

# PROCEDURA ONE-WAY ANOVA

## STATISTIČKI SOFTVER 4

Beograd,  
18.05.2015.

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- ✘ Analiza varijanse je statistička metoda kojom se ispituje efekat jedne ili više nezavisnih promenljivih na jednu zavisnu promenljivu.
  - ✘ Nezavisno promenljive se nazivaju faktori uticaja i oni sadrže više nivoa (grupa). Samim tim one spadaju u kategorijske promenljive.
  - ✘ Kada se ispituje uticaj jedne nezavisne promenljive (jednog faktora), koji ima tri ili više grupa, na zavisno promenljivu, onda je to jednofaktorska analiza varijanse.

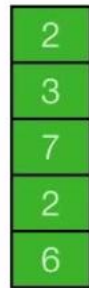
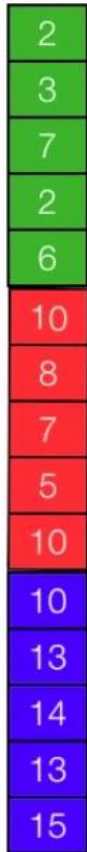
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- ✘ Varijacija između grupa upoređuje se sa varijacijom unutar grupa, da bi se ocenila razlika između srednjih vrednosti.
  - ✘ Testira se hipoteza da tri ili više grupa imaju istu srednju vrednost.

$$H_0: \mu_1 = \mu_2 = \mu_3$$

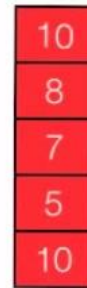
$$H_1: \mu_1 = \mu_2 = \mu_3 \text{ is not true} \\ \text{(at least one } \mu_i \neq \mu_j \text{)}$$

# Analysis of Variance

Sum of Squares Between Groups



mean



mean



mean

1.  $\text{mean} - \text{mean}$                        $\text{mean} - \text{mean}$                        $\text{mean} - \text{mean}$
2.  $(\text{mean} - \text{mean})^2$                        $(\text{mean} - \text{mean})^2$                        $(\text{mean} - \text{mean})^2$
3.  $(\text{mean} - \text{mean})^2 + (\text{mean} - \text{mean})^2 + (\text{mean} - \text{mean})^2$
4.  $(\text{mean} - \text{mean})^2 + (\text{mean} - \text{mean})^2 + (\text{mean} - \text{mean})^2 \times 5$

