

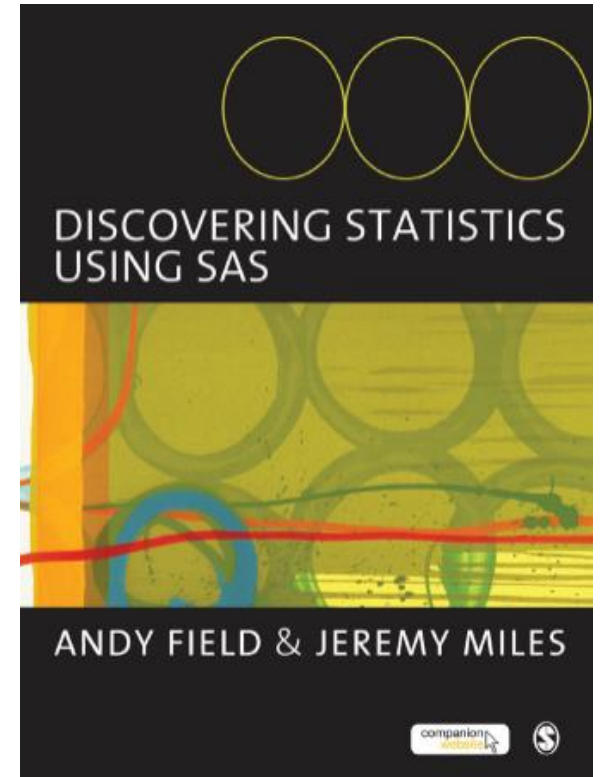
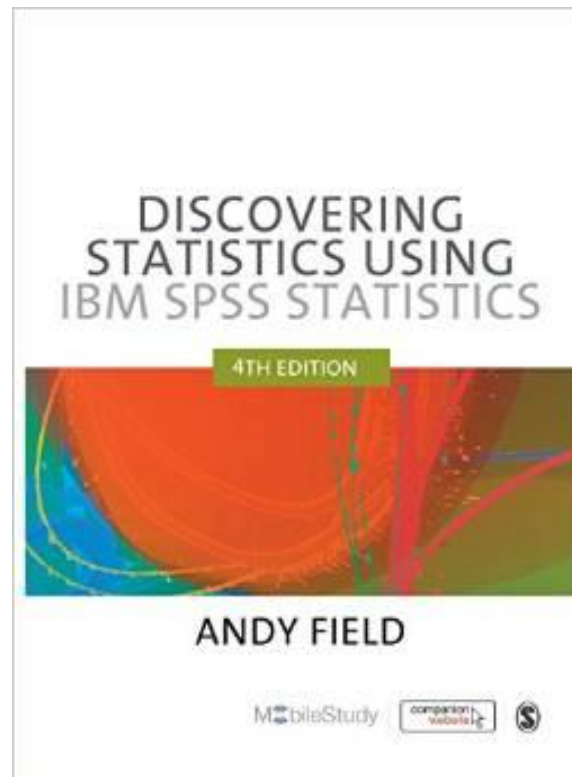
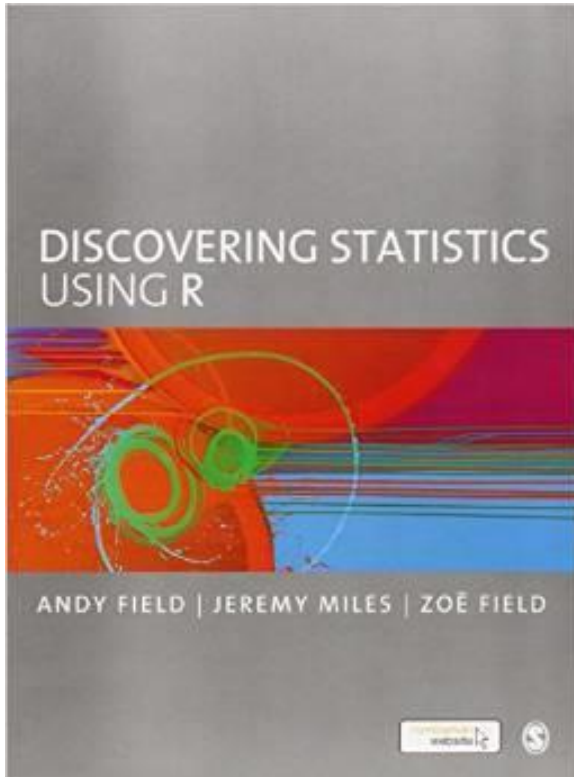
Kvantitativna analiza in R

doc. dr. Franc Brcar

Pregled poglavij

Prirejeno po: Field, A., Miles, J., & Field, Z. (2012).
Discovering Statistics Using R. London: SAGE.

Discovering Statistics Using R & SPSS & SAS



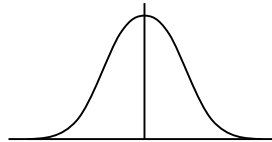
Pregled poglavij

1. Uvod
2. Osnove statistike
3. R-okolje
4. Preučevanje podatkov z grafi
5. Statistične omejitve in predpostavke
6. Korelacija
7. Linearna regresija
8. Logistična regresija
9. Primerjava dveh povprečij s t-testom
10. Primerjava več povprečij (ANOVA – GLM 1)
11. Analiza kovarianc (ANCOVA – GLM 2)
12. Faktorska ANOVA (GLM 3)
13. Ponavljajoče merjenje (GLM 4)
14. Mešane analize (GLM 5)
15. Ne-parametrični testi
16. Multivariatna analiza variance (MANOVA)
17. Faktorska analiza
18. Kategorne spremenljivke in HI-kvadrat test
19. Več-nivojski modeli

1. poglavje

Zakaj statistika

- Spremenljivke:
 - *Nominal* – imenska: (DA/Ne).
 - *Ordinal* – urejenostna: (prvi/drugi/tretji, 1/2/3/4/5).
 - *Interval* – intervalna: (165 cm, 93 Kg, -3/-2/-1/0/1/2/3).
 - *Rational* – razmernostna: (0,85 s).



