# Untitled

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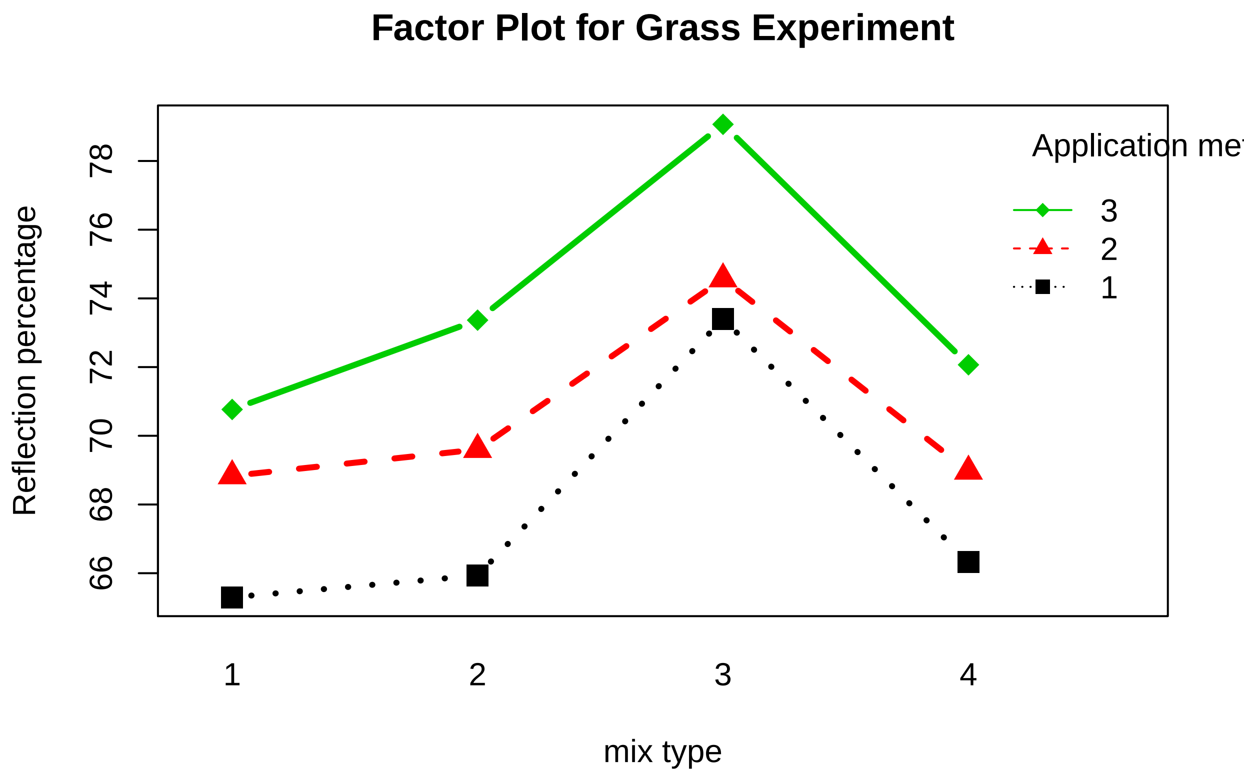
## 4a

```
day <- as.factor(c(rep(1,12),rep(2,12),rep(3,12)))
application <- as.factor(rep(c(rep(1,4),rep(2,4),rep(3,4)),3))
mix <- as.factor(rep(c(1,2,3,4),9))
reflect <- c(64.5,66.3,74.1,66.5,
             68.3, 69.5, 73.8, 70.0,
             70.3, 73.1, 78.0, 72.3,
             65.2, 65.0, 73.8, 64.8,
             69.2, 70.3, 74.5, 68.3,
             71.2, 72.8, 79.1, 71.5,
             66.2, 66.5, 72.3, 67.7,
             69.0, 69.0, 75.4, 68.6,
             70.8, 74.2, 80.1, 72.4)


df.4 <- data.frame(day,application,mix,reflect)
```

```
interaction.plot(x.factor=df.4$mix,trace.factor=df.4$application,
    response=df.4$reflect,trace.label="Application method",
    xlab="mix type",ylab="Reflection percentage",
    col=1:4,lwd=3,type="b",pch=c(15,17,18:19),
    main="Factor Plot for Grass Experiment",cex=1.5)
```




Because the lines don't intersect, we don't suspect an interaction effect present.

