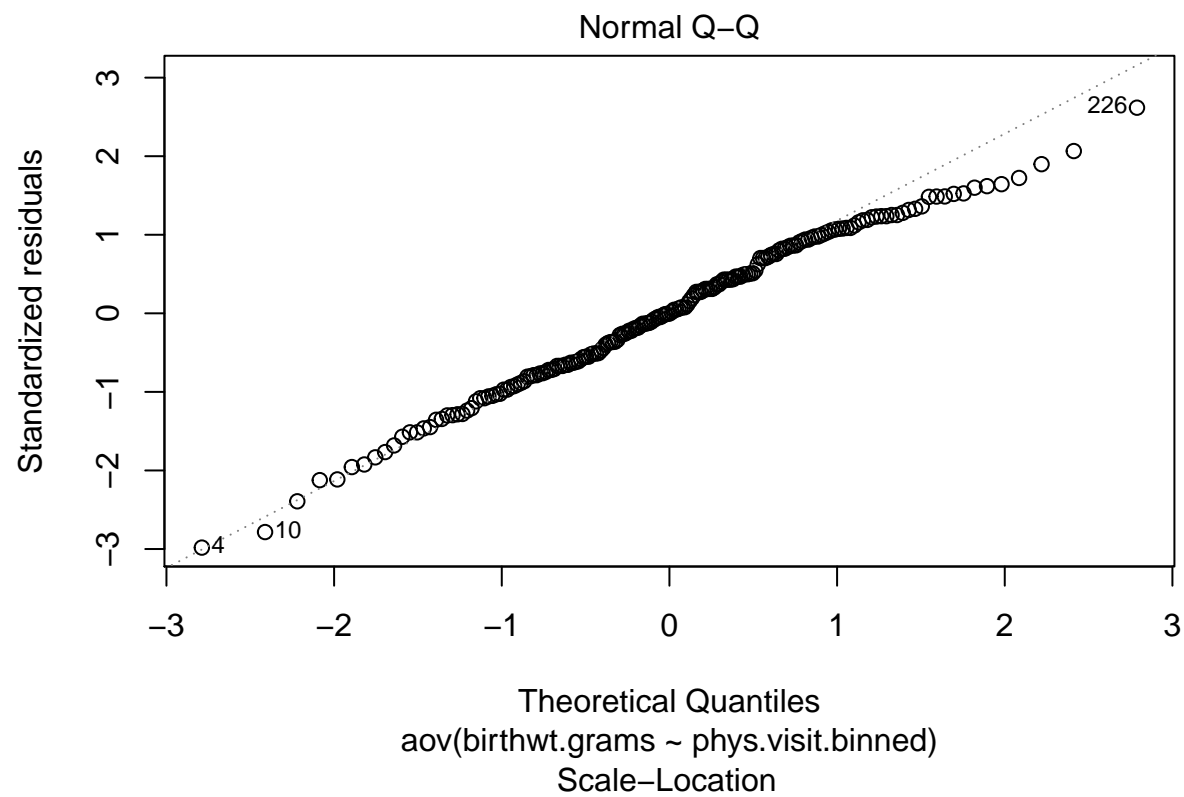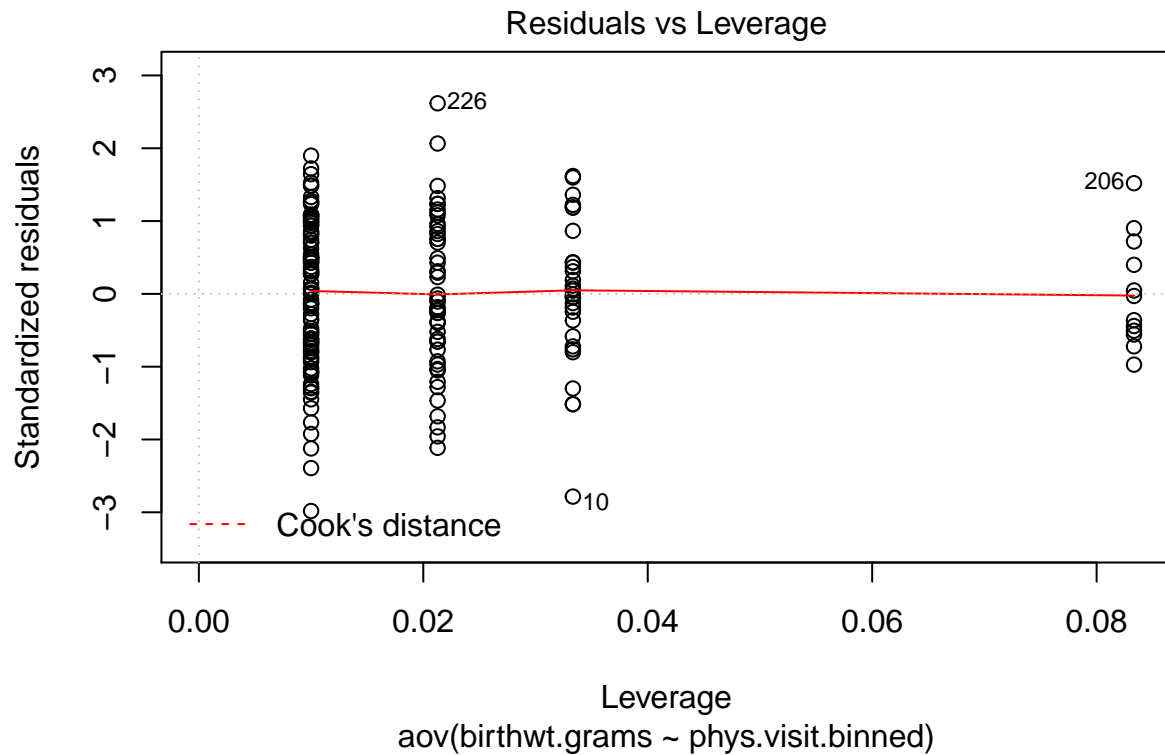
```
posthoc <- TukeyHSD(x=aov.birthwt, 'phys.visit.binned', conf.level=0.95)

print(posthoc)

##   Tukey multiple comparisons of means
##     95% family-wise confidence level
##
## Fit: aov(formula = birthwt.grams ~ phys.visit.binned, data = birthwt)
##
## $phys.visit.binned
##                   diff       lwr      upr     p adj
## 1-0           242.86000  -90.35099 576.0710 0.2360659
## 2-0           145.19333 -247.01844 537.4051 0.7724282
## 3.or.more-0   -62.89000 -638.49952 512.7195 0.9920501
## 2-1           -97.66667 -537.96332 342.6300 0.9394260
## 3.or.more-1  -305.75000 -915.14100 303.6410 0.5636139
## 3.or.more-2  -208.08333 -851.63434 435.4677 0.8361567

plot(posthoc)