Normalna
porazdelitev

2. poglavje

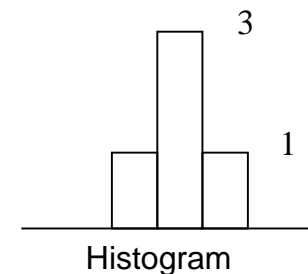
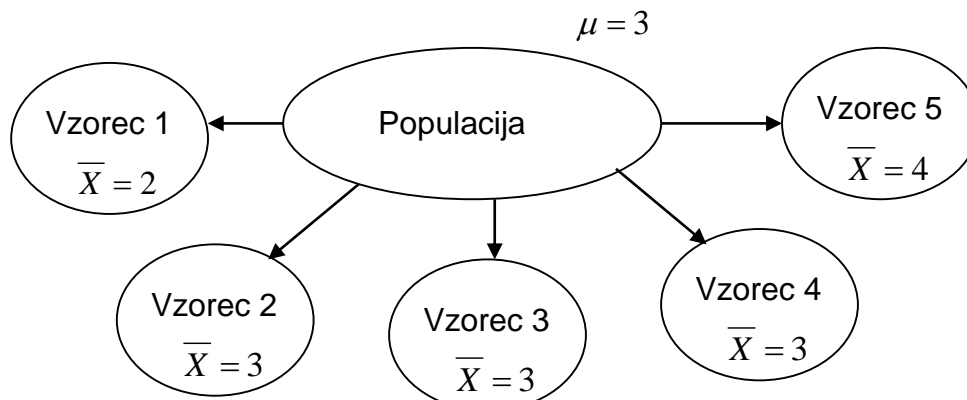
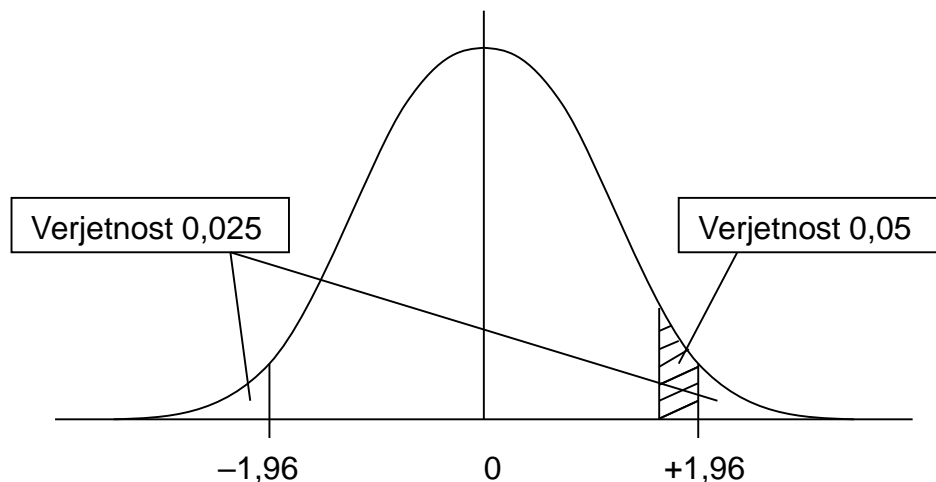
Vse kar ste želeli vedeti o statistiki

- Moč učinka:
- $r = 0,1$... majhen efekt.
- $r = 0,3$... srednji efekt.
- $r = 0,5$... velik efekt (močan).

Tabela 1: Napake tipa I (α) in II (β)

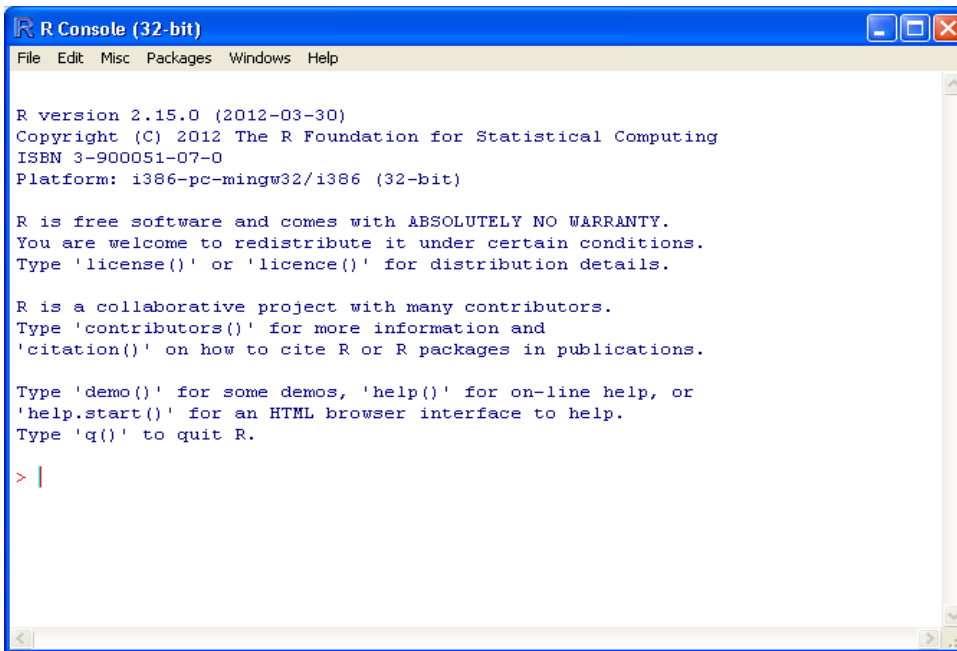
| | H0 je pravilna | H0 je napačna |
|------------------|--------------------------|--------------------------|
| Zavrnamo | α = napaka tipa I | Pravilna odločitev |
| Sprejmemo | Pravilna odločitev | β = napaka tipa II |

Opomba. H0: Izdelek je dober



3. poglavje R okolje

- R 2.12.2, R 2.15.1, ...
- > install.packages("Rcmdr", dependencies=TRUE)
- > library(Rcmdr)



```
R R Console (32-bit)
File Edit Misc Packages Windows Help

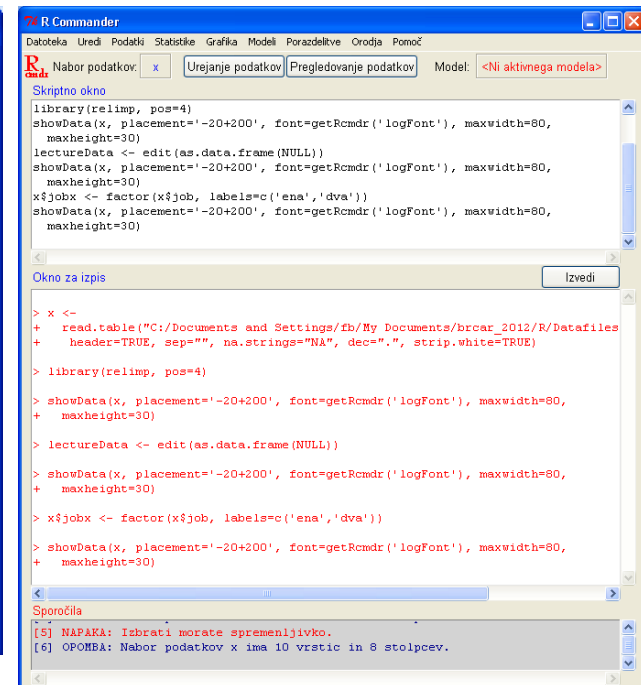
R version 2.15.0 (2012-03-30)
Copyright (C) 2012 The R Foundation for Statistical Computing
ISBN 3-900051-07-0
Platform: i386-pc-mingw32/i386 (32-bit)

R is free software and comes with ABSOLUTELY NO WARRANTY.
You are welcome to redistribute it under certain conditions.
Type 'license()' or 'licence()' for distribution details.

R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.

Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

> |
```



```
R Commander
Datoteka Uredi Podatki Statistike Grafika Modeli Porazdeljive Orodja Pomoč

Nabor podatkov: x Urejanje podatkov Pregledovanje podatkov Model: <Ni aktivnega modela>

Skriptno okno
library(relimp, pos=4)
showData(x, placement='-20+200', font=getRcmdr('logFont'), maxwidth=80,
maxheight=30)
lectureData <- edit(as.data.frame(NULL))
showData(x, placement='-20+200', font=getRcmdr('logFont'), maxwidth=80,
maxheight=30)
x$jobx <- factor(x$job, labels=c('ena','dva'))
showData(x, placement='-20+200', font=getRcmdr('logFont'), maxwidth=80,
maxheight=30)

Okno za izpis Izvedi

> x <-
+ read.table("C:/Documents and Settings/lb/My Documents/brcar_2012/R/Datafiles
+ header=TRUE, sep=", na.strings="NA", dec=".", strip.white=TRUE)

> library(relimp, pos=4)

> showData(x, placement='-20+200', font=getRcmdr('logFont'), maxwidth=80,
+ maxheight=30)

> lectureData <- edit(as.data.frame(NULL))

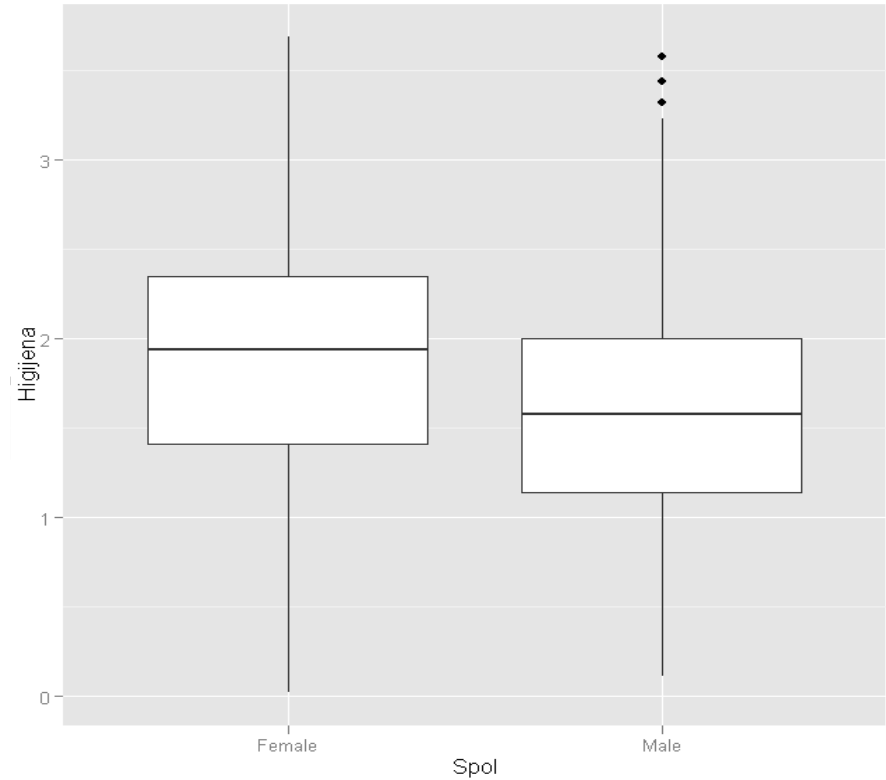
> showData(x, placement='-20+200', font=getRcmdr('logFont'), maxwidth=80,
+ maxheight=30)

> x$jobx <- factor(x$job, labels=c('ena','dva'))

> showData(x, placement='-20+200', font=getRcmdr('logFont'), maxwidth=80,
+ maxheight=30)

Sporočila
[5] NAPAKA: Izbrati morate spremenljivko.
[6] OPOMBA: Nabor podatkov x ima 10 vrstic in 8 stolpcev.
```