## 4b

```
out.4b <- aov(reflect~day+mix*application,data=df.4)
summary(out.4b)
```

```
##                 Df Sum Sq Mean Sq F value   Pr(>F)
## day              2   2.04    1.02   1.470   0.2517
## mix              3 307.48  102.49 147.584 1.01e-14 ***
## application      2 222.09  111.05 159.903 7.85e-14 ***
## mix:application  6  10.04    1.67   2.409   0.0609 .
## Residuals       22  15.28    0.69
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

the p-value for mix:application is .0609 which is higher than 0.05, so we conclude that there is no interaction effect present. This agrees with the statment from 4a.

## 4c

The applcation's pvalue is $1.01 * 10^{-14}$ and the mix's pvalue is $7.85 * 10^{-14}$ Both application and mix type have p-values under 0.05, so we conclude that both application and mix type are significant effects.

## 4d

## 5a

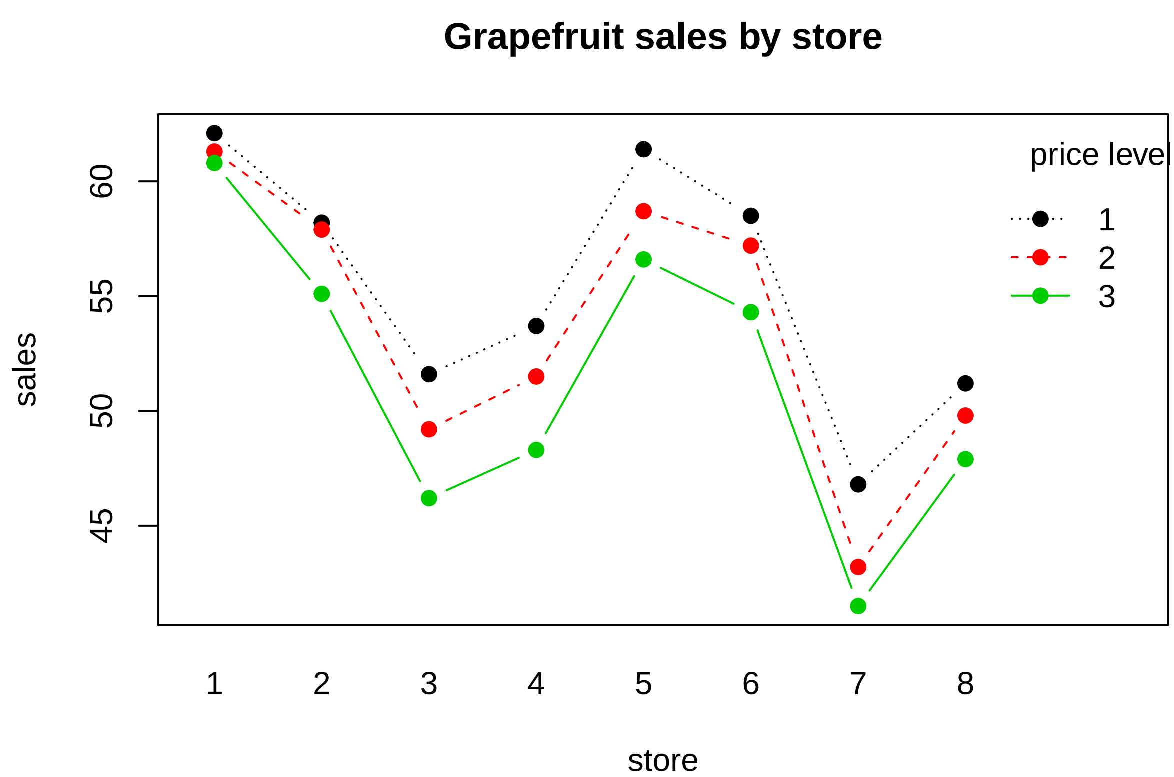
```
sales <- c(62.1, 61.3, 60.8,
 58.2, 57.9 ,55.1,
 51.6 ,49.2 ,46.2,
 53.7, 51.5 ,48.3,
 61.4, 58.7 ,56.6,
 58.5, 57.2 ,54.3,
 46.8, 43.2, 41.5,
51.2, 49.8, 47.9)

store<- as.factor(sort(rep(c(1,2,3,4,5,6,7,8),3)))

price<- as.factor(rep(c(1,2,3),8))


df.5<-data.frame(sales,store,price)
```

```
interaction.plot(x.factor=df.5$store,trace.factor=df.5$price,
    response=df.5$sales,fun=mean,type="b",col=1:6,trace.label="price level",
    xlab="store",ylab="sales",main="Grapefruit sales by store",fixed=T,pch=19)
```




Yes each of the lines look roughly parallel to the others.

## 5b

```r
library(car)
```

```
## Warning: package 'car' was built under R version 3.4.4
```

```
## Loading required package: carData
```

```
## Warning: package 'carData' was built under R version 3.4.4
```

```r
df5.2 <- with(df.5,cbind(sales[price=="1"],sales[price=="2"],
    sales[price=="3"]))

df5.mlm <- lm(df5.2~1)
price <- as.factor(1:3)
options(contrasts=c("contr.sum", "contr.poly"))
df5.aov <- Anova(df5.mlm,idata=data.frame(price),
    idesign=~price,type="III")
summary(df5.aov,multivariate=F)
```

