Technology Arts Sciences Cologne
Faculty of Economics, Business and Law
Prof. Dr. Arrenberg
Room 221, Tel. 39 14
jutta.arrenberg@th-koeln.de

Exercises Quantitative Methods
Worksheet: Analysis of Variance

Exercise 9.1
Please open the file *Dauer_Museum.sav*. Is there evidence of a significant difference
in the mean duration of visiting of the different museums Museum Ludwig, Wallraf
Richartz Museum, Roemisch-Germanisches?

Exercise 9.2
Please open the file *buecher.sav*. Test the null hypothesis of equal theoretical means
of the monthly costs for books of the different school education levels.

Exercise 9.3
Please open the file *Tiefkühl.sav*. Consider the two variables:
X =Annual Income
Y =Monthly costs for frozen food
Please compute the three income classes:
1: up to 20 000
2: 20 001 up to 50 000
3: 50 001 or more
Is there evidence of a significant difference in the mean costs for frozen food of the
three different income classes?

Exercise 9.4 (Berenson et al., page 489)
The following data represent the US-nationwide highest yield of different types of
accounts in 2007 (CD=Certificate Deposit):

Money Market	Six-Month CD	One Year CD	2.5-Year CD	Five-Year CD
5.21	5.50	5.41	5.35	5.35
5.19	5.44	5.40	5.25	5.30
5.20	5.40	5.40	5.20	5.25
5.16	5.40	5.40	5.20	5.25
5.12	5.39	5.39	5.15	5.22

At the 0.05 level of significance, is there evidence of a difference in the mean yields
of the different accounts?

Exercise 9.5 (Berenson et al., page 489)
The retailing manager of a supermarket chain wants to determine whether product

1

location has any effect on the sale of pet toys. Three different aisle locations are considered: front, middle, and rear. A random sample of 18 stores is selected, with 6 stores randomly assigned to each aisle location. The size of the display area and the price of the product are constant in all stores. At the end of a one-month trial period, the sales volumes (in thousands of dollars) of the product in each store were as follows:

Aisle Location		
Front	Middle	Rear
8.6	3.2	4.6
7.2	2.4	6.0
5.4	2.0	4.0
6.2	1.4	2.8
5.0	1.8	2.2
4.0	1.6	2.8

At the 0.05 level of significance, is there evidence of a significant difference in mean sales among the various aisle locations?

Exercise 9.6 (Anderson et al., page 451)
Managers at all levels of organization need adequate information to perform their respective tasks. One study investigated the effect the source has on the dissemination of information. In this particular study the sources of information were superior, a peer and a subordinate. In each case, a measure of dissemination was obtained, with higher values indicating greater dissemination of information. Use $\alpha=0.05$ and the following data to test whether the source of information significantly affects dissemination. What is your conclusion, and what does it suggest about the use and dissemination of information?

Superior	Peer	Subordinate
8	6	6
5	6	5
4	7	7
6	5	4
6	3	3
7	4	5
5	7	7
5	6	5

Exercise 9.7 (Berenson et al. page 489)
An advertising agency has been hired by a manufacturer of pens to develop an advertising campaign for the upcoming holiday season. To prepare for this project, the research director decides to initiate a study of the effect of advertising on product perception. An experiment is designed to compare five different advertisements:

- Advertisement A greatly undersells the pen's characteristics.

- Advertisement B slightly undersells the pen's characteristics.

- Advertisement C slightly oversells the pen's characteristics.

- Advertisement D greatly oversells the pen's characteristics.

- Advertisement E attempts to correctly state the pen's characteristics.

A Sample of 30 adult respondents, taken from a larger focus group, is randomly assigned to the five advertisements, so that there are six respondents to each. After reading the advertisement and developing a sense of product expectation, all respondents are unknowingly receive the same pen to evaluate. The respondents are permitted to test the pen and the plausibility of advertising copy. The respondents are then asked to rate on the product characteristic scales (1= lowest performance, up to 7= highest performance) on appearance, durability, and writing performance. The sum of the scales of the three ratings for the 30 respondents are as follows:

A	B	C	D	E
15	16	8	5	12
18	17	7	6	19
17	21	10	13	18
19	16	15	11	12
19	19	14	9	17
20	17	14	10	14

Pen.sav

a) At the level 0.05 of significance, is there evidence of a difference in the mean rating of the five advertisements?

b) If appropriate, determine which advertisements differ in mean ratings?

c) At the level 0.05 of significance, is there evidence of a difference in the variation in ratings among the five advertisements?

d) Which advertisement(s) should you use and which advertisement(s) should you avoid? Explain!

Solution of exercise 9.7

X = Sum of three points for appearance, durability and writing performance of a pen

Y = kind of advertisement (A, B, C, D, E)

a) ANOVA

Tests of Normality

Advertisement	p-value	
	Lilliefors	Shapiro-Wilk
A	≥ 0.200	0.607
B	0.100	0.161
C	0.152	0.223
D	≥ 0.200	0.798
E	≥ 0.200	0.264

The points are Normally distributed for each kind of advertisement.

p-value Levene test $= 0.089$

Homogeneity of the five variances

p-value ANOVA ≈ 0.000

rejection of H_0, at least two means differ significantly.

b) Pairwise comparison of the mean values

Pair	Levene test	t-test	Welch test
A, B	0.710	0.765	–
A, C	0.019	–	0.003
A, D	0.234	0.000	–
A, E	0.044	–	0.104
B, C	0.032	–	0.005
B, D	0.341	0.000	–
B, E	0.076	0.149	–
C, D	0.418	0.241	–
C, E	0.576	0.060	–
D, E	0.676	0.005	–

Advertisements A and B are significantly different from advertisements C and D. Advertisement E is only different from advertisement D.

c) p-value Levene test $= 0.089$

There is no evidence of a significant difference in the variation in the ratings among the five advertisements.

d) Average values of the sum of the three points:

Advertisement	Average value of the three points
A	18.0
B	$17.\overline{6}$
C	$11.\overline{3}$
D	9.0
E	$15.\overline{3}$

The advertisements underselling the pen's characteristics had the highest average ratings, and the advertisements overselling the pen's characteristics had the lowest average ratings. Therefore, if you use an advertisement that undersells the pen's characteristics, you will get the highest satisfaction with the product, if the customer buys the pen in spite the poor rating.

Technology Arts Sciences Cologne
Faculty of Economics, Business and Law
Prof. Dr. Arrenberg
Room 221, Tel. 39 14
jutta.arrenberg@th-koeln.de

Exercises Quantitative Methods
Worksheet: Recoding

1. Transform → Recode into Different Variables

2. Numeric Variable = Income

3. Ouput Variable
   Name = Income_cat
   Change

4. Old and New Values

5. Old Value
   Range, LOWEST through value: 20 000
   New Value
   Value = 1
   Add

6. Old Value
   Range: 20 001 through 58 000
   New Value
   Value = 2
   Add

7. Old Value
   Range, value through HIGHEST: 58 001
   New Value
   Value = 3
   Add
   Continue

8. ok