4. poglavje Grafii



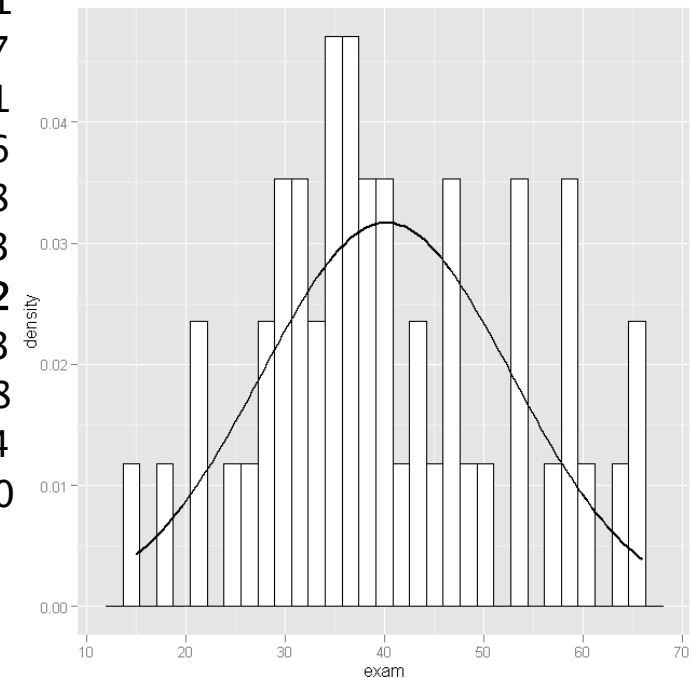
5. poglavje

Raziskovanje predpostavk

- Shapiro-Wilk test normalnosti.

```
> round(stat.desc(rexam[,c("exam", "computer", "lectures",
  "numeracy")], basic=FALSE, norm=TRUE), digits=3)
```

| | exam | computer | lectures | numeracy |
|--------------|---------------|---------------|---------------|--------------|
| median | 60.000 | 51.500 | 62.000 | 4.000 |
| mean | 58.100 | 50.710 | 59.765 | 4.850 |
| SE.mean | 2.132 | 0.826 | 2.168 | 0.271 |
| CI.mean.0.95 | 4.229 | 1.639 | 4.303 | 0.537 |
| var | 454.354 | 68.228 | 470.230 | 7.321 |
| std.dev | 21.316 | 8.260 | 21.685 | 2.706 |
| coef.var | 0.367 | 0.163 | 0.363 | 0.558 |
| skewness | -0.104 | -0.169 | -0.410 | 0.933 |
| skew.2SE | -0.215 | -0.350 | -0.849 | 1.932 |
| kurtosis | -1.148 | 0.221 | -0.285 | 0.763 |
| kurt.2SE | -1.200 | 0.231 | -0.298 | 0.798 |
| normtest.w | 0.961 | 0.987 | 0.977 | 0.924 |
| normtest.p | 0.005 | 0.441 | 0.077 | 0.000 |

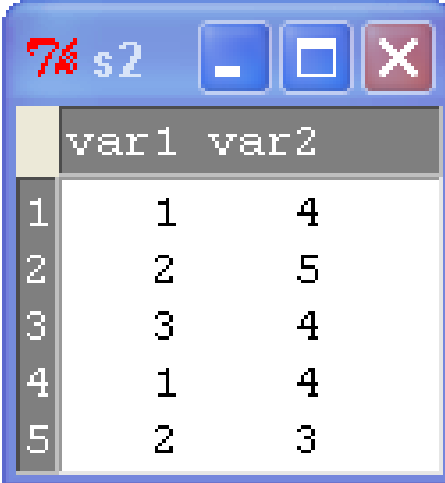


6. poglavje Korelacija

- Korelacije:
 - Pearson
 - Spearman (NP), Kendall (NP), bootstrapping (NP)
 - Bi-serial (ena spremenljivka je kontinuirana dihotomna)
 - Point-bi-serial (ena spremenljivka je diskretna dihotomna)
 - Partial (imamo še kontrolno spremenljivko, ki vpliva na obe spremenljivki)
 - Semi-partial (imamo še kontrolno spremenljivko, ki vpliva na eno spremenljivko)

> cor(examData2)

| | Exam | Anxiety | Revise |
|---------|------------|------------|------------|
| Exam | 1.0000000 | -0.4409934 | 0.3967207 |
| Anxiety | -0.4409934 | 1.0000000 | -0.7092493 |
| Revise | 0.3967207 | -0.7092493 | 1.0000000 |



The screenshot shows a window titled '7 s2' with a data frame containing 5 rows and 2 columns. The columns are labeled 'var1' and 'var2'. The data values are as follows:

| | var1 | var2 |
|---|------|------|
| 1 | 1 | 4 |
| 2 | 2 | 5 |
| 3 | 3 | 4 |
| 4 | 1 | 4 |
| 5 | 2 | 3 |

