Postgraduate Student   : KONSTANTINOS KONSTANTINIDIS
Registration Number   : 7115152400017
Deadline for Responses Submission: 7/3/2025

2nd SET OF EXERCISES

1. The following table contains the results of the Wechsler Adult Intelligence Scale (WAIS) tests to 40 first-year students of the Department of Psychology at a university. Specifically, it includes the FSIQ (Full Scale IQ), VIQ (Verbal IQ), and PIQ (Performance IQ) scores, which describe the overall performance in Vocabulary, Similarities, Block Design and Picture Completion tests of the WAIS scale. It also includes the MRI (Magnetic Resonance Imaging) measurement of the size (in pixels) of the study participants' brains as well as their weight and height.

s/n	FSIQ (X_1)	VIQ (X_2)	PIQ (X_3)	Weight (pounds) (X_4)	Height (inches) (X_5)	Brain size via MRI (X_6)
1	133	132	124	118	64.5	816932
2	140	150	124	127	72.5	1001121
3	139	123	150	143	73.3	1038437
4	133	129	128	172	68.8	965353
5	137	132	134	147	65.0	951545
6	99	90	110	146	69.0	928799
7	138	136	131	138	64.5	991305
8	92	90	98	175	66.0	854258
9	89	93	84	134	66.3	904858
10	133	114	147	172	68.8	955466
11	132	129	124	118	64.5	833868
12	141	150	128	151	70.0	1079549
13	135	129	124	155	69.0	924059
14	140	120	147	155	70.5	856472
15	96	100	90	146	66.0	878897
16	83	71	96	135	68.0	865363
17	132	132	120	127	68.5	852244
18	100	96	102	178	73.5	945088
19	101	112	84	136	66.3	808020
20	80	77	86	180	70.0	889083
21	83	83	86	175	75.1	892420
22	97	107	84	186	76.5	905940
23	135	129	134	122	62.0	790619
24	139	145	128	132	68.0	955003
25	91	86	102	114	63.0	831772
26	141	145	131	171	72.0	935494
27	85	90	84	140	68.0	798612
28	103	96	110	187	77.0	1062462
29	77	83	72	106	63.0	793549
30	130	126	124	159	66.5	866662
31	133	126	132	127	62.5	857782
32	144	145	137	191	67.0	949589

s/n	FSIQ (X₁)	VIQ (X₂)	PIQ (X₃)	Weight (pounds) (X₄)	Height (inches) (X₅)	Brain size via MRI (X₆)
33	103	96	110	192	75.5	997925
34	90	96	86	181	69.0	879987
35	83	90	81	143	66.5	834344
36	133	129	128	153	66.5	948066
37	140	150	124	144	70.5	949395
38	88	86	94	139	64.5	893983
39	81	90	74	148	74.0	930016
40	89	91	89	179	75.5	935863

A. Perform a Principal Component Analysis (PCA) to the above 6 variables in order to determine:

i. The smallest number of Principal Components that describe at least 80% of the total variability.

ii. The coordinates of each of the Principal Components of the question i. with respect to the initial variables.

iii. The coordinates of the data in the above table in the coordinates system defined by the Principal Components of the question i.

It is given that the assumptions required for PCA application are valid.

B. Then produce the Y-index calculated using the values of the variables in the above table based on the relation:

$$Y = 3*(X_1 + X_2 + X_3) - 4* X_4 + 5*X_5 + 3* X_6$$

Next, find the coefficients of the multiple linear regression model of the variable Y, taking as independent variables the Principal Components of the question A.i. It is given that the assumptions required for the application of the multiple linear regression model are valid.

2. A company of medical equipment sells three types of analyzers and is interested to find out if the type of analyzer sold has an effect on whether a sale is made, as well as what time of day the sale is made. The following table records the sales in hundreds of Euros of 36 company's representatives divided by the type of analyzer and by the time of day:

Time of Day	Analyzer Type 1	Analyzer Type 2	Analyzer Type 3
Morning	6,3	6,1	3,2
	7,1	3,9	4,2
	5,5	4,3	4,8
	5,9	4,8	5,3
Noon	5,3	5,3	5,1
	6,6	3,9	3,7
	6,8	4,2	4,8
	7,2	4,1	4,7
Afternoon	8,2	4,3	4,9
	9,1	5,8	5,5

	6,4	4,1	4,8
	7,5	5,2	5,7

test, at a significance level of 5%, the validity of the following hypotheses:

a) The type of analyzers does not affect sales.

b) The time of day does not affect sales.

c) There is no interaction between the type of analyzers and the time of day.