```

95% family–wise confidence level

Differences in mean levels of phys.visit.binned
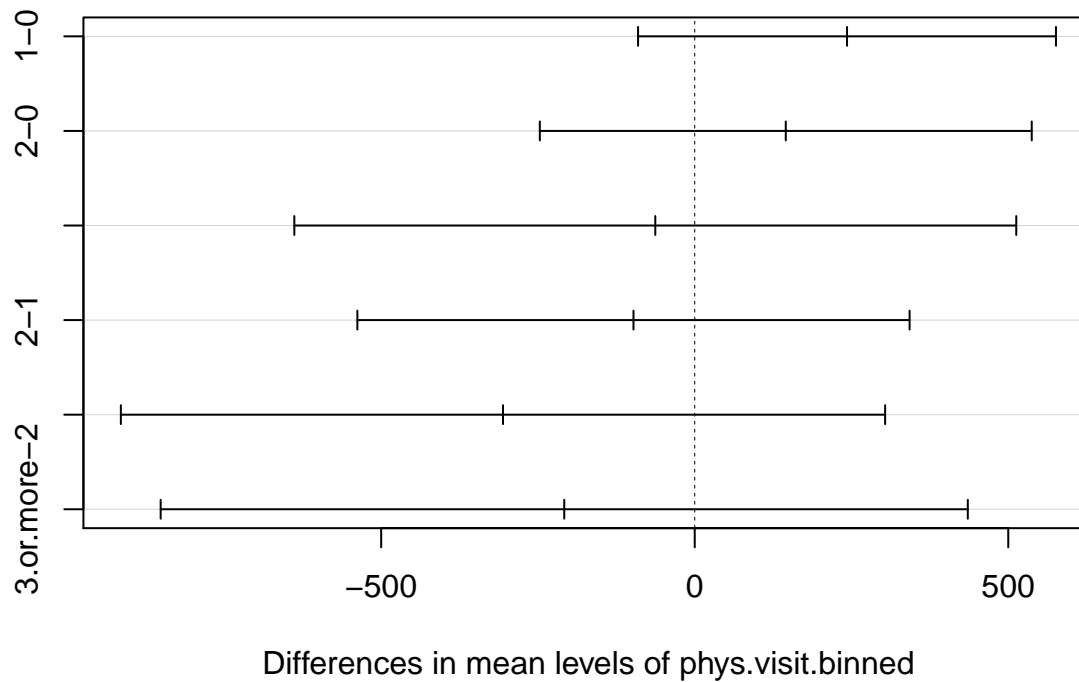
Three-way ANOVA

```
twaov.birthwt <- aov(birthwt.grams ~ race+mother.smokes+phys.visit.binned, data = birthwt)
summary(twaov.birthwt)
```

```
##                    Df    Sum Sq Mean Sq F value   Pr(>F)
## race                2   5015725 2507863   5.227 0.006205 **
## mother.smokes       1   7322575 7322575  15.262 0.000132 ***
## phys.visit.binned   3    311098  103699   0.216 0.885120
## Residuals         182  87320257  479782
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```