7. poglavje

Regresija

- Regresija
 - Enostavna regresija
 - Multipla regresija
 - Robustna regresija: bootstrapping (NP)
 - Multipla regresija s kategorno napovedno spremenljivko

$$Y_i = (b_0 + b_1 X_i) + \varepsilon_i$$

- Odvisna spremenljivka (rezultat).
 - Neodvisna spremenljivka (napovedna spremenljivka).
- ```
> model<-lm(sales~adverts,data=album1)
> summary(model)
```

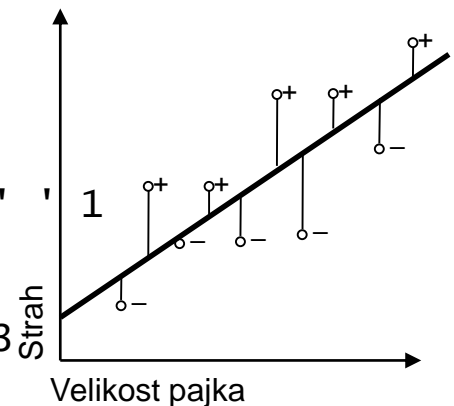
|   | Odvisna | Neodvisna |
|---|---------|-----------|
| 1 | 1       | 4         |
| 2 | 2       | 5         |
| 3 | 3       | 4         |
| 4 | 1       | 4         |
| 5 | 2       | 3         |

Coefficients:

```
 Estimate Std. Error t value Pr(>|t|)
(Intercept) 1.341e+02 7.537e+00 17.799 <2e-16 ***
adverts 9.612e-02 9.632e-03 9.979 <2e-16 ***
```

---  
 Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

```
Residual standard error: 65.99 on 198 degrees of freedom
Multiple R-squared: 0.3346, Adjusted R-squared: 0.3313
F-statistic: 99.59 on 1 and 198 DF, p-value: < 2.2e-16
```



## 8. poglavje

### Logistična regresija

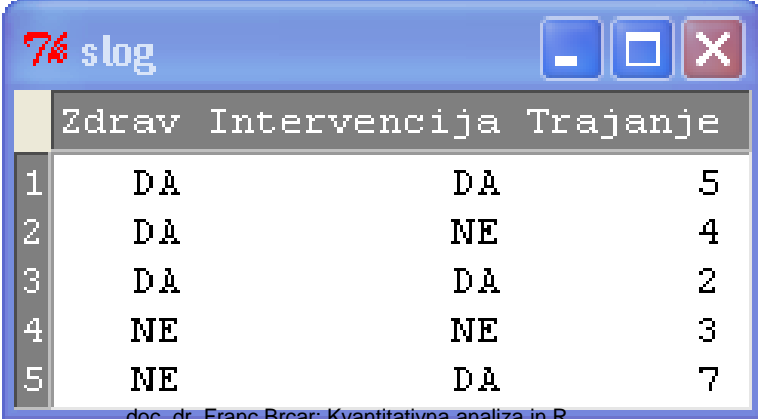
- Logistična regresija
  - Logistična regresija (odvisna spremenljivka je kategorna)
  - Multinomialna logistična regresija (odvisna spremenljivka ima več kategorij)

```
> Model<-glm(Zdrav~Intervencija+Trajanje, data=Podatki,
family=binomial(), na.action=na.exclude)
```

```
> summary(Model)
```

Coefficients:

|                              | Estimate  | Std. Error | z value | Pr(> z ) |    |
|------------------------------|-----------|------------|---------|----------|----|
| (Intercept)                  | -0.234660 | 1.220563   | -0.192  | 0.84754  |    |
| Intervencija[T.Intervencija] | 1.233532  | 0.414565   | 2.975   | 0.00293  | ** |
| Trajanje                     | -0.007835 | 0.175913   | -0.045  | 0.96447  |    |



|   | Zdrav | Intervencija | Trajanje |
|---|-------|--------------|----------|
| 1 | DA    | DA           | 5        |
| 2 | DA    | NE           | 4        |
| 3 | DA    | DA           | 2        |
| 4 | NE    | NE           | 3        |
| 5 | NE    | DA           | 7        |

doc. dr. Franc Broar: Kvantitativna analiza in R.

Prirejeno po: Field, A., Miles, J., & Field, Z. (2012). Discovering Statistics Using R. London: SAGE.

## 9. poglavje

### Primerjava dveh povprečij (*t*-test)

- Odvisni *t*-test
- Wilcoxon signed-rank, WRS.

```
> t.test(spiderwide$real,spiderwide$picture,paired=TRUE)
Paired t-test
```

data: x2\$real and x2\$picture

t = 2.4725, df = 11, p-value = 0.03098

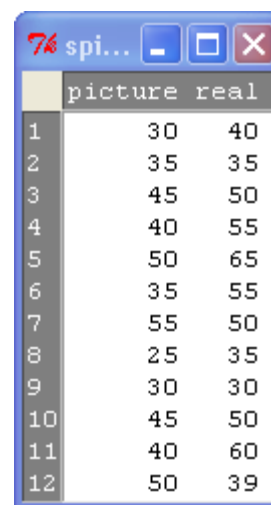
- Neodvisni *t*-test.
- Wilcoxon rank-sum & Mann-Whitney, WRS.

```
> t.test(Anxiety~Group,data=spiderLong)
```

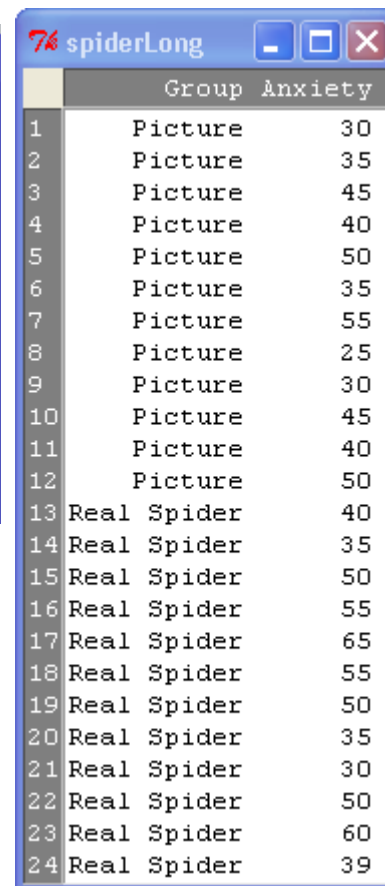
welch Two Sample t-test

data: Anxiety by Group

t = -1.6813, df = 21.385, p-value = 0.1072



|    | picture | real |
|----|---------|------|
| 1  | 30      | 40   |
| 2  | 35      | 35   |
| 3  | 45      | 50   |
| 4  | 40      | 55   |
| 5  | 50      | 65   |
| 6  | 35      | 55   |
| 7  | 55      | 50   |
| 8  | 25      | 35   |
| 9  | 30      | 30   |
| 10 | 45      | 50   |
| 11 | 40      | 60   |
| 12 | 50      | 39   |



|    | Group       | Anxiety |
|----|-------------|---------|
| 1  | Picture     | 30      |
| 2  | Picture     | 35      |
| 3  | Picture     | 45      |
| 4  | Picture     | 40      |
| 5  | Picture     | 50      |
| 6  | Picture     | 35      |
| 7  | Picture     | 55      |
| 8  | Picture     | 25      |
| 9  | Picture     | 30      |
| 10 | Picture     | 45      |
| 11 | Picture     | 40      |
| 12 | Picture     | 50      |
| 13 | Real Spider | 40      |
| 14 | Real Spider | 35      |
| 15 | Real Spider | 50      |
| 16 | Real Spider | 55      |
| 17 | Real Spider | 65      |
| 18 | Real Spider | 55      |
| 19 | Real Spider | 50      |
| 20 | Real Spider | 35      |
| 21 | Real Spider | 30      |
| 22 | Real Spider | 50      |
| 23 | Real Spider | 60      |
| 24 | Real Spider | 39      |

