Aula Prática 03 - Estatística Experimental

DELINEAMENTO EM QUADRADO LATINO

```
> rm(list = ls(all = TRUE))
> require(dae)
> t <- 5
> n <- t * t
> Standard.order <- factor(1:n)
> Random.Order <- order(rep(runif(t), each = t), rep(runif(t),
+     times = t))
> cana.design <- fac.divide(Random.Order, list(linha = t, coluna = t))
> tratamento <- factor(c("A", "B", "C", "D", "E", "B", "C", "D",
+     "E", "A", "C", "D", "E", "A", "B", "D", "E", "A", "B", "C",
+     "E", "A", "B", "C", "D"), labels = c("A", "B", "C", "D",
+     "E"))
> cana.design <- data.frame(Standard.order, Random.Order, cana.design,
+     tratamento)
> cana.design[cana.design$Random.Order, ] <- cana.design
> cana.design[, 3:5]
```

```
   linha coluna tratamento
1      1      1          B
2      1      2          D
3      1      3          E
4      1      4          C
5      1      5          A
6      2      1          D
7      2      2          A
8      2      3          B
9      2      4          E
10     2      5          C
11     3      1          E
12     3      2          B
13     3      3          C
14     3      4          A
15     3      5          D
16     4      1          A
17     4      2          C
18     4      3          D
19     4      4          B
20     4      5          E
21     5      1          C
22     5      2          E
23     5      3          A
24     5      4          D
25     5      5          B
```

```
> linha <- c(1, 1, 1, 1, 1, 2, 2, 2, 2, 2, 3, 3, 3, 3, 3, 4, 4,
+     4, 4, 4, 5, 5, 5, 5, 5)