```
##
## Univariate Type III Repeated-Measures ANOVA Assuming Sphericity
##
##              Sum Sq num Df Error SS den Df F value    Pr(>F)
## (Intercept)  68587      1   745.18      7 644.282 3.762e-08 ***
## price           67      2     9.57     14  49.346 4.567e-07 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Mauchly Tests for Sphericity
##
##       Test statistic p-value
## price        0.67868  0.3126
##
##
## Greenhouse-Geisser and Huynh-Feldt Corrections
##  for Departure from Sphericity
##
##        GG eps Pr(>F[GG])
## price 0.75682  8.802e-06 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##          HF eps   Pr(>F[HF])
## price 0.9212925 1.186949e-06
```

The p=value for the Mauchly test is .3126, so the test is not significant against the Huynh-Feldt condition and sphericity is an appropriate assumption.

## 5c

```
out.5 <- lm(sales~store+price,data=df.5)
anova(out.5)
```

```
## Analysis of Variance Table
##
## Response: sales
##           Df Sum Sq Mean Sq F value    Pr(>F)
## store      7 745.19 106.455 155.693 3.473e-12 ***
## price      2  67.48  33.740  49.346 4.567e-07 ***
## Residuals 14   9.57   0.684
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

The p-vlue for this test is $4.567 * 10^{-7}$. This pvalue is less than alpha, so we conclude there is sufficient evidence that price level has a significant effect.

## 6a

```
truth<- c(3, 1, 2, 5, 4,
 4, 2, 1, 3, 5,
 4, 2, 3, 1, 5,
 3, 1, 2, 5, 4,
 4, 1, 2, 5, 3,
 4, 2, 1, 3, 5,
 4, 1, 2, 3, 5,
 5, 1, 3, 2, 4,
 4, 2, 3, 1, 5,
 5, 1, 2, 3, 4)

subject<- as.factor(sort(rep(c(1,2,3,4,5,6,7,8,9,10),5)))

ad<- as.factor(rep(c(1,2,3,4,5),10))

df6<-data.frame(truth,subject,ad)
```

```
out6 <- anova(lm(truth~ad,data=df6))

n <- length(unique(df6$subject))
r <- length(unique(df6$ad))

out6
```

```
## Analysis of Variance Table
##
## Response: truth
##           Df Sum Sq Mean Sq F value    Pr(>F)
## ad         4   63.4 15.8500  19.488 2.302e-09 ***
## Residuals 45   36.6  0.8133
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
tmp <- out6$"Sum Sq"/c((r-1),(n-1)*(r-1))
F.star <- tmp[1]/tmp[2]
```

```r
pf(F.star,r-1,(n-1)*(r-1),lower=F)
```

```
## [1] 1.723857e-07
```

So $F_R^* = \frac{MSTR}{MSRM} = \frac{63.4/(10-1)}{36.6/((10-1)(5-1))} = 15.59$ which is distributed F with degrees 9,36

which has a pvalue of $1.72 * 10^{-7}$ which indicates highly significant evidence of advertisment affecting how participants perceive truthfulness.

# 6b

```r
library(xtable)
```

```
## Warning: package 'xtable' was built under R version 3.4.3
```

```r
g <- r*(r-1)/2
truth.means <- c(by(df6[,1],df6[,3],mean))
CIs<-rbind((apply(combn(truth.means,2), 2, diff))-qnorm(1-(.2/(2*g)))*sqrt(r*(r+1)/(6*n)),
(apply(combn(truth.means,2), 2, diff))+qnorm(1-(.2/(2*g)))*sqrt(r*(r+1)/(6*n)))

comparison.first<-c("A","A","A","A","B","B","B","C","C","D")
comparison.second<- c("B","C","D","E","C","D","E","D","E","E")
CI.lower<-CIs[1,]
CI.upper<-CIs[2,]
differ<-c("yes","yes","no","no",
          "no","yes","yes",
          "no","yes",
          "no")

df.6b<-data.frame(comparison.first,comparison.second,CI.lower,CI.upper,differ)

xtable(df.6b)
```

% latex table generated in R 3.4.0 by xtable 1.8-2 package % Mon Nov 26 00:08:26 2018

| | comparison.first | comparison.second | CI.lower | CI.upper | differ |
|---|---|---|---|---|---|
| 1 | A | B | -4.24 | -0.96 | yes |
| 2 | A | C | -3.54 | -0.26 | yes |
| 3 | A | D | -2.54 | 0.74 | no |
| 4 | A | E | -1.24 | 2.04 | no |
| 5 | B | C | -0.94 | 2.34 | no |
| 6 | B | D | 0.06 | 3.34 | yes |
| 7 | B | E | 1.36 | 4.64 | yes |
| 8 | C | D | -0.64 | 2.64 | no |
| 9 | C | E | 0.66 | 3.94 | yes |
| 10 | D | E | -0.34 | 2.94 | no |