# 10. poglavje

## Primerjava več povprečij – neodvisna ANOVA (GLM1)

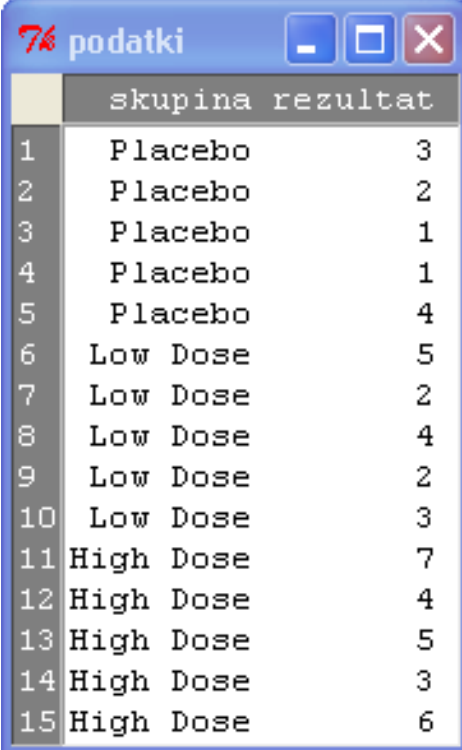
- Neodvisna ANOVA

- Kruskal-Wallis (NP), WRS

```
> anovaModel<-aov(rezultat~skupina,data=podatki)
```

```
> summary(anovaModel)
```

|                           | Df | Sum Sq | Mean Sq | F value | Pr(>F)    |
|---------------------------|----|--------|---------|---------|-----------|
| skupina                   | 2  | 20.133 | 10.0667 | 5.1186  | 0.02469 * |
| Residuals                 | 12 | 23.600 | 1.9667  |         |           |
|                           |    |        |         |         |           |
| Low Dose - Placebo == 0   |    | 1.0000 | -1.3670 | 3.3670  |           |
| High Dose - Placebo == 0  |    | 2.8000 | 0.4330  | 5.1670  |           |
| High Dose - Low Dose == 0 |    | 1.8000 | -0.5670 | 4.1670  |           |



|    | skupina   | rezultat |
|----|-----------|----------|
| 1  | Placebo   | 3        |
| 2  | Placebo   | 2        |
| 3  | Placebo   | 1        |
| 4  | Placebo   | 1        |
| 5  | Placebo   | 4        |
| 6  | Low Dose  | 5        |
| 7  | Low Dose  | 2        |
| 8  | Low Dose  | 4        |
| 9  | Low Dose  | 2        |
| 10 | Low Dose  | 3        |
| 11 | High Dose | 7        |
| 12 | High Dose | 4        |
| 13 | High Dose | 5        |
| 14 | High Dose | 3        |
| 15 | High Dose | 6        |

# 11. poglavje

## Analiza kovarianc, ANCOVA (GLM2)

- Neodvisni ANOVA dodamo kovariat
- ```
> viagraModel<-aov(libido~partnerLibido+dose,
data=viagraData)
> Anova(viagraModel,type="III")
Anova Table (Type III tests)
```

Response: libido

| | Sum Sq | Df | F value | Pr(>F) | |
|---------------|--------|----|---------|---------|---|
| (Intercept) | 12.943 | 1 | 4.2572 | 0.04920 | * |
| partnerLibido | 15.076 | 1 | 4.9587 | 0.03483 | * |
| dose | 25.185 | 2 | 4.1419 | 0.02745 | * |
| Residuals | 79.047 | 26 | | | |

| | dose | libido | partnerLibido |
|----|-----------|--------|---------------|
| 1 | Placebo | 3 | 4 |
| 2 | Placebo | 2 | 1 |
| 3 | Placebo | 5 | 5 |
| 4 | Placebo | 2 | 1 |
| 5 | Placebo | 2 | 2 |
| 6 | Placebo | 2 | 2 |
| 7 | Placebo | 7 | 7 |
| 8 | Placebo | 2 | 4 |
| 9 | Placebo | 4 | 5 |
| 10 | Low Dose | 7 | 5 |
| 11 | Low Dose | 5 | 3 |
| 12 | Low Dose | 3 | 1 |
| 13 | Low Dose | 4 | 2 |
| 14 | Low Dose | 4 | 2 |
| 15 | Low Dose | 7 | 6 |
| 16 | Low Dose | 5 | 4 |
| 17 | Low Dose | 4 | 2 |
| 18 | High Dose | 9 | 1 |
| 19 | High Dose | 2 | 3 |
| 20 | High Dose | 6 | 5 |
| 21 | High Dose | 3 | 4 |
| 22 | High Dose | 4 | 3 |
| 23 | High Dose | 4 | 3 |
| 24 | High Dose | 4 | 2 |
| 25 | High Dose | 6 | 0 |
| 26 | High Dose | 4 | 1 |
| 27 | High Dose | 6 | 3 |
| 28 | High Dose | 2 | 0 |
| 29 | High Dose | 8 | 1 |
| 30 | High Dose | 5 | 0 |

12. poglavje

Faktorska (neodvisna) ANOVA (GLM3)

- Faktorska neodvisna ANOVA
- Neodvisni ANOVA dodamo grupe (faktorje)

– NP je WRS

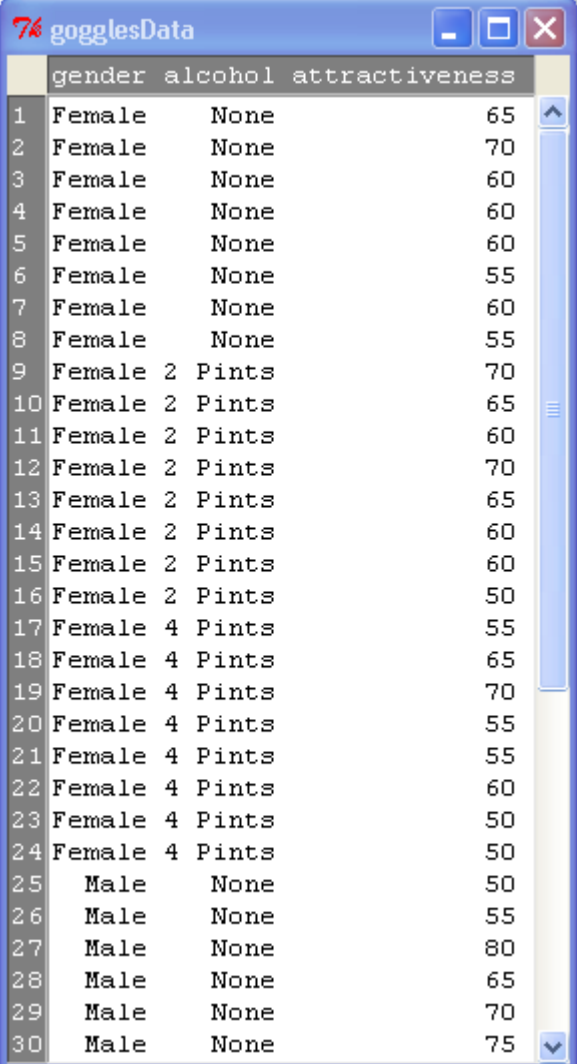
```
> model<-lm(attractiveness~alcohol*gender,  
data=gogglesData)
```

```
> Anova(model)
```

Anova Table (Type II tests)

