

# **Statistics and Probability**

## Quarter 4 – Module 19: **Solving Problems Involving Correlation Analysis**



#### Statistics and Probability – Grade 11 Alternative Delivery Mode Quarter 4 – Module 19: Solving Problems Involving Correlation Analysis First Edition, 2021

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# Statistics and Probability

## Quarter 4 – Module 19: Solving Problems Involving Correlation Analysis



## **Introductory Message**

This Self-Learning Module (SLM) is prepared so that you, our dear learners, can continue your studies and learn while at home. Activities, questions, directions, exercises, and discussions are carefully stated for you to understand each lesson.

Each SLM is composed of different parts. Each part shall guide you step-bystep as you discover and understand the lesson prepared for you.

Pre-tests are provided to measure your prior knowledge on lessons in each SLM. This will tell you if you need to proceed on completing this module or if you need to ask your facilitator or your teacher's assistance for better understanding of the lesson. At the end of each module, you need to answer the post-test to self-check your learning. Answer keys are provided for each activity and test. We trust that you will be honest in using these.

In addition to the material in the main text, Notes to the Teacher are also provided to our facilitators and parents for strategies and reminders on how they can best help you on your home-based learning.

Please use this module with care. Do not put unnecessary marks on any part of this SLM. Use a separate sheet of paper in answering the exercises and tests. And read the instructions carefully before performing each task.

If you have any questions in using this SLM or any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator.

Thank you.



## What I Need to Know

This module was designed and written with you in mind. It is here to help you master the nature of Biology. The scope of this module permits it to be used in many different learning situations. The language used recognizes the diverse vocabulary level of students. The lessons are arranged to follow the standard sequence of the course. But the order in which you read them can be changed to correspond with the textbook you are now using.

The module is divided into three lessons, namely:

- Lesson 1 Biology: The Science of Life
- Lesson 2 Biological Concepts as Applied in Technology
- Lesson 3 Tools Used in the Development of Biology and Biotechnology

After going through this module, you are expected to:

- 1. identify the unifying ideas in biology;
- 2. explain the different life processes;
- 3. explain biological concepts in a given technology;
- 4. identify the parts and function of the microscope;
- 5. name special tools used in research and technology; and
- 6. describe the contributions of Filipino and foreign scientists in the field of biology and technology



### What I Know

Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

- 1. What is used to determine the existence, strength, and direction of relationship between bivariate data?
  - a. correlation

- c. hypothesis
- d. interpretation b. regression
- 2. Miguel needs to analyze the strength of the relationship between two variables. What is the correct statistical method he needs to conduct?
  - a. z-test c. Pearson's co
  - b. Pearson's r d. regression analysis
- 3. Which of the following Pearson coefficients is considered having the strongest positive correlation?
  - a. r = -0.93
  - b. r = -0.81

c. r = 0.58d. r = 0.75

c. 0.49

- 4. Given the scatter plot below, describe the strength of correlation of the variables involved.
  - a. The variables have no correlation.
  - b. The variables have perfect positive correlation.
  - c. The variables have strong positive correlation.
  - d. The variables have weak positive correlation.



5. In question number 4, which of the following values of *r* represents the scatter plot?

a. 1

b. 0.98



- the values of y increase.
- b. As the values of x increase, the values of y remain the same.
- c. As the values of x decrease, the values of y decrease.
- d. As the values of x increase, the values of y decrease.



d. -0.99

7. A recent study was conducted in school and it was found out that as a student's number of absences increase, the academic performance tends to decline. Which of the following values of r is appropriate to represent the correlation of the variables in the given statement?

a0.48	b. 0	c. 0.15	d.	1

- 8. In a survey, the correlation coefficient r between drinking coffee and the number of hours you stay awake was found to be 0.87. Which of the following statements best describes the result?
  - a. As you drink more coffee, the number of hours you stay awake stays the same.
  - b. As you drink more coffee, the number of hours you stay awake increases.
  - c. As you drink more coffee, the number of hours you stay awake decreases.
  - d. As you drink less coffee, the number of hours you stay awake tends to increase.
- 9. Researchers found out that the correlation coefficient *r* between the number of hours people watch television and their body weight was nearly 0. Which of the following best describes the result?
  - a. The longer time a person watches television, the more s/he gains weight.
  - b. The longer time a person watches television, the more s/he loses weight.
  - c. The less time a person watches television, the more s/he gains weight.
  - d. There is no relationship between the number of hours watching television and weight of a person.

For numbers 10-12, refer to the following situation:

A trainer wants to find out the relationship between the person's height and pulse rate. The table below shows the gathered data from 7 people.