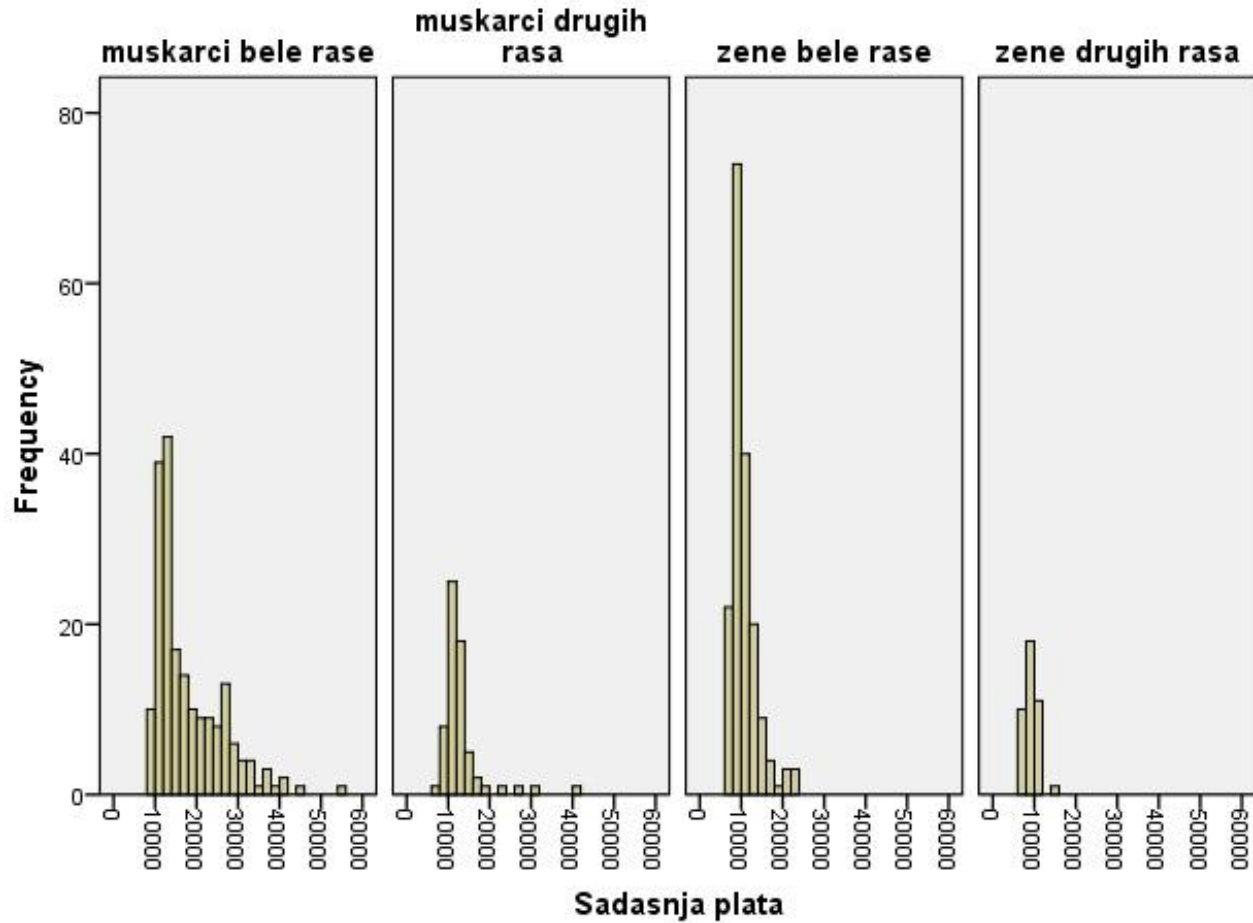
$$SS_{total} = \sum_{j=1}^p \sum_{i=1}^{n_j} (x_{ij} - \bar{x})^2$$

$$SS_{between} = \sum_{j=1}^p n_j (\bar{x}_j - \bar{x})^2$$

$$SS_{within} = \sum_{j=1}^p \sum_{i=1}^{n_j} (x_{ij} - \bar{x}_j)^2$$

$$F = \frac{MSB}{MSW} = \frac{SSB/dfb}{SSW/dfw}$$

### Polno-rasna podela



# USLOVI ZA PRIMENU ANOVE

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- ✘ Neprekidna zavisna promenljiva
- ✘ Faktor se sastoji od dve ili više nezavisnih grupa
- ✘ Nezavisnost obzervacija
- ✘ Bez outlier-a
- ✘ Zavisna promenljiva ima priblizno normalnu raspodelu
- ✘ Homogenost varijanse

# SPSS

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- ✘ Analyze -> Compare Means -> One-way ANOVA
- ✘ Dependent Variable
- ✘ Factor

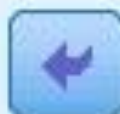




# One-Way ANOVA



- Identifikacioni bro...
- Pocetnicka plata [...]
- pol zaposlenog [...]
- Seniornost na po...
- Nivo obrazovanja ...
- Kategorija zaposl...
- Rasna klasifikaci...
- Starost radnika [s...
- radno iskustvo [r...



## Dependent List:

- Sadasnja plata [spl...

## Factor:

- Polno-rasna podela [...]

Contrasts...

Post Hoc...

Options...

Bootstrap...