Response: attractiveness

| | Sum Sq | Df | F value | Pr(>F) | |
|----------------|--------|----|---------|-----------|-----|
| alcohol | 3332.3 | 2 | 20.0654 | 7.649e-07 | *** |
| gender | 168.7 | 1 | 2.0323 | 0.1614 | |
| alcohol:gender | 1978.1 | 2 | 11.9113 | 7.987e-05 | *** |
| Residuals | 3487.5 | 42 | | | |



| | gender | alcohol | attractiveness |
|----|--------|---------|----------------|
| 1 | Female | None | 65 |
| 2 | Female | None | 70 |
| 3 | Female | None | 60 |
| 4 | Female | None | 60 |
| 5 | Female | None | 60 |
| 6 | Female | None | 55 |
| 7 | Female | None | 60 |
| 8 | Female | None | 55 |
| 9 | Female | 2 Pints | 70 |
| 10 | Female | 2 Pints | 65 |
| 11 | Female | 2 Pints | 60 |
| 12 | Female | 2 Pints | 70 |
| 13 | Female | 2 Pints | 65 |
| 14 | Female | 2 Pints | 60 |
| 15 | Female | 2 Pints | 60 |
| 16 | Female | 2 Pints | 50 |
| 17 | Female | 4 Pints | 55 |
| 18 | Female | 4 Pints | 65 |
| 19 | Female | 4 Pints | 70 |
| 20 | Female | 4 Pints | 55 |
| 21 | Female | 4 Pints | 55 |
| 22 | Female | 4 Pints | 60 |
| 23 | Female | 4 Pints | 50 |
| 24 | Female | 4 Pints | 50 |
| 25 | Male | None | 50 |
| 26 | Male | None | 55 |
| 27 | Male | None | 80 |
| 28 | Male | None | 65 |
| 29 | Male | None | 70 |
| 30 | Male | None | 75 |

13. poglavje

Odvisna ANOVA – ponovljeno mejenje (GLM4)

- Odvisna ANOVA
 - Friedman-ova ANOVA (NP)
 - NP je WRS
 - Faktorska odvisna ANOVA
- > ezANOVA(data=longBush,
 dv=.(Retch),
 wid=.(Participant),
 within=.(Animal),
 detailed=TRUE,
 type=.(3))
- Faktorska odvisna ANOVA

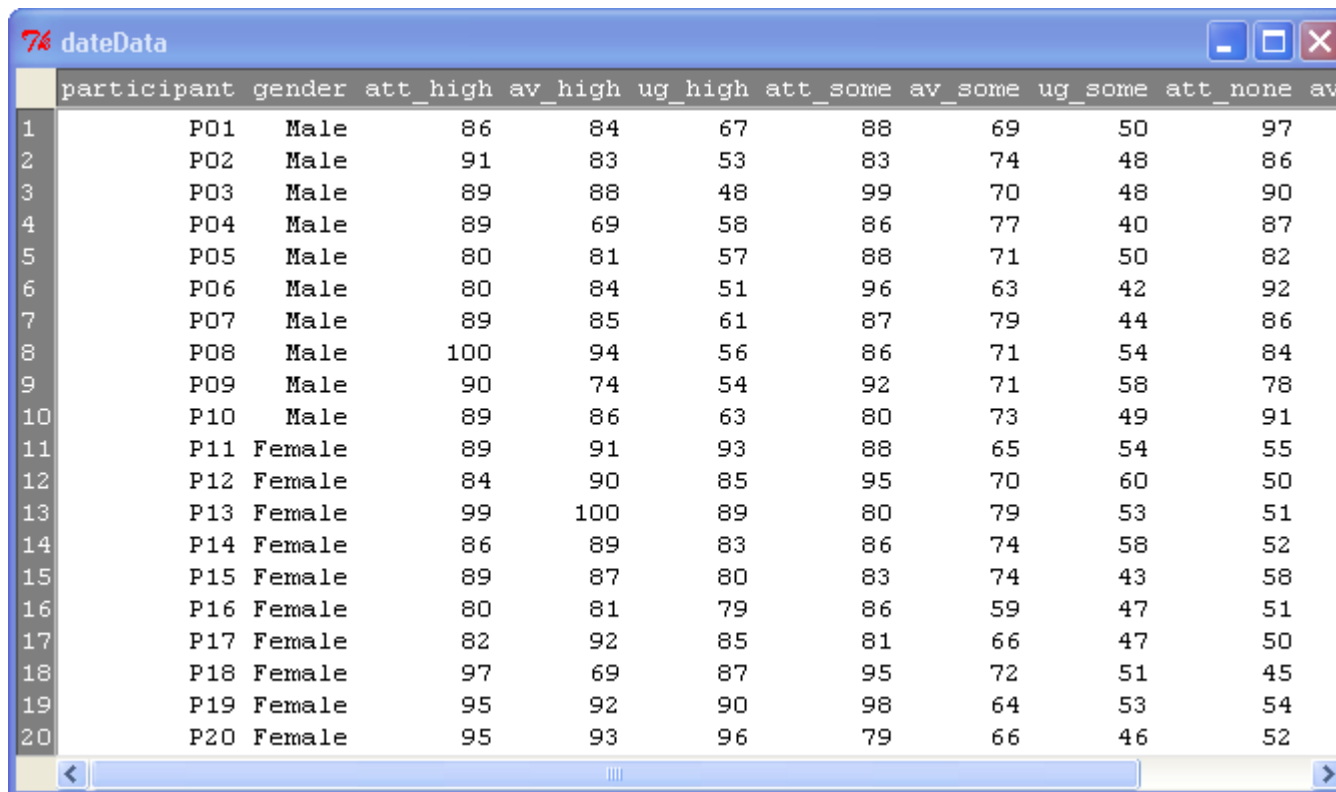
| | participant | stick_insect | kangaroo_testicle | fish_eye | witchetty_grub |
|---|-------------|--------------|-------------------|----------|----------------|
| 1 | P1 | 8 | 7 | 1 | 6 |
| 2 | P2 | 9 | 5 | 2 | 5 |
| 3 | P3 | 6 | 2 | 3 | 8 |
| 4 | P4 | 5 | 3 | 1 | 9 |
| 5 | P5 | 8 | 4 | 5 | 8 |
| 6 | P6 | 7 | 5 | 6 | 7 |
| 7 | P7 | 10 | 2 | 7 | 2 |
| 8 | P8 | 12 | 6 | 8 | 1 |

| | beerpos | beerneg | beerneut | winepos | wineneg | wineneut | waterpos | waterneg | waterneu | par |
|---|---------|---------|----------|---------|---------|----------|----------|----------|----------|-----|
| 1 | 1 | 6 | 5 | 38 | -5 | 4 | 10 | -14 | -2 | |
| 2 | 43 | 30 | 8 | 20 | -12 | 4 | 9 | -10 | -13 | |
| 3 | 15 | 15 | 12 | 20 | -15 | 6 | 6 | -16 | 1 | |
| 4 | 40 | 30 | 19 | 28 | -4 | 0 | 20 | -10 | 2 | |
| 5 | 8 | 12 | 8 | 11 | -2 | 6 | 27 | 5 | -5 | |
| 6 | 17 | 17 | 15 | 17 | -6 | 6 | 9 | -6 | -13 | |
| 7 | 30 | 21 | 21 | 15 | -2 | 16 | 19 | -20 | 3 | |
| | .. | .. | .. | .. | - | - | .. | .. | - | |

14. poglavje

Mešana ANOVA (GLM4)

