Output from mpg.R

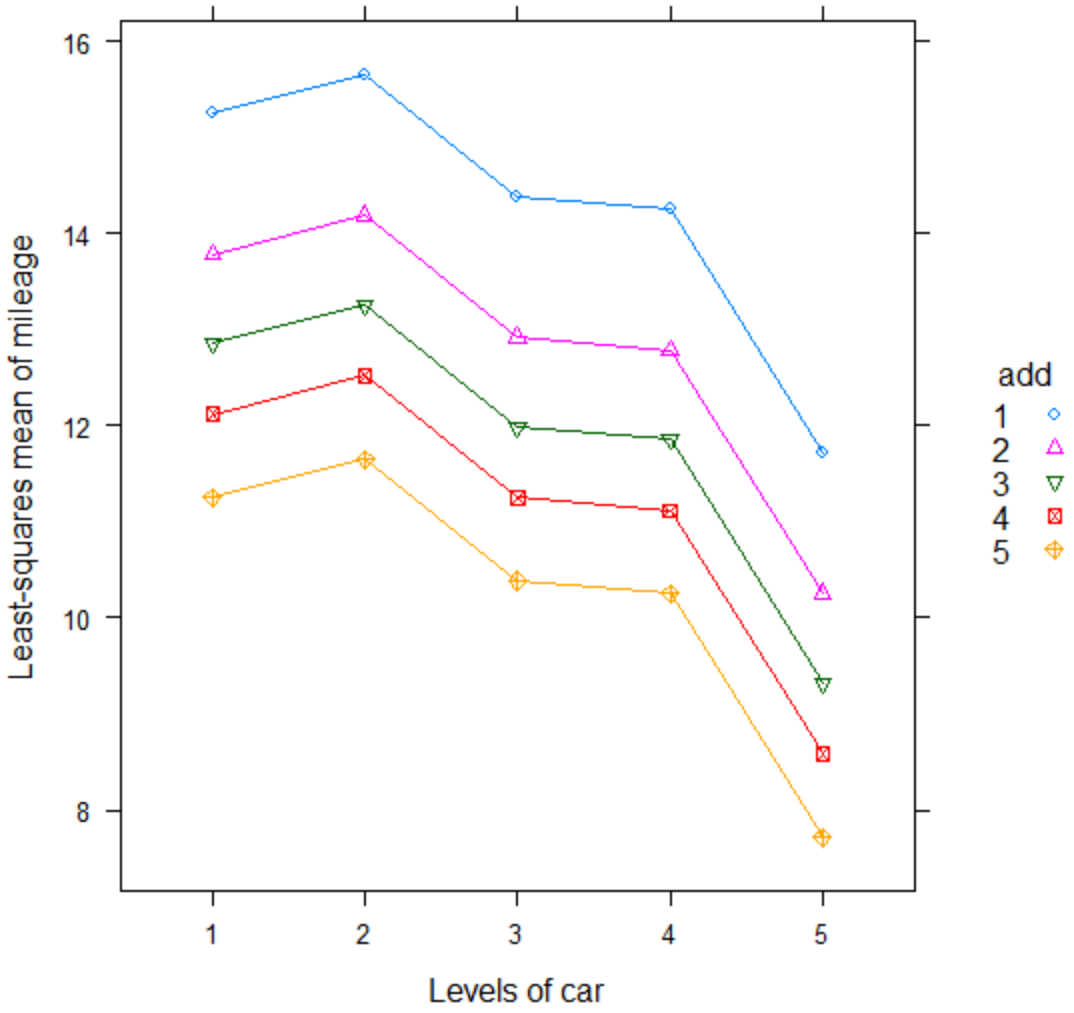
```
> # mpg.R
>
> library(lsmeans)
> library(car)
> library(plyr)
> #library(phia)
> #library(doBy)
>
> # get the data
> mpg <- read.table(file="mpg.dat",header=T,
+                   colClasses=c("factor","factor","numeric"))
> head(mpg)
  car add mileage
1   1   2      14
2   1   3      12
3   1   4      13
4   1   5      11
5   2   1      17
6   2   2      14
> is.factor(mpg$car)
[1] TRUE
> is.factor(mpg$mileage)
[1] FALSE
>
> # the intra-block analysis of a BIBD using ANOVA
> m1<-aov(mileage~add+car,data=mpg)
> summary(m1)
            Df Sum Sq Mean Sq F value  Pr(>F)
add          4  31.70   7.925   8.703 0.00203 **
car          4  35.23   8.808   9.673 0.00132 **
Residuals   11  10.02   0.911
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
> # note that the summary function gives F tests based on type I
> # or sequential sums of squares. To get F tests based on the type III
> # SS, we need the Anova() function from the car package.