3. The measurements of two characteristics x and y measured in pairs during a medical study on nine patients are recorded in the following table:

X	4	7	1	5	8	5	2	4	3
Y	80	92	52	76	106	100	69	71	65

If the two characteristics x and y follow normal distributions:

a. Plot the scatter diagram of the pairs of measurements.

b. Can you infer from the visual observation of the above diagram that x and y are correlated?

c. Calculate the appropriate correlation coefficient.

d. Can we reject the hypothesis that the correlation coefficient for the population is zero at the 5% significance level?

4. The following table provides the experience and monthly salaries of (randomly selected) nurses in a country X:

Experience (years)	Monthly salary (hundreds of Euros)
18	57
10	50
4	25
5	28
6	33
3	19
16	50
8	45
14	52

a. Provide the scatter plot of the data using experience as an independent variable and monthly salary as a dependent variable.

b. On the above graph, plot the least squares line that fits the data points.

c. What percentage of the variability of the dependent variable is explained by the above line?

d. Provide the interpretation of the coefficients of the above line.

e. What is the forecasted monthly salary of a nurse when her experience is equal to:

   i. 9 years;   ii. 15 years;   iii. 21 years;

f. Can we reject the hypothesis that there is no linear relationship between the monthly salary and the experience for nurses in country X, at a 5% significance level?

<u>Hint:</u> Provide analytically the conditions to apply the linear regression and check their validity.

5. The following was recently published on a news site:

"A hypertension pill may possibly "erase" bad memories

A widespread drug commonly used for hypertension and arrhythmias seems to erase memories associated with fears. This strange property could perhaps be exploited against phobic disorders and post-traumatic stress disorder.

Propranolol, a beta blocker drug, has reduced fears in volunteers who had been 'taught' to be afraid of spiders, according to Dutch researchers in a publication in the "Nature Neuroscience" journal.

60 of the study volunteers at the University of Amsterdam were asked to look at spider photos as they were subjected to a harmless but painful electrical shock. This experience created fearful memories.

Other volunteers in the control group were asked to look at the same photos without being shocked, so their memories of the experience was neutral and not accompanied by fear.

The following day, some of the volunteers in the shock group received propranolol, while others received placebo for comparison.

On the third day of the experiment, all volunteers were asked to look at the same images again while a special device measured the levels of anxiety from subtle contractions of the muscles around the eyes.

Shocked volunteers who had not received the drug experienced phobic reactions, while those who took the pill after the shock remained as neutral as the volunteers who had seen the spiders but without the shock.

The conclusion is that propranolol fights the phobic reaction by weakening the painful memory, said the head of the researchers Dr. Meryl Kidd.

Neuroscientists nowadays know that memories are open to slight modifications as they are recalled, a process called "reconsolidation". Previous studies in animals have shown that propranolol affects memories not during their initial storage, but during their recall and "reconsolidation".

Kidd's research team is now planning to study how long the action of the drug lasts in memory and to test the technique in people who actually suffer from phobic disorders or post-traumatic stress."

Describe how do you think the study was organized and carried out.

a. What hypothesis tests were carried out by the researchers?

b. What type of data should be collected and used to test each of the above hypotheses?

c. What methods were used to test each of the above hypotheses? Justify your answer.

d. What s the result of the application of each of the above methods according to the aforementioned summary?

Remarks:

1. Where no specific significance level is stated, you should consider it equal to 0,05.

2. Your responses must include, among others, the null and the alternative hypothesis as well as the type of the hypothesis tests you have used (two-sided or one-sided).

3. Your replies must also present in detail the necessary conditions for applying the method you have selected and the testing of their validity (in case the validity does not arise from the exercise).

4. In addition, the codes (eg MATLAB) and the charts that have been used must be included.