Untitled

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3

```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
library(agricolae)
```

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

```r
impure <- c(5,4,6,3,5,
            3,1,4,2,3,
            1,1,3,1,2)

temperature <- as.factor(sort(rep(c(100,125,150),5)))
pressure <- as.factor(rep(c(25,30,35,40,45),1))

tab.3<-data.frame(impure,temperature,pressure)
```

```r
out.single <- anova(lm(impure~temperature+pressure,data=tab.3))
out.single
```

```
## Analysis of Variance Table
##
## Response: impure
##             Df Sum Sq Mean Sq F value    Pr(>F)
## temperature  2 23.333  11.667  46.667 3.885e-05 ***
## pressure     4 11.600   2.900  11.600  0.002063 **
## Residuals    8  2.000   0.250
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
nonadditivity(impure,temperature,pressure,df=out.single$"Df"[3],
    MSerror=out.single$"Mean Sq"[3])
```

```
##
## Tukey's test of nonadditivity
## impure
##
## P : 2.666667
## Q : 72.17778
##
## Analysis of Variance Table
##
## Response: residual
```

```
##                Df  Sum Sq  Mean Sq F value Pr(>F)
## Nonadditivity  1 0.09852 0.098522  0.3627  0.566
## Residuals      7 1.90148 0.271640
```

```
## $P
## Nonadditivity
##      2.666667
##
## $Q
## Nonadditivity
##      72.17778
##
## $ANOVA
## Analysis of Variance Table
##
## Response: residual
##                Df  Sum Sq  Mean Sq F value Pr(>F)
## Nonadditivity  1 0.09852 0.098522  0.3627  0.566
## Residuals      7 1.90148 0.271640
```

```r
grand <- mean(impure)
mean1 <- c(by(tab.3[,1],tab.3[,2],mean))
mean2 <- c(by(tab.3[,1],tab.3[,3],mean))
n <- rep(1,1)

tab.3b <- tab.3
tab.3b[,1] <- ((rep(mean1,n)-grand)*impure)
Pj <- c(by(tab.3b[,1],tab.3b[,3],sum))

P <- sum(Pj*(mean2-grand))

ss1 <- sum((mean1-grand)^2)
ss2 <- sum((mean2-grand)^2)

ss1;ss2
```

```
## [1] 4.666667
```

```
## [1] 3.866667
```

```r
P^2/(ss1*ss2)
```

```
## [1] 2.317488
```

Test statistic:0.3627 df:1 p-value:.566 Because the p-value (0.566) is greater than alpha=0.05, we see that nonadditvity is not significant, so a there is not a significant interaction present.

4a

```r
library(xtable)
```

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

```r
A=c("-","+","Factor B means")
B.minus = c(16.1,24.03,20.2)
B.plus = c(14.93,40.28,27.61)
```

```r
factor.a.means=c(15.52,32.16,23.84)
table.4a=data.frame(A,B.minus,B.plus,factor.a.means)
xtable(table.4a)
```