> coluna <- c(1, 2, 3, 4, 5, 1, 2, 3, 4, 5, 1, 2, 3, 4, 5, 1, 2,
+     3, 4, 5, 1, 2, 3, 4, 5)
> trat <- c("D", "A", "B", "C", "E", "C", "E", "A", "B", "D", "E",
+     "B", "C", "D", "A", "B", "D", "E", "A", "C", "A", "C", "D",
```

```
+     "E", "B")
> prod <- c(432, 518, 458, 583, 331, 724, 478, 524, 550, 400, 489,
+     384, 556, 297, 420, 494, 500, 313, 486, 501, 515, 660, 438,
+     394, 318)
> dad <- data.frame(cbind(linha, coluna, trat, prod))
> dad
```

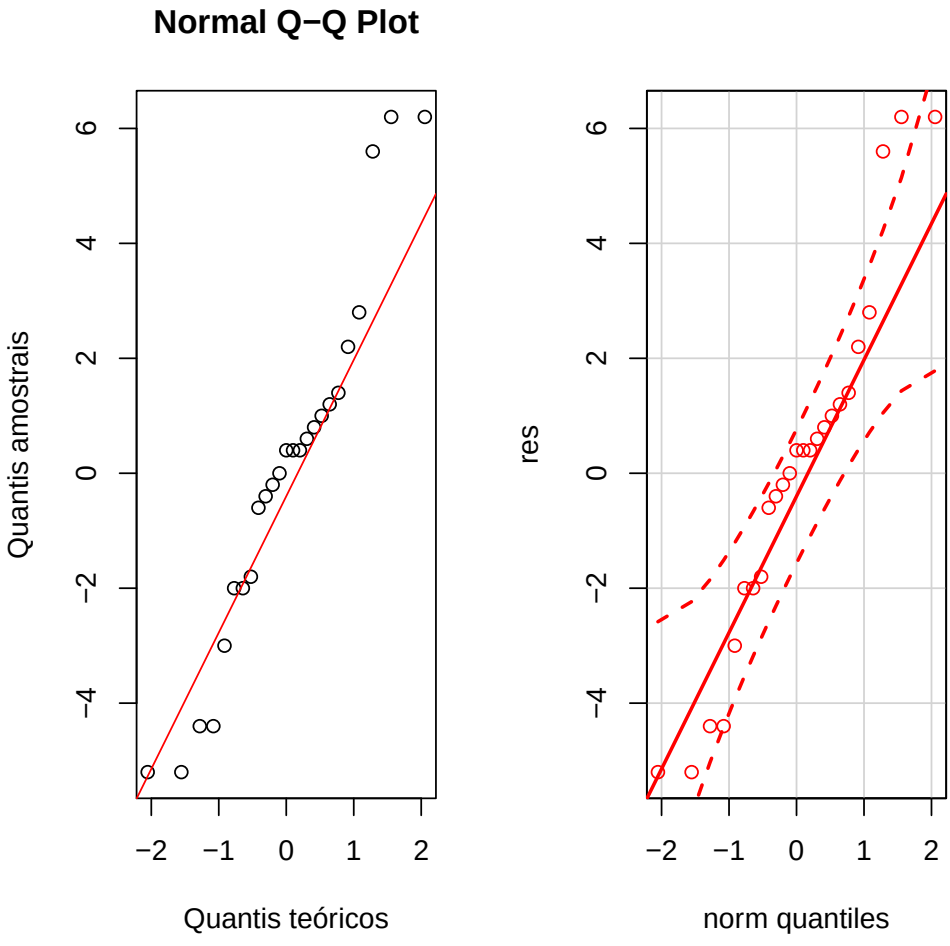
	linha	coluna	trat	prod
1	1	1	D	432
2	1	2	A	518
3	1	3	B	458
4	1	4	C	583
5	1	5	E	331
6	2	1	C	724
7	2	2	E	478
8	2	3	A	524
9	2	4	B	550
10	2	5	D	400
11	3	1	E	489
12	3	2	B	384
13	3	3	C	556
14	3	4	D	297
15	3	5	A	420
16	4	1	B	494
17	4	2	D	500
18	4	3	E	313
19	4	4	A	486
20	4	5	C	501
21	5	1	A	515
22	5	2	C	660
23	5	3	D	438
24	5	4	E	394
25	5	5	B	318

```
> dad$prod <- as.numeric(dad$prod)
> rm(linha, coluna, trat, prod)

> dad$linha <- as.factor(dad$linha)
> dad$coluna <- as.factor(dad$coluna)

> bartlett.test(prod ~ linha + coluna + trat, dad)

        Bartlett test of homogeneity of variances

data:  prod by linha by coluna by trat
Bartlett's K-squared = 0.497, df = 4, p-value = 0.9738

> modelo <- aov(prod ~ linha + coluna + trat, data = dad)
> anova(modelo)

Analysis of Variance Table
```

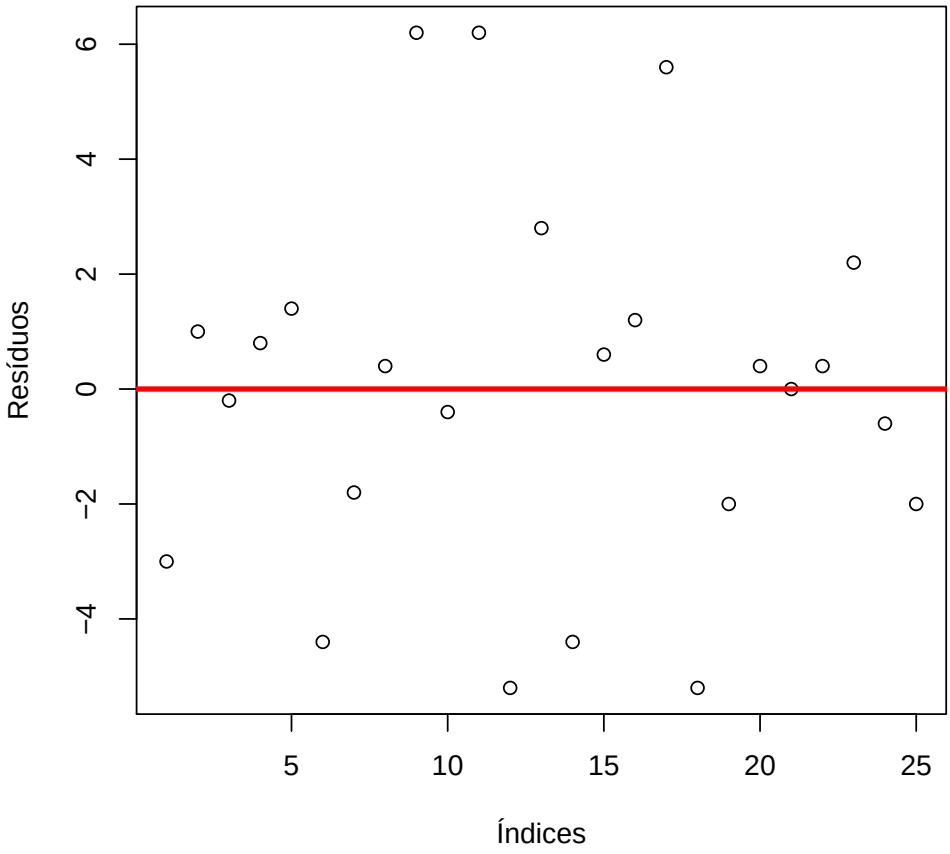
```
Response: prod
          Df Sum Sq Mean Sq F value   Pr(>F)
linha      4  129.2  32.300  1.6123 0.234538
coluna     4  210.8  52.700  2.6306 0.087004 .