Height in inches (X)	62	64	71	64	75	67	66
Pulse rate per minute (Y)	103	90	83	71	85	87	69

10. What is the computed Pearson's sample correlation coefficient?

a0.75 b.	-0.28	c0.17	d.	0.123
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11. What is the strength of correlation?

a.	no correlation	c.	weak negative
b.	strong negative	d.	weak positive

- 12. Based on the findings, which of the following best describes the result?
  - a. The taller a person, the lower is his pulse rate.
  - b. The taller a person, the higher is his pulse rate.
  - c. The shorter a person, the lower is his pulse rate.
  - d. There is no correlation between a person's height and his pulse rate.

For numbers 13-15, refer to the situation below:

Mr. Antonio always instilled among his students the value of striving hard for excellence. That's why he wants to determine if a relationship exists between the number of hours students spend in studying and their final grade. The table below indicates the final exam grade and the number of hours spent in studying for a Mathematics exam.

study hours (X)	2	4	3	1	5	6
final exam grade (Y)	76	89	83	69	91	94

- 13. What is the computed Pearson's sample correlation coefficient? a. -1 b. -0.98 c. 0.98 d. 1
- 14. What is the strength of correlation?

a.	perfect negative	c. strong positive

- b. perfect positive d. weak positive
- 15. Based on the findings, which of the following best describes the result?
  - a. As a student spends more time in studying, the higher is the final exam grade.
  - b. A student spending less time in studying tends to have a higher final exam grade.
  - c. As a student spends more time in studying, the lower is the final exam grade.
  - d. No correlation exists between the hours spent in studying and the final exam grade of the students.

## Solving Problems Involving Correlation Analysis

Correlation analysis is one of the most important statistical tools that you may consider employing in conducting your research studies. In this module, you will learn how to solve problems involving correlation analysis. Remember your previous lessons on describing the form, direction, and strength of association between two variables and on calculating the Pearson's *r*. These skills you learned in the previous modules will help you understand the concepts presented here. You will dig deeper in the concept of correlation analysis by solving problems and interpreting the results in the context of the problems presented.

First, you need a recall on how to calculate Pearson's sample correlation coefficient by answering the first activity.



## What's In

In correlation analysis, we calculate a sample correlation coefficient specifically by using Pearson's sample correlation coefficient (Pearson's r). Given the bivariate data below, compute for the Pearson's r.

Student	Number of	Final Average
Student	Absences	Grade
1	16	77
2	2	86
3	14	75
4	9	87
5	8	85
6	4	86
7	2	89

What is the value of Pearson's r? What does this value mean in terms of student's number of absences and their final average grade? Can you interpret the value of Pearson's r? To give you more background on problems involving correlation analysis, let's have another activity.



What's New

Determine the trend of correlation of the situations below. Then, estimate and interpret the r value. Choose your answers from the choices in the box below.

	Bivariate Data	Direction/ Trend of Correlation	Estimated <i>r</i> Value	Degree/ Strength of Correlation
1.	age of a child and his clothing			
	size			
2.	volume of alcohol intake and			
	level of safety in driving a car			
3.	weight of a person and his/her			
	skill level in memorizing poem			
4.	hours spent working out at the			
	gym and the volume of body			
	fats			
5.	score in Quarterly Assessment			
	in Mathematics			
	and numbers of hours spent in			
	studying Mathematics			

#### **Choices:**

Direction/Trend	<u>Estimated r</u>	Degree/Strength of Correlation
positive negative no/negligible	0.0001 -0.75 0.98	strong no/negligible weak perfect

#### **Guide Questions:**

- 1. How did you find the activity?
- 2. How did you come up with the trend of the correlation in each item?
- 3. Did you find it easy to pick from the choices for the estimated *r* value? Why?

- 4. What helped you decide the degree/strength of correlation?
- 5. Knowing that *r* value ranges from -1 to 1, make a scale for the degree/strength of correlation as to no/negligible, weak, strong, and perfect. What are your considerations in deciding the boundaries for each category?



**Correlation** is used to determine the existence, strength, and direction of the relationship between two variables. Correlation coefficient *r* is a number between -1 and 1 that describes both the strength and the direction of correlation. In symbol, we write  $-1 \le r \le 1$ .

In the first activity in *What's In*, you solved for the value of r and identified its trend. In *What's New* activity, you identified the trends, estimated the values of r, and based on the values, you chose the correct descriptions of the strength of the correlation. So now, we will interpret r value by looking at the scale that gives both *strength and direction of correlation*.



Using the correlation scale, we can determine the **strength** of the correlation coefficient *r*. For example, you have r = 0.63 which means that there is a "strong positive correlation" between the two variables. To interpret, we can simply state it this way: "As x values increase, y values also increase and vice versa."