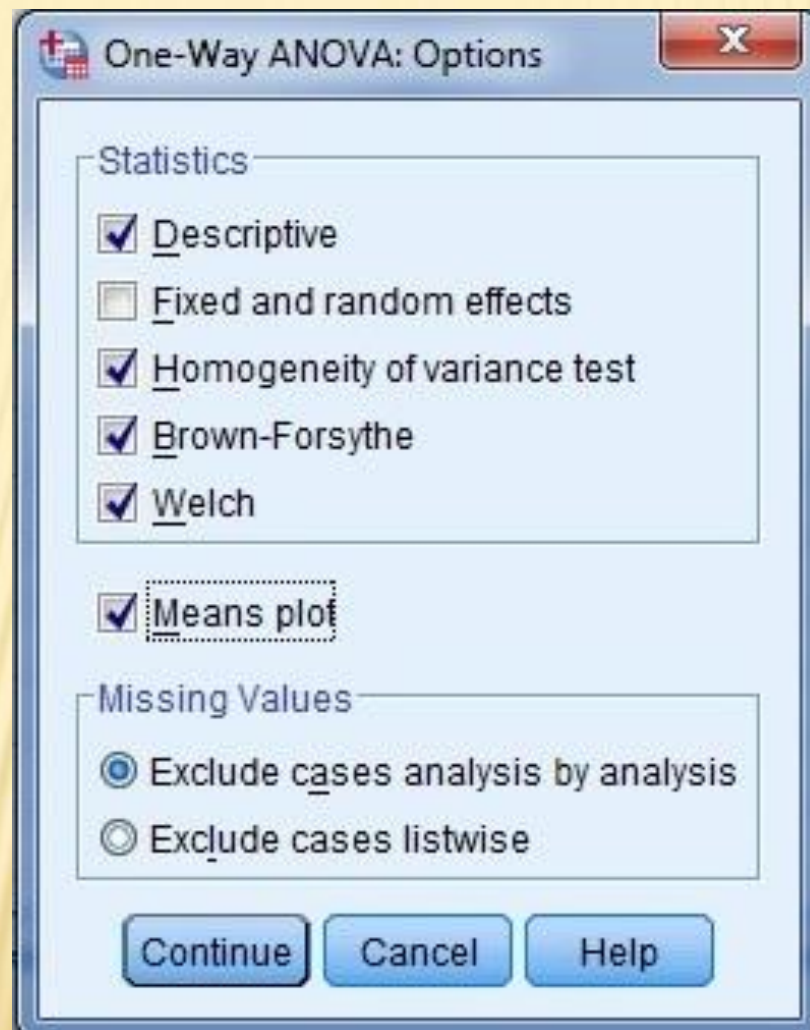
OK

Paste

Reset

Cancel

Help





## One-Way ANOVA: Post Hoc Multiple Comparisons



### Equal Variances Assumed

 LSD S-N-K Waller-Duncan Bonferroni TukeyType I/Type II Error Ratio:  Sidak Tukey's-b Dunnett Scheffe DuncanControl Category:  R-E-G-W F Hochberg's GT2

Test

 R-E-G-W Q Gabriel 2-sided  < Control  > Control

### Equal Variances Not Assumed

 Tamhane's T2 Dunnett's T3 Games-Howell Dunnett's CSignificance level:

### Descriptives

Sadasnja plata

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
					muskarci bele rase	194		
muskarci drugih rasa	64	12898,44	5223,953	652,994	11593,53	14203,34	7860	40000
zene bele rase	176	10682,72	3204,757	241,568	10205,95	11159,48	6300	23250
zene drugih rasa	40	9225,00	1588,947	251,235	8716,83	9733,17	6540	14040
Total	474	13767,83	6830,265	313,724	13151,36	14384,29	6300	54000

### Test of Homogeneity of Variances

Sadasnja plata

Levene Statistic	df1	df2	Sig.
49,387	3	470	,000

### ANOVA

Sadasnja plata

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	5687782262	3	1895927421	54,405	,000
Within Groups	16378857008	470	34848631,93		
Total	22066639270	473			

### Robust Tests of Equality of Means

Sadasnja plata

	Statistic <sup>a</sup>	df1	df2	Sig.
Welch	63,886	3	172,728	,000
Brown-Forsythe	79,616	3	297,985	,000

a. Asymptotically F distributed.