- Kombinacija odvisnega in neodvisnega dizajna
- Odvisni ANOVA dodamo grupe
- Mixed ANOVA
 - WRS



| | participant | gender | att_high | av_high | ug_high | att_some | av_some | ug_some | att_none | av |
|----|-------------|--------|----------|---------|---------|----------|---------|---------|----------|----|
| 1 | P01 | Male | 86 | 84 | 67 | 88 | 69 | 50 | 97 | |
| 2 | P02 | Male | 91 | 83 | 53 | 83 | 74 | 48 | 86 | |
| 3 | P03 | Male | 89 | 88 | 48 | 99 | 70 | 48 | 90 | |
| 4 | P04 | Male | 89 | 69 | 58 | 86 | 77 | 40 | 87 | |
| 5 | P05 | Male | 80 | 81 | 57 | 88 | 71 | 50 | 82 | |
| 6 | P06 | Male | 80 | 84 | 51 | 96 | 63 | 42 | 92 | |
| 7 | P07 | Male | 89 | 85 | 61 | 87 | 79 | 44 | 86 | |
| 8 | P08 | Male | 100 | 94 | 56 | 86 | 71 | 54 | 84 | |
| 9 | P09 | Male | 90 | 74 | 54 | 92 | 71 | 58 | 78 | |
| 10 | P10 | Male | 89 | 86 | 63 | 80 | 73 | 49 | 91 | |
| 11 | P11 | Female | 89 | 91 | 93 | 88 | 65 | 54 | 55 | |
| 12 | P12 | Female | 84 | 90 | 85 | 95 | 70 | 60 | 50 | |
| 13 | P13 | Female | 99 | 100 | 89 | 80 | 79 | 53 | 51 | |
| 14 | P14 | Female | 86 | 89 | 83 | 86 | 74 | 58 | 52 | |
| 15 | P15 | Female | 89 | 87 | 80 | 83 | 74 | 43 | 58 | |
| 16 | P16 | Female | 80 | 81 | 79 | 86 | 59 | 47 | 51 | |
| 17 | P17 | Female | 82 | 92 | 85 | 81 | 66 | 47 | 50 | |
| 18 | P18 | Female | 97 | 69 | 87 | 95 | 72 | 51 | 45 | |
| 19 | P19 | Female | 95 | 92 | 90 | 98 | 64 | 53 | 54 | |
| 20 | P20 | Female | 95 | 93 | 96 | 79 | 66 | 46 | 52 | |

15. poglavje

Ne-parametrični testi

- Neparametrični testi
 - Wilcoxon rank-sum test & M-W test – neodvisen t -test
 - Wilcoxon signed-rank test – odvisen t -test
 - Kruskal-Wallis – neodvisna ANOVA
 - Friedman ANOVA – odvisna ANOVA

| | drug | sundayBDI |
|----|---------|-----------|
| 1 | Ecstasy | 15 |
| 2 | Ecstasy | 35 |
| 3 | Ecstasy | 16 |
| 4 | Ecstasy | 18 |
| 5 | Ecstasy | 19 |
| 6 | Ecstasy | 17 |
| 7 | Ecstasy | 27 |
| 8 | Ecstasy | 16 |
| 9 | Ecstasy | 13 |
| 10 | Ecstasy | 20 |
| 11 | Alcohol | 16 |
| 12 | Alcohol | 15 |
| 13 | Alcohol | 20 |
| 14 | Alcohol | 15 |

| | sundayBDI | wedsBDI |
|----|-----------|---------|
| 1 | 15 | 28 |
| 2 | 35 | 35 |
| 3 | 16 | 35 |
| 4 | 18 | 24 |
| 5 | 19 | 39 |
| 6 | 17 | 32 |
| 7 | 27 | 27 |
| 8 | 16 | 29 |
| 9 | 13 | 36 |
| 10 | 20 | 35 |
| 11 | 16 | 5 |
| 12 | 15 | - |
| 13 | 20 | - |
| 14 | 15 | - |

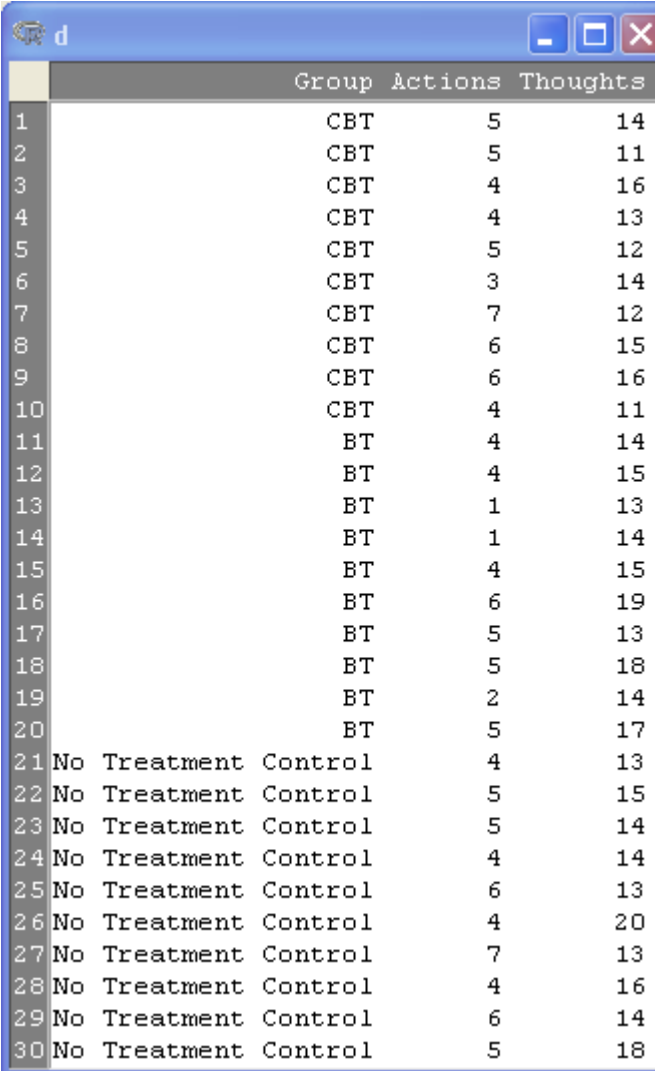
| | Start | Month1 | Month2 |
|----|-----------|-----------|-----------|
| 1 | 63.74562 | 65.38369 | 81.34006 |
| 2 | 62.98285 | 66.24456 | 69.31040 |
| 3 | 65.98489 | 67.69847 | 77.89319 |
| 4 | 107.26758 | 102.72155 | 91.32564 |
| 5 | 66.58389 | 69.44708 | 72.86975 |
| 6 | 120.46445 | 119.96376 | 114.25894 |
| 7 | 62.01109 | 66.09247 | 68.01017 |
| 8 | 71.87376 | 73.61720 | 55.43131 |
| 9 | 83.00535 | 75.81079 | 71.62893 |
| 10 | 76.62397 | 67.65546 | 68.60000 |