In interpreting the linear relationship of two bivariate data, refer to the value of r and the scale presented above. We can state our interpretation in different ways. In order for you to solve problems involving correlation analysis, you must know how to calculate the value of r and interpret this value using the scale. Since computing for r value is a necessary skill, you may go back to the previous lesson if you feel that you haven't mastered it yet. Otherwise, proceed to the following examples of solving for r.

- **Scenario:** Filipino employees are known for being persistent and hardworking. That is why they truly value every single cent of their salary. Here are some situations showing the relationship between the salary and spending of a Filipino employee.
- **Situation 1:** There is a survey wherein the correlation coefficient r between salary and spending of employee was found to be 0.97.
- *Interpretation:* There is a "strong positive correlation" between salary and spending of employees.
- Situation 2: In another survey, the correlation coefficient r between salary and spending of employee was found to be 0.38.
- *Interpretation:* There is a "weak positive correlation" between salary and spending of employees.
- **Situation 3:** In another survey, the correlation coefficient r between salary and spending of employee was found to be -0.81.
- *Interpretation:* There is a "strong negative correlation" between salary and spending of employees.
- **Situation 4:** In another survey, the correlation coefficient r between salary and spending of employee was found to be -0.19.
- *Interpretation:* There is a "weak negative correlation" between salary and spending of employees.

Bivariate Data	Computed	Interpretation
Divariate Data	Pearson's r	interpretation
Temperature and the		There is a strong negative correlation
number of hot chocolate	-0.781	between the temperature and the
products sold		number of hot chocolate products sold.
Amount of coffee intake		There is a weak positive correlation
and number of hours	0.426	between the amount of coffee intake
you stay awake		and number of hours you stay awake.
Height and salary of	0	There is no correlation between the
teachers	0	height and salary of teachers.

For more examples, see the table below:

If data are in a **scatter plot**, we can determine the strength of correlation and value of *r* by estimating it. Refer to the given examples below:

Scatter Plot	Estimated Strength of the Correlation	Estimated Value of <i>r</i>
	Strong Positive Correlation	The value of $r$ should be in the range between 0.5 and $1$ . We can say $0.8$ or 0.75 as long as it is within the range in the correlation scale.
30 25 20 15 10 5 0 0 2 4 6 8 10	Weak Negative Correlation	The value of $r$ should be in the range between 0 and -0.5 We can say -0.39 as long as it is within the range in the correlation scale.

The closeness of the points around the trend line determines the strength of the correlation. The closer the points to the trend line, the stronger the correlation of the variables is.

This is comparable to Filipino family ties, right? The closeness of each family member will lead them to a stronger family relationship.





What's More

### Activity 1.1 Is My Value Enough? Then, Why?

Values of <i>r</i>	Strength of Correlation
0.16	weak positive correlation
-1	1.
-0.94	2.
0.78	3.
0.43	4.
-0.19	5.
0	6.
1	7.

Using the correlation scale, identify the strength of correlation in each value of  $\boldsymbol{r}$ .

#### Activity 1.2 Who Is He?

He was the proponent of *Pearson's Sample Correlation Coefficient* during the latter half of the nineteenth century while conducting a series of studies on individual differences with Sir Francis Galton. It is now referred to as the Pearson's r.



Based on the scatter plot, ENCIRCLE its corresponding strength of correlation and choose the value of r from the LETTER BOX below. Write on the DECODE section the letter that corresponds to your answer. The letters arranged accordingly will spell out the FIRST NAME of Pearson.

Scatter Plot	Strength of Correlation	Value of <i>r</i>
	Perfect Positive Correlation	1.
	Perfect Negative Correlation	
	Strong Negative Correlation	2.
	No Correlation	

	Strong Positive Correlation	3.
	Weak Positive Correlation	
14 12 10 8 6	Strong Negative Correlation	4.
	Weak Negative Correlation	

#### LETTER BOX

R	S	Α	Ι	L	K
0.26	-1	0	-0.27	-0.83	1

DECODE...

				PEARSON
1	2	3	4	

#### Activity 1.3 R You Interpreting?

The following are the results of some other researches with their correlation coefficients. Make an interpretation for each survey. Item number 1 is already given as an example.

1. In a survey, the correlation coefficient r between engine size and fuel consumption was found to be -0.9.

Interpretation: <u>There is a strong negative correlation between engine size</u> <u>and fuel consumption.</u>

2. In another survey, the correlation coefficient r between engine size and fuel consumption was found to be -0.261.

Interpretation: \_\_\_\_\_

3. In a survey, the correlation between the number of hours per week students spent studying and their performance in an exam was found to be 0.72.