trat       4  719.6 179.900  8.9800 0.001356 **
Residuals 12  240.4  20.033
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
> res <- modelo$residuals
```

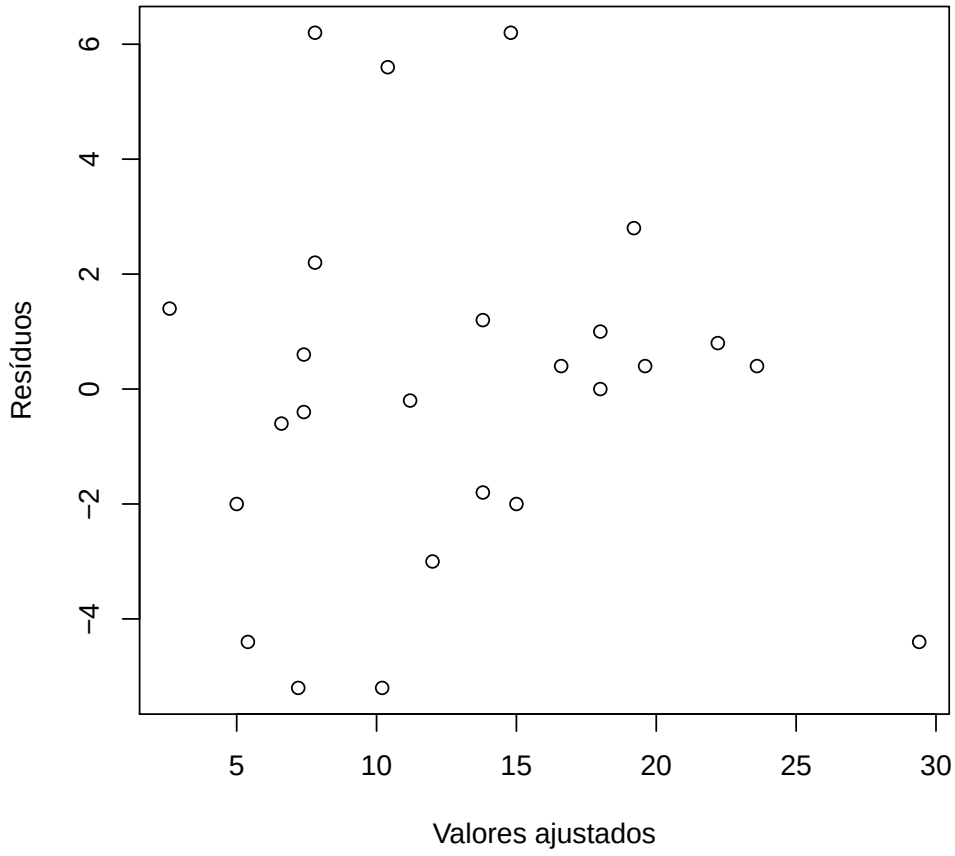
```
> require(car)
> par(mfrow = c(1, 2))
> qqnorm(res, xlab = "Quantis teóricos", ylab = "Quantis amostrais")
> qqline(res, col = "red")
> qqPlot(res)
```




```
> par(mfrow = c(1, 1))
> plot(res, xlab = "Índices", ylab = "Resíduos")
> abline(h = 0, col = "red", lwd = 3)
```



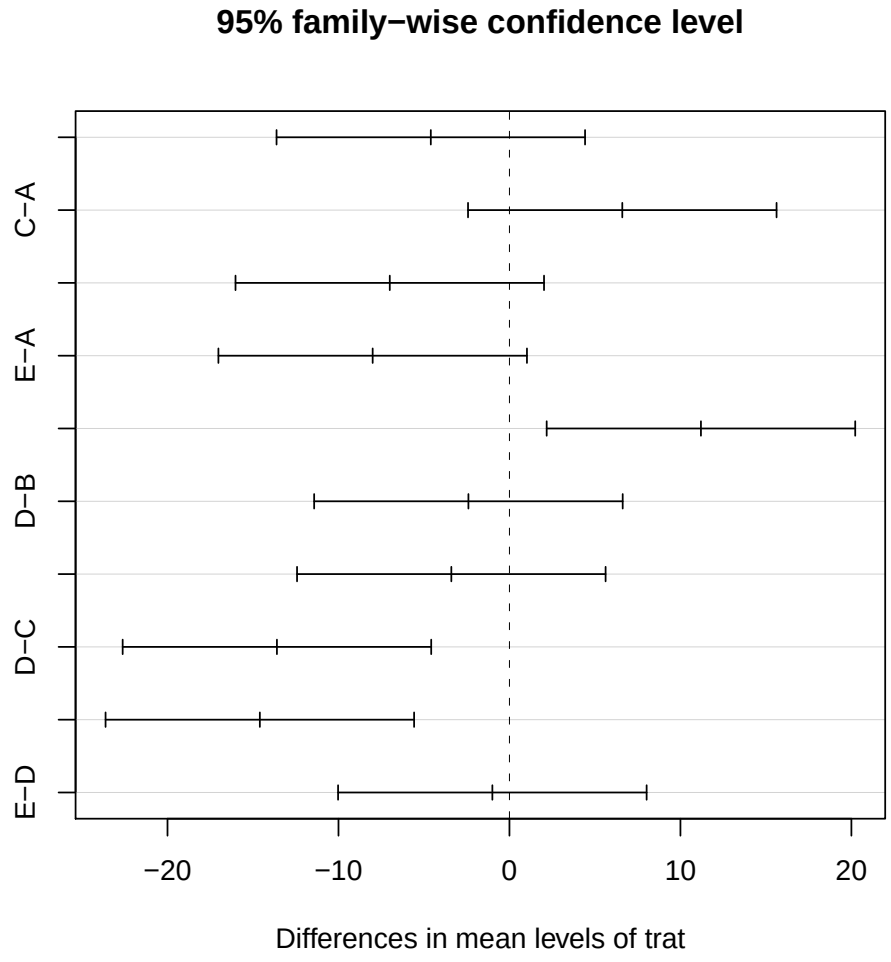

```
> plot(fitted(modelo), res, xlab = "Valores ajustados", ylab = "Resíduos")
```




```
> shapiro.test(res)

        Shapiro-Wilk normality test

data:  res
W = 0.9435, p-value = 0.1784


> TukeyHSD(modelo, "trat", ordered = TRUE, conf.level = 0.95)


  Tukey multiple comparisons of means
    95% family-wise confidence level
    factor levels have been ordered

Fit: aov(formula = prod ~ linha + coluna + trat, data = dad)

$trat
    diff       lwr      upr     p adj
D-E  1.0 -8.022930 10.02293 0.9961878
B-E  3.4 -5.622930 12.42293 0.7509740
A-E  8.0 -1.022930 17.02293 0.0916265
```

```
C-E 14.6  5.577070 23.62293 0.0018048
B-D  2.4 -6.622930 11.42293 0.9102037
A-D  7.0 -2.022930 16.02293 0.1615515
C-D 13.6  4.577070 22.62293 0.0032080
A-B  4.6 -4.422930 13.62293 0.5102088
C-B 11.2  2.177070 20.22293 0.0133795
C-A  6.6 -2.422930 15.62293 0.2005556
```

```
> plot(TukeyHSD(modelo, "trat"))
```




```
> require(laercio)
> LTukey(modelo, "trat", conf.level = 0.95)
```

```
 TUKEY TEST TO COMPARE MEANS

 Confidence level:  0.95
 Dependent variable:  prod
 Variation Coefficient:  34.4297 %

Independent variable:  trat
```

Factors	Means	
C	22.2	a
A	15.6	ab
B	11	b
D	8.6	b
E	7.6	b