## Homogeneous Subsets

### Sadasnja plata

Tukey HSD<sup>a,b</sup>

Polno-rasna podela	N	Subset for alpha = 0.05		
		1	2	3
zene drugih rasa	40	9225,00		
zene bele rase	176	10682,72	10682,72	
muskarci drugih rasa	64		12898,44	
muskarci bele rase	194			17790,16
Sig.		,415	,091	1,000

Means for groups in homogeneous subsets are displayed.

- Uses Harmonic Mean Sample Size = 77,728.
- The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

### Multiple Comparisons

Dependent Variable: Sadasnja plata

	(I) Polno-rasna podela	(J) Polno-rasna podela	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Games-Howell	muskarci bele rase	muskarci drugih rasa	4891.727 <sup>*</sup>	875.955	.000	2618.79	7164.66
		zene bele rase	7107.449 <sup>*</sup>	631.863	.000	5473.48	8741.42
		zene drugih rasa	8565.165 <sup>*</sup>	635.621	.000	6920.33	10210.00
	muskarci drugih rasa	muskarci bele rase	-4891.727 <sup>*</sup>	875.955	.000	-7164.66	-2618.79
		zene bele rase	2215.722 <sup>*</sup>	696.244	.011	389.29	4042.15
		zene drugih rasa	3673.438 <sup>*</sup>	699.657	.000	1837.73	5509.15
	zene bele rase	muskarci bele rase	-7107.449 <sup>*</sup>	631.863	.000	-8741.42	-5473.48
		muskarci drugih rasa	-2215.722 <sup>*</sup>	696.244	.011	-4042.15	-389.29
		zene drugih rasa	1457.716 <sup>*</sup>	348.531	.000	549.80	2365.64
	zene drugih rasa	muskarci bele rase	-8565.165 <sup>*</sup>	635.621	.000	-10210.00	-6920.33
		muskarci drugih rasa	-3673.438 <sup>*</sup>	699.657	.000	-5509.15	-1837.73
		zene bele rase	-1457.716 <sup>*</sup>	348.531	.000	-2365.64	-549.80

\*. The mean difference is significant at the 0.05 level.