>
> Anova(m1,type=3)
Anova Table (Type III tests)

Response: mileage
            Sum Sq Df  F value   Pr(>F)
(Intercept) 398.68  1 437.8167 3.29e-10 ***
add          35.73  4   9.8103 0.001247 **
car          35.23  4   9.6730 0.001321 **
Residuals    10.02 11
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
>
> # get the contrasts of interest
> c1<-c(2,2,2,-3,-3)
> c2<-c(-1,0,1,0,0)
> c3<-c(1,-2,1,0,0)
> c4<-c(0,0,0,1,-1)
```

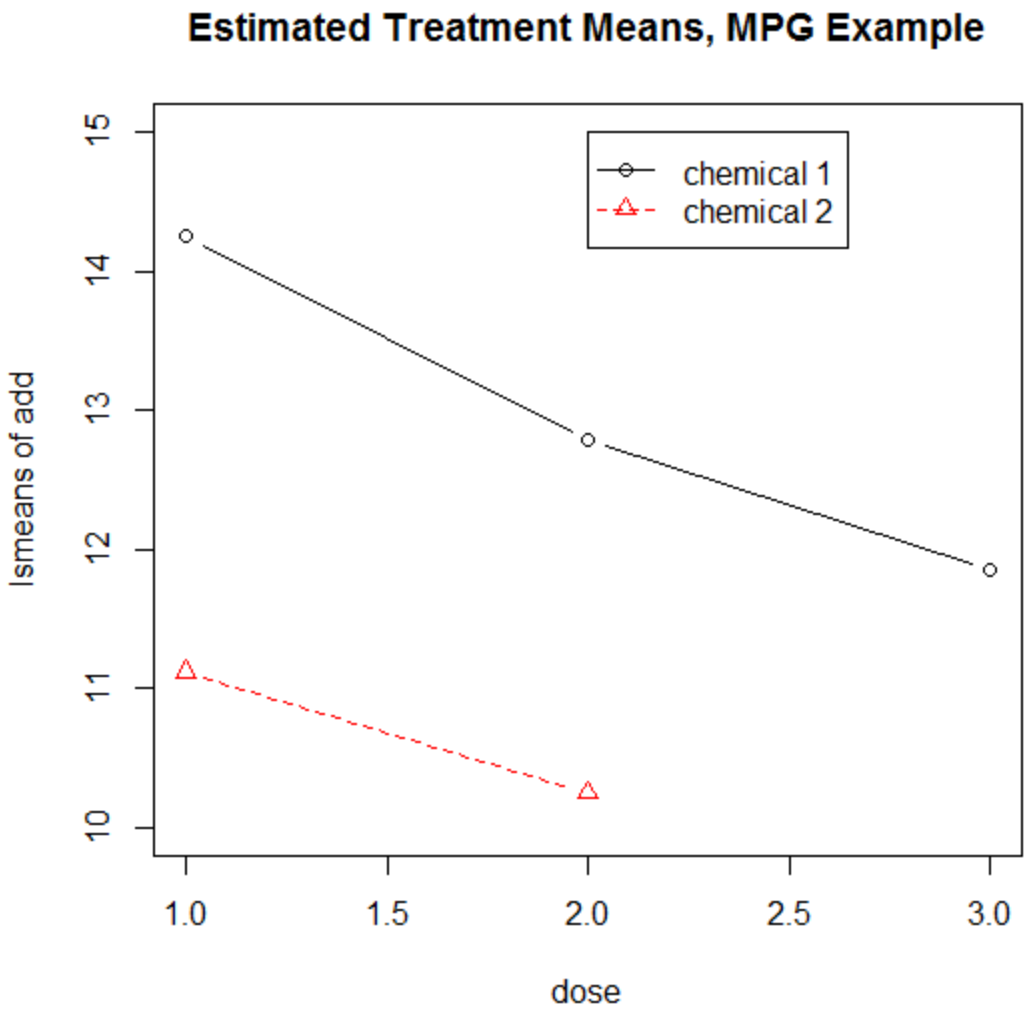
```
>
> lsmeans(m1,specs=lsm~add,contr=list(lsm=list(chemicals=c1,
+                                              linear_chem1=c2,
+                                              nonlinear_chem1=c3,
+                                              doses_chem2=c4)))
$`add lsmeans`
 add   lsmean        SE df  lower.CL upper.CL
   1 14.25000 0.4896866 11 13.172207 15.32779
   2 12.78333 0.4896866 11 11.705540 13.86113
   3 11.85000 0.4896866 11 10.772207 12.92779
   4 11.11667 0.4896866 11 10.038874 12.19446
   5 10.25000 0.4896866 11  9.172207 11.32779

$`add lsm`
                  estimate        SE df  t.ratio p.value
chemicals       13.6666667 2.6990458 11  5.06352 0.00036
linear_chem1    -2.4000000 0.6968906 11 -3.44387 0.00549
nonlinear_chem1  0.5333333 1.2070500 11  0.44185 0.66716
doses_chem2      0.8666667 0.6968906 11  1.24362 0.23949
    p values are not adjusted

>
> # use package plyr to get means instead of lsmeans for each level of add
> # and car. These are not the right estimators of these means, but are produced
> # here for comparison with the lsmeans, which should be used instead.
> ddply(mpg, .(add), summarize, mean_mileage=mean(mileage))
  add mean_mileage
1   1        14.00