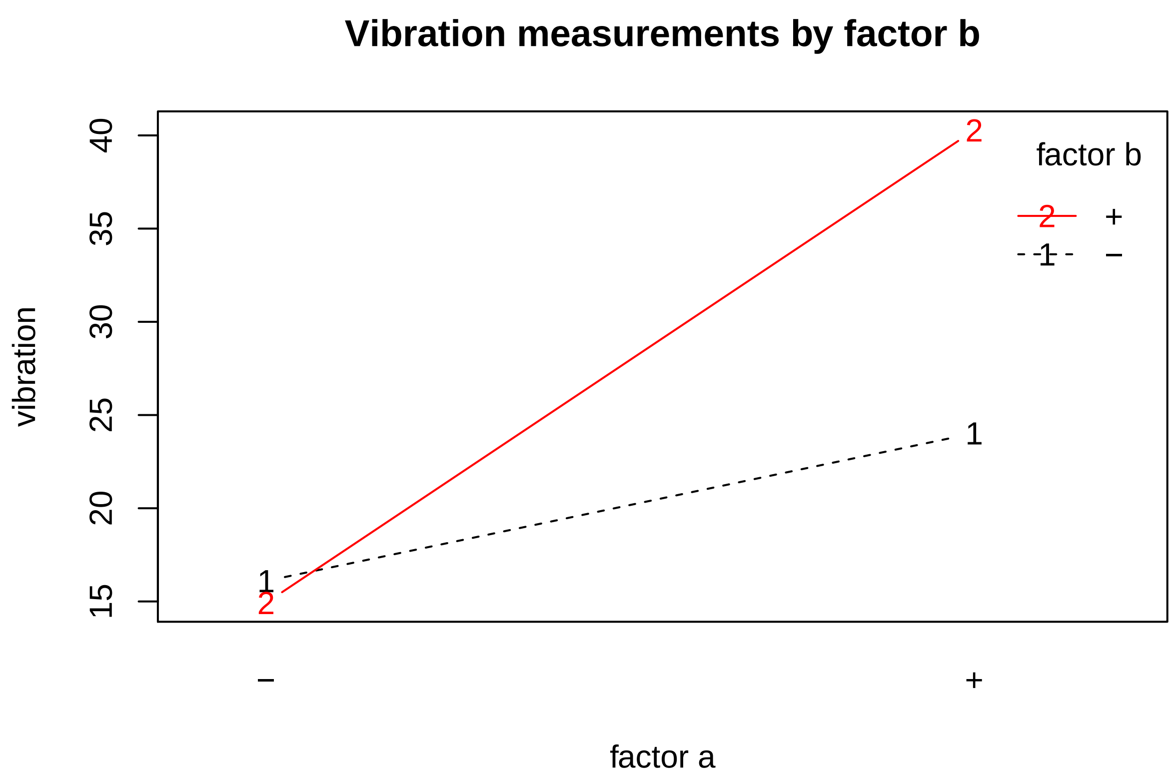
% latex table generated in R 3.4.0 by xtable 1.8-2 package % Mon Nov 05 01:58:52 2018

	A	B.minus	B.plus	factor.a.means
1	-	16.10	14.93	15.52
2	+	24.03	40.28	32.16
3	Factor B means	20.20	27.61	23.84

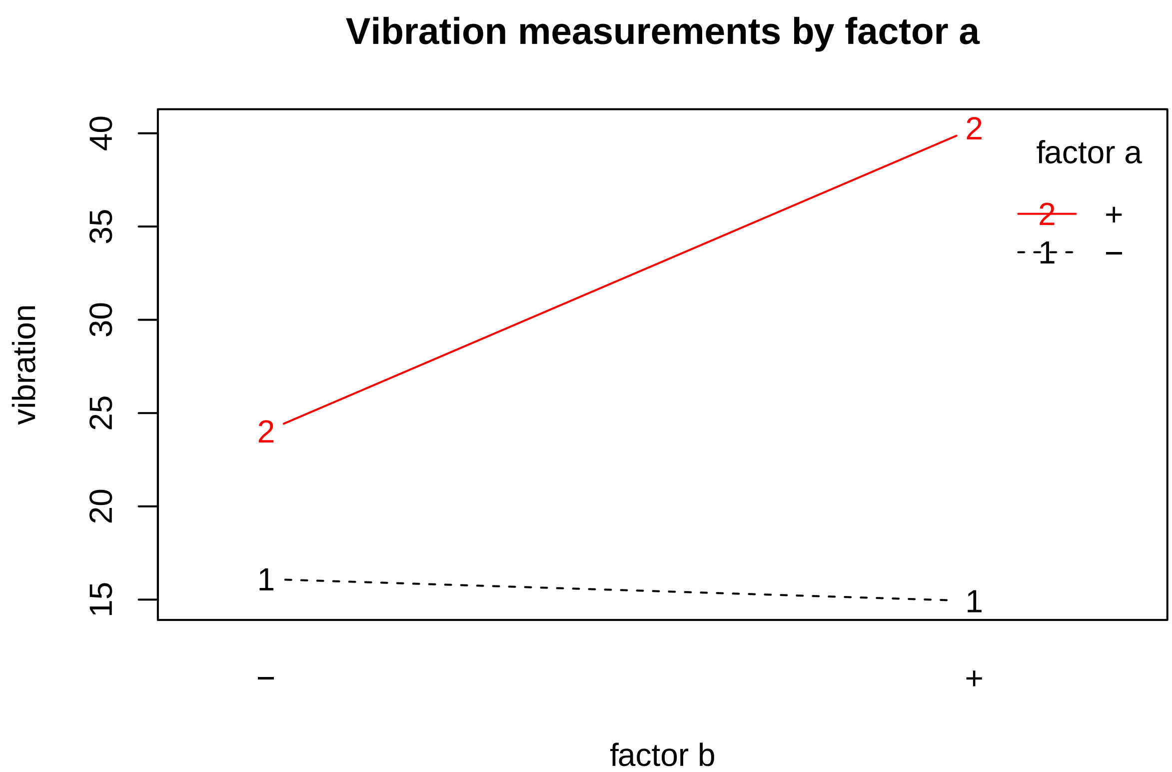
4b

```r
vib=c(18.2,18.9,12.9,14.4,
      27.2,24,22.4,22.5,
      15.9,14.5,15.1,14.2,
      41,43.9,36.3,39.9)
fac.a=as.factor(c(rep("-",4),rep("+",4),rep("-",4),rep("+",4)))
fac.b=as.factor(c(rep("-",4),rep("-",4),rep("+",4),rep("+",4)))
tab.4b=data.frame(vib,fac.a,fac.b)
```

```r
interaction.plot(x.factor=tab.4b$fac.a,trace.factor = tab.4b$fac.b,response = tab.4b$vib,
                 fun=mean,type = 'b',col = 1:2,trace.label = "factor b",
                 xlab="factor a",ylab="vibration", main="Vibration measurements by factor b")
```



```r
interaction.plot(x.factor=tab.4b$fac.b,trace.factor = tab.4b$fac.a,response = tab.4b$vib,
                 fun=mean,type = 'b',col = 1:2,trace.label = "factor a",
                 xlab="factor b",ylab="vibration", main="Vibration measurements by factor a")
```



