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## Exercises Quantitative Methods

Worksheet: Compare Means

### Exercise

Two different teams fit automatic doors in a car. On basis of a sample check the null hypothesis of no difference between the expected time of fitting in the two teams. We have stopped the following time (in minutes) for fitting:

Team 1	100	120	135	140	105	180	100	180	70
Team 2	150	105	135	125	130	125	105	125	

Check the null hypothesis with an appropriate test.

Do the mean values of the variables  $X =$  “time for fitting (in min) of team 1“ and  $Y =$  “time for fitting (in min) of team 2“ differ?

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**Exercise 5.1** (*workers.sav*) Anderson et. al page 354

Suppose independent random samples of 15 unionized women and 20 non-unionized women in a skilled manufacturing job provide the following hourly wage rates (€).

Union Workers									
22.40	18.90	16.70	14.05	16.20	20.00	16.10	16.30	19.10	16.50
18.50	19.80	17.00	14.30	17.20					
Non-union Workers									
17.60	14.40	16.60	15.00	17.65	15.00	17.55	13.30	11.20	15.90
19.20	11.85	16.65	15.20	15.30	17.00	15.10	14.30	13.90	14.50

Does there appear to be any difference in the mean wage rate for these two groups? Explain.

**Exercise 5.2** (*BLK\_Cola.sav*) Berenson et. al page 422

You want to determine whether the mean weekly sales of BLK cola are the same when using a normal shelf location and when using an end-aisle display. The first sample contains the weekly sales of BLK cola from 10 stores selected to use the normal shelf location, and the second sample contains the weekly sales of BLK cola from the 10 stores selected to use the end-aisle display. The following table contains the cola sales (in number of cases) for the two samples:

Display Location									
Normal Display					End-Aisle Display				
22	34	52	62	30	52	71	76	54	67
40	64	84	56	59	83	66	90	77	84

Please determine whether the mean weekly sales of BLK cola are the same when using a normal shelf location and when using an end-aisle display.

**Exercise 5.3** Berenson et. al page 441

Can students save money by comparison shopping for textbooks at Amazon.com? To investigate this possibility, a random sample of 15 textbooks used during Spring 2007 semester at Miami University was selected. The prices for these textbooks at both local bookstore and through Amazon.com were recorded. The prices for the textbooks are given below:

Book Name	Book Store	Amazon
Principles of Microeconomics	120.00	101.22
Calculus: Early Transcendentals	137.50	115.33
Exploring Wine	65.00	37.05
Manual de Grammatica	82.75	71.36
Deviant Behavior	90.00	83.00
Modern Architecture Since 1900	39.95	26.37
Rise of Christianity	40.00	26.40
Commercial Banking	120.00	108.99
A Romance of a Republic	25.00	14.99
Chemistry in Context	133.75	102.30
Universal Principles of Design	40.00	26.40
In Mixed Company	79.50	68.76
International Marketing	154.75	126.15
Russia & Western Civilization	30.95	31.95
Enterprise Information Systems	155.75	126.97

At the 0.05 level of significance, is there evidence of a difference between the mean price of textbooks at the local book store and Amazon.com?

**Exercise 5.4** Berenson et. al page 441

A newspaper article discussed the opening of a Whole Foods Market in the Time-Warner building in New York City. The following data compared the prices of some kitchen staples at the new Whole Foods Market and the Fairway supermarket located about 15 blocks from Time-Warner building:

Item	Whole Foods	Fairway
Half-gallon milk	2.19	1.35
Dozen eggs	2.39	1.69
Tropicana orange juice (64 oz.)	2.00	2.49
Head of Boston lettuce	1.98	1.29
Ground round, 1 lb.	4.99	3.69
Bumble Bee tuna, 6 oz. can	1.79	1.33
Granny Smith apples (1 lb.)	1.69	1.49
Box DeCecco linguini	1.99	1.59
Salmon steak, 1 lb.	7.99	5.99
Whole chicken, per pound	2.19	1.49

At the 0.05 level of significance, is there evidence that the mean price is higher at Whole Foods Market than at Fairway supermarket?

Remark: In 2016 the analyst Dave Wasserman found out, that Donald Trump won 76% of counties with a Cracker Barrel (a Tennessee-based diner) and 22% of counties

with a Whole Foods Market.

**Exercise 5.5** (*Pen.sav*) (Berenson page 489)

An advertising agency has been hired by 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 *A, B, C, D, E*:

Advertisement	Pen's characteristics
<i>A</i>	greatly underselled
<i>B</i>	slightly underselled
<i>C</i>	slightly overselled
<i>D</i>	greatly overselled
<i>E</i>	correctly stated

A sample of six adult respondents for every of the five kind of advertisements was taken from a larger focus group. The 30 respondents are randomly assigned to the five kinds of advertisements, so that there are six respondents to each. After reading the advertisements and developing a sense of “product expectation“, all respondents unknowingly receive the same pen to evaluate. The respondents are permitted to test the pen and the plausibility of the advertising copy. The respondents are then asked to rate the pen with points form 1=lowest to 7=highest on the product characteristic scales of

- appearance
- durability
- writing performance.

The sums of points of the three ratings for the 30 respondents are as follows:

<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	<i>E</i>
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

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

Solution of exercise 5.5:

		Tests of Normality					
		Kolmogorov-Smirnov <sup>a</sup>			Shapiro-Wilk		
	Advertisement	Statistic	df	Sig.	Statistic	df	Sig.
Points	A	,212	6	,200*	,933	6	,607
	B	,299	6	,100	,851	6	,161
	C	,281	6	,152	,869	6	,223
	D	,172	6	,200*	,957	6	,798
	E	,206	6	,200*	,879	6	,264

\* This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Pair	$p$ -value $t$ -test or Welch test
$A, B$	0.765
$A, C$	0.003
$A, D$	0.000
$A, E$	0.104
$B, C$	0.005
$B, D$	0.000
$B, E$	0.149
$C, D$	0.241
$C, E$	0.060
$D, E$	0.005

There is evidence of a significant difference in the mean rating of advertisements underselling the pen's characteristics and of advertisements overselling the pen's characteristics.

Advertisements  $A$  and  $B$ , that are underselling the pen's characteristics had highest mean ratings with 18 resp.  $17.\bar{6}$  points. And the advertisements  $C$  and  $D$ , that are overselling the pen's characteristics, had the lowest mean ratings with  $11.\bar{3}$  resp. 9 points. Therefore, use an advertisement that undersells the pen's characteristics.