### Contrast Coefficients

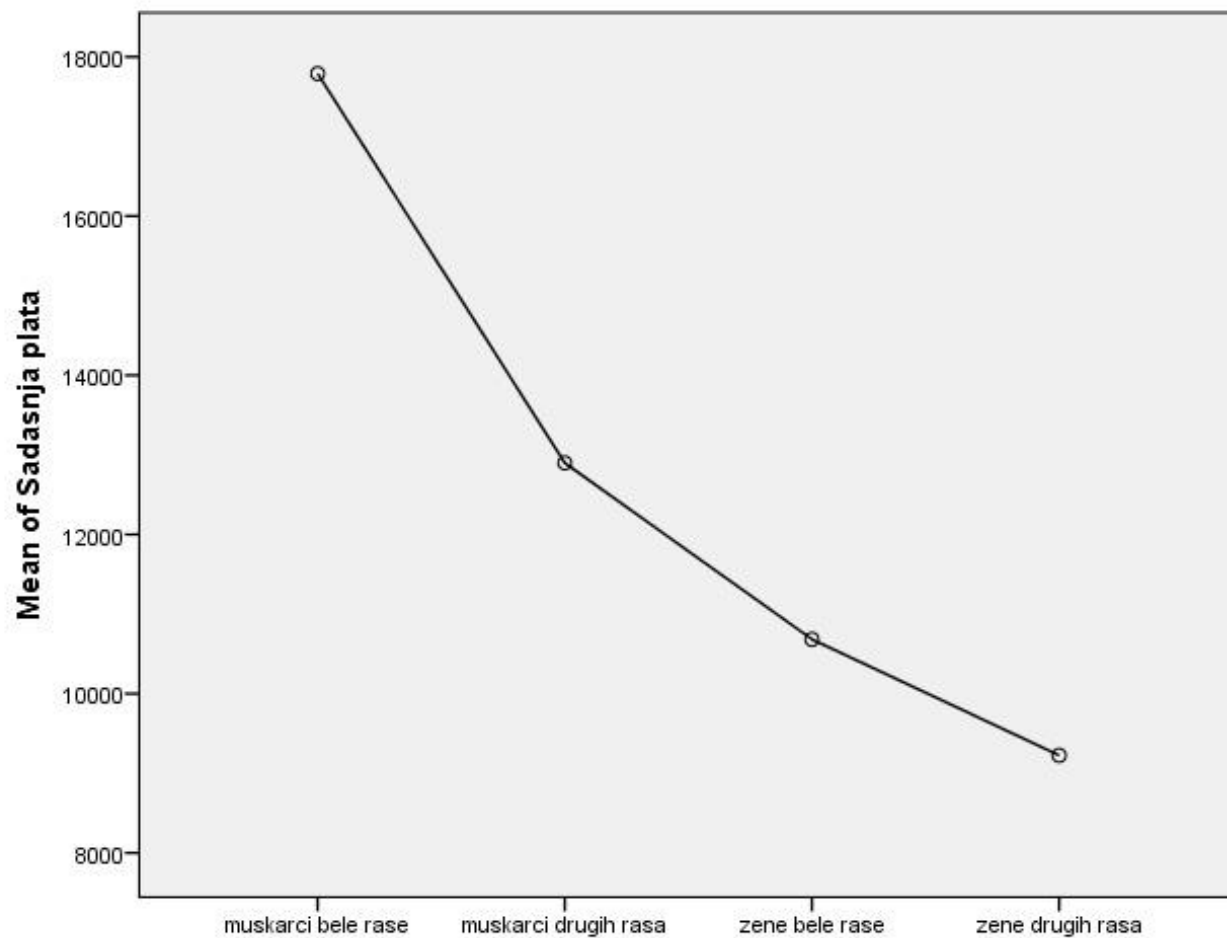
Contrast	Polno-rasna podela			
	muskarci bele rase	muskarci drugih rase	zene bele rase	zene drugih rase
1	-2	-2	2	2
2	0	0	1	-1
3	1	-1	0	0

### Contrast Tests

		Contrast	Value of Contrast	Std. Error	t	df	Sig. (2-tailed)
Sadasnja plata	Assume equal variances	1	-21561.77	2678.329	-8.050	470	.000
		2	1457.72	1034.031	1.410	470	.159
		3	4891.73	850.965	5.748	470	.000
	Does not assume equal variances	1	-21561.77	1885.493	-11.436	218.828	.000
		2	1457.72	348.531	4.182	121.335	.000
		3	4891.73	875.955	5.584	168.785	.000



## Means Plots



# EFFECT SIZE

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- ✘ Vrednost koja govori o tome koliko nezavisna promenjiva utice na zavisnu.
- ✘ Krece se izmedju 0 i 1

$$\eta^2 = \frac{SS_{\text{between}}}{SS_{\text{total}}}$$

## ✘ Analyze->General linear model->Univariate

### Tests of Between-Subjects Effects

Dependent Variable: Sadasnja plata

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	5687782262 <sup>a</sup>	3	1895927421	54.405	.000	.258
Intercept	49745723553	1	49745723553	1427.480	.000	.752
pol_rasa	5687782262	3	1895927421	54.405	.000	.258
Error	16378857008	470	34848631.93			
Total	1.119E+11	474				
Corrected Total	22066639270	473				

a. R Squared = .258 (Adjusted R Squared = .253)

# KRAJ

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