| | Soya | Sperm |
|----|-------------|------------|
| 17 | No Soya | 9.6185687 |
| 18 | No Soya | 10.0481410 |
| 19 | No Soya | 10.3229182 |
| 20 | No Soya | 21.0800000 |
| 21 | 1 Soya Meal | 0.3255391 |
| 22 | 1 Soya Meal | 0.3641975 |
| 23 | 1 Soya Meal | 0.6292157 |
| 24 | 1 Soya Meal | 0.6359349 |
| 25 | 1 Soya Meal | 0.7657087 |
| 26 | 1 Soya Meal | 1.5325388 |
| 27 | 1 Soya Meal | 1.6222084 |
| 28 | 1 Soya Meal | 1.7059739 |
| 29 | 1 Soya Meal | 1.9400000 |
| 30 | 1 Soya Meal | 2.4796328 |
| 31 | 1 Soya Meal | 2.7104913 |
| 32 | 1 Soya Meal | 4.1161159 |
| 33 | 1 Soya Meal | 5.6510126 |
| 34 | 1 Soya Meal | 6.7596653 |
| 35 | 1 Soya Meal | 7.0786499 |
| 36 | 1 Soya Meal | 7.2635264 |
| 37 | 1 Soya Meal | 7.9150662 |
| 38 | 1 Soya Meal | 8.0444065 |
| 39 | 1 Soya Meal | 12.0950189 |
| 40 | 1 Soya Meal | 18.4700000 |
| 41 | 4 Soya Meal | 0.4025473 |
| 42 | 4 Soya Meal | 0.5981972 |
| 43 | 4 Soya Meal | 0.9587061 |
| 44 | 4 Soya Meal | 1.2032736 |
| 45 | 4 Soya Meal | 1.3126042 |
| 46 | 4 Soya Meal | 1.3542799 |
| 47 | 4 Soya Meal | 1.6000000 |
| 48 | 4 Soya Meal | 1.6000000 |
| 49 | 4 Soya Meal | 1.6000000 |
| 50 | 4 Soya Meal | 1.6000000 |

16. poglavje

Multivariatna analiza variance (MANOVA)

- MANOVA
 - Neodvisna ANOVA z dvema odvisnima spremenljivkama
 - Diskriminantna analiza
 - WRS



| | Group | Actions | Thoughts | |
|----|--------------|---------|----------|----|
| 1 | CBT | 5 | 14 | |
| 2 | CBT | 5 | 11 | |
| 3 | CBT | 4 | 16 | |
| 4 | CBT | 4 | 13 | |
| 5 | CBT | 5 | 12 | |
| 6 | CBT | 3 | 14 | |
| 7 | CBT | 7 | 12 | |
| 8 | CBT | 6 | 15 | |
| 9 | CBT | 6 | 16 | |
| 10 | CBT | 4 | 11 | |
| 11 | BT | 4 | 14 | |
| 12 | BT | 4 | 15 | |
| 13 | BT | 1 | 13 | |
| 14 | BT | 1 | 14 | |
| 15 | BT | 4 | 15 | |
| 16 | BT | 6 | 19 | |
| 17 | BT | 5 | 13 | |
| 18 | BT | 5 | 18 | |
| 19 | BT | 2 | 14 | |
| 20 | BT | 5 | 17 | |
| 21 | No Treatment | Control | 4 | 13 |
| 22 | No Treatment | Control | 5 | 15 |
| 23 | No Treatment | Control | 5 | 14 |
| 24 | No Treatment | Control | 4 | 14 |
| 25 | No Treatment | Control | 6 | 13 |
| 26 | No Treatment | Control | 4 | 20 |
| 27 | No Treatment | Control | 7 | 13 |
| 28 | No Treatment | Control | 4 | 16 |
| 29 | No Treatment | Control | 6 | 14 |
| 30 | No Treatment | Control | 5 | 18 |

17. poglavje

Raziskovalna faktorska analiza

```
> pc3<-principal(raqData,nfactors=4,rotate="varimax")
> print.psych(pc3,cut=0.3,sort=TRUE)
```

Principal Components Analysis

Call: principal(r = raqMatrix, nfactors = 4, rotate = "varimax")

Standardized loadings based upon correlation matrix

| item | RC3 | RC1 | RC4 | RC2 | h2 | u2 |
|------|-----|------|-------|------|------|------|
| Q06 | 6 | 0.80 | | | 0.65 | 0.35 |
| Q18 | 18 | 0.68 | 0.33 | | 0.60 | 0.40 |
| Q13 | 13 | 0.65 | | | 0.54 | 0.46 |
| Q07 | 7 | 0.64 | 0.33 | | 0.55 | 0.45 |
| Q14 | 14 | 0.58 | 0.36 | | 0.49 | 0.51 |
| Q10 | 10 | 0.55 | | | 0.33 | 0.67 |
| Q15 | 15 | 0.46 | | | 0.38 | 0.62 |
| Q20 | 20 | | 0.68 | | 0.48 | 0.52 |
| Q21 | 21 | | 0.66 | | 0.55 | 0.45 |
| Q03 | 3 | | -0.57 | 0.37 | 0.53 | 0.47 |
| Q12 | 12 | 0.47 | 0.52 | | 0.51 | 0.49 |
| Q04 | 4 | 0.32 | 0.52 | 0.31 | 0.47 | 0.53 |
| Q16 | 16 | 0.33 | 0.51 | 0.31 | 0.49 | 0.51 |
| Q01 | 1 | | 0.50 | 0.36 | 0.43 | 0.57 |
| Q05 | 5 | 0.32 | 0.43 | | 0.34 | 0.66 |
| Q08 | 8 | | | 0.83 | 0.74 | 0.26 |
| Q17 | 17 | | | 0.75 | 0.68 | 0.32 |
| Q11 | 11 | | | 0.75 | 0.69 | 0.31 |
| Q09 | 9 | | | 0.65 | 0.48 | 0.52 |
| Q22 | 22 | | | 0.65 | 0.46 | 0.54 |
| Q23 | 23 | | | 0.59 | 0.41 | 0.59 |
| Q02 | 2 | | -0.34 | 0.54 | 0.41 | 0.59 |
| Q19 | 19 | | -0.37 | 0.43 | 0.34 | 0.66 |

| SD = Strongly Disagree, D = Disagree, N = Neither, A = Agree, SA = Strongly Agree | | | | | | |
|---|--|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| | | SD | D | N | A | SA |
| 1 | Statistics make me cry | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 2 | My friends will think I'm stupid for not being able to cope with R | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 3 | Standard deviation excite me | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 4 | I dream that Pearson is attacking me with correlation coefficient | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 5 | Idon't understand statistics | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 6 | I have little experience of computers | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 7 | All computers hate me | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 8 | I have never been good at mathematics | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 9 | My friends are better at statistics than me | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 10 | Computers are useful only for playing games | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

18. poglavje

χ^2 -test

- Kategorni podatki
 - HI-kvadrat
 - Loglinearna analiza (več kategornih spremenljivk)

```
> CrossTable(catsData$Training, catsData$Dance, fisher=T, chisq=T,
  expected=T, sresid=T, format="SPSS", prop.c=T, prop.t=T, prop.chisq=T)
```

Total Observations in Table: 200

| catsData\$Training | catsData\$Dance | | Row Total |
|---------------------|-----------------|---------|-----------|
| | No | Yes | |
| Affection as Reward | 114 | 48 | 162 |
| | 100.440 | 61.560 | |
| | 1.831 | 2.987 | |
| | 70.370% | 29.630% | 81.000% |
| | 91.935% | 63.158% | |
| | 57.000% | 24.000% | |
| | 1.353 | -1.728 | |
| Food as Reward | 10 | 28 | 38 |
| | 23.560 | 14.440 | |
| | 7.804 | 12.734 | |
| | 26.316% | 73.684% | 19.000% |
| | 8.065% | 36.842% | |
| | 5.000% | 14.000% | |
| | -2.794 | 3.568 | |
| Column Total | 124 | 76 | 200 |
| | 62.000% | 38.000% | |

Pearson's Chi-squared test

Chi² = 25.35569 d.f. = 1 p = 0.00476

19. poglavje

Več-nivojski linearni model

- Razredi so ugnezdjeni v različne šole in dobimo naslednji nivo.
 - Neodvisen dizajn.
 - Odvisen dizajn.