As these lines are not parallel, there is an interaction effect present.

4c

Simple effect of bit size on vibration with a cutting speed of 40 rpm: $24.03 - 16.1 = 7.93$. So the average vibration of 1/8 bitsizes was 7.93 greater than that for 1/16 bitsizes when cutting speed was 40.

Simple effect of bit size on vibration with a cutting speed of 90 rpm: $40.28 - 14.93 = 25.35$. So The average vibration of 1/8 bitsizes was 25.35 greater than that for 1/16 bitsizes when cutting speed was 90.

Simple effect of cutting speed on vibration with a bit size of 1/16 in.: $14.93 - 16.1 = -1.17$. So The average vibration of 90 cutting speed was 1.17 smaller than that for 40 cutting speed when bitsize was 1/16.

Simple effect of cutting speed on vibration with a bit size of 1/8 in.: $40.28 - 24.03 = 16.25$. So The average vibration of 90 cutting speed was 16.25 greater than that for 40 cutting speed when bitsize was 1/8.

Main effect of bit size on vibration.:$32.16 - 15.52 = 16.64$. So The difference in vibration between 1/16 and 1/8 bit sizes is 16.64 in favor of the 1/8 bitsize when averaged over both cutting speeds

Main effect of cutting speed on vibration. $27.6 - 20.2 = 7.4$. So The difference in vibration between 40 and 90 rpms is 7.4 in favor of the 90rpm speed when averaged over both bit sizes

Interaction effect of bit size and cutting speed on vibration. $\frac{25.35-7.93}{2} = 8.71$. So One-half the average difference between bitsize was 8.71 greater with a speed of 90rpm than it was with a 40rpm speed.

5a

Each pair occurred together once in the same block. we have 4 treatments and 6 blocks, so $b \neq t$ so this BIBD is not symmetric $\lambda = \frac{r(k-1)}{t-1} = \frac{3*1}{3} = 1$ efficiency is $\frac{t\lambda}{rk} = \frac{4*1}{3*2} = \frac{2}{3}$

5b

```
library(lsmeans)
```

```
## Loading required package: emmeans

## Warning: package 'emmeans' was built under R version 3.4.4

## The 'lsmeans' package is now basically a front end for 'emmeans'.
## Users are encouraged to switch the rest of the way.
## See help('transition') for more information, including how to
## convert old 'lsmeans' objects and scripts to work with 'emmeans'.
```

```
block <- c(1,4,2,4,1,2,3,4,1,3,2,3)
temp <- sort(rep(c(25,30,35,40),3))
germ <- c(24.65,1.34,
          24.38,2.24,
          29.17,21.25,
          5.9,1.83,
          28.90,18.27,
          25.53,8.42)
```