2   2        12.75
3   3        11.50
4   4        11.75
5   5        10.25
> ddply(mpg, .(car), summarize, mean_mileage=mean(mileage))
  car mean_mileage
1   1        12.50
2   2        13.50
3   3        12.00
4   4        12.50
5   5         9.75
>
> # Plot of estimated means for each additive, by car. Note that this is an
> # additive model, so the mean profiles are necessarily parallel (the model
> # constrains them to be so). Allowing them to be otherwise would require a
> # replicated experiment and a more complex model (e.g., one with a car*add
> # interaction)
> lsmip(m1,add~car)
```




```
>
> # plot of add means to show the "dose" effect for each chemical
> # create variables "dose" and "chemical"
> addmeans<-lsmeans(m1,specs=~add)[[1]]
> addmeans$dose<-c(1,2,3,1,2)
> addmeans$chemical<-c(1,1,1,2,2)
> head(addmeans)
 add   lsmean        SE df  lower.CL upper.CL dose chemical
   1 14.25000 0.4896866 11 13.172207 15.32779    1        1
   2 12.78333 0.4896866 11 11.705540 13.86113    2        1
   3 11.85000 0.4896866 11 10.772207 12.92779    3        1
   4 11.11667 0.4896866 11 10.038874 12.19446    1        2
   5 10.25000 0.4896866 11  9.172207 11.32779    2        2
>
> plot(addmeans$dose[1:3],addmeans$lsmean[1:3],ylim=c(10,15),
+      type="b",lty=1,pch=1,col=1,
+      main="Estimated Treatment Means, MPG Example",ylab="lsmeans of add",
+      xlab="dose")
> lines(addmeans$dose[4:5],addmeans$lsmean[4:5],type="b",lty=2,pch=2,col=2)
> legend(2,15,legend=c("chemical 1","chemical
2"),lty=c(1,2),pch=c(1,2),col=c(1,2))
```


Estimated Treatment Means, MPG Example
chemical 1
chemical 2
lsmeans of add
10
11
12
13
14
15
1.0
1.5
2.0
2.5
3.0
dose