Interpretation: \_\_\_\_\_

4. In another survey, the correlation between the number of hours per week students spent studying and their performance in an exam was found to be 0.483.

Interpretation:	 	
-		

5. In a survey, the correlation between educational attainment and amount of income was found to be 0.88.

Interpretation: \_\_\_\_\_

6. In a survey, the correlation between educational attainment and amount of income was found to be -0.4.

Interpretation: \_\_\_\_\_

#### Activity 1.4 Read, Solve, Analyze, and Then Interpret

Read the following situations. Using each data, calculate the Pearson's sample correlation coefficient. After obtaining Pearson's *r*, analyze and interpret the result. (Show your solution.)

1. The table shows the data obtained from six students of Mapalad Integrated High School in a study about the number of hours a student exercises each week and the score s/he gets in a test.

Student	Hours (X)	Score (Y)
А	1	25
В	2	5
С	3	20
D	4	40
Е	5	25
F	6	9

2. A group of Senior High School students is conducting collaborative research and they want to determine whether there is a correlation between the age of tricycles (in years) in a certain city and the mileage it runs (in kilometers). The data are shown below.

Age of a tricycle, in yrs <b>(X)</b>	0.5	1	1.5	2	3	4
Mileage, in km/liter <b>(Y)</b>	16	14	10	12	10	12



## What I Have Learned

Fill in the blanks to complete the statements.

- 1. \_\_\_\_\_\_ is used to determine the existence, strength, and direction of relationship between two variables.
- 2. A statistical method to know the correlation between bivariate data is called
- 3. Correlation coefficient *r* is a number between \_\_\_\_ and \_\_\_\_ that describes both the strength and the direction of correlation. In symbol, we write\_\_\_\_\_.

Fill in the boxes with the corresponding strength of correlation.



Briefly explain how to interpret the value of r.



The following are data on the height of a father and his eldest son, in inches:

Height of the father (X)	70	66	69	65	68	72
Height of the eldest son (Y)	69	68	65	61	68	70

Do the data support the hypothesis that height is hereditary? Explain.

Support your explanation with statistical computations.



Multiple Choice. Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

- 1. Which of the following statements about correlation is NOT correct?
  - a. Every correlation has strength only.
  - b. Correlation is a number from -1 and 1.
  - c. A correlation can either be positive or negative.
  - d. Correlation determines the direction between two variables.
- 2. Miguel needs to analyze the strength of the relationship between two variables. What is the correct statistical method he needs to conduct?
  - a. z-test
  - b. Pearson co
  - c. Pearson alpha
  - d. Pearson's sample correlation coefficient
- 3. Which of the following Pearson coefficients is considered to have the weakest negative correlation?
  - a. 0.45 b. -0.1 c. -0.45 d. -0.98
- 4. Given the scatter plot below, describe the strength of correlation of the variables involved.
  - a. The variables have a perfect positive correlation.
  - b. The variables have a strong positive correlation.
  - c. The variables have a strong negative correlation.
  - d. The variables have a weak negative correlation.



- 5. In question number 4, which of the following values of *r* represents the scatter plot?
  - a. 0.001 b. 0

c. -0.47

d. -0.85

- 6. Which of the following interpretation best describes the given scatter plot?
  - a. As x values increase, y values increase.
  - b. As x values increase, y values decrease.
  - c. As x values increase, y values remain the same.
  - d. As x values decrease, y values increase.



- 7. There is a survey indicating that as the weather gets colder, air conditioning costs decrease. Which of the following values of *r* is appropriate to the result of the survey?
  - a. -0.93 b. 0 c. 0.19 d. 0.87
- 8. The correlation coefficient r between the number of bags of popcorn and the number of sodas sold at each performance of the circus over one week was found to be 0.62. Which conclusion can be drawn from the result?
  - a. There is no correlation between popcorn sales and soda sales.
  - b. There is a strong positive correlation between popcorn sales and soda sales.
  - c. There is a weak positive correlation between popcorn sales and soda sales.
  - d. There is a strong negative correlation between popcorn sales and soda sales.
- 9. An ornithologist, a person who studies every aspect of birds, found out that the correlation coefficient r between wing length and tail length of 12 different species of bird was 0.43. Which conclusion can be drawn from the result?
  - a. A bird with longer wing length has shorter tail length.
  - b. A bird with shorter wing length has longer tail length.
  - c. A bird with longer wing length also has longer tail length.
  - d. There is no correlation between bird's wing length and tail length.

For numbers 10-12, refer to the following situation:

The law of demand is an economic principle that explains the correlation between the price of a good and its demand. The table below shows the price of a good and its quantity of demand.

Price in Peso	11	12	13	16	18	19	20
Demand	38	31	26	23	20	20	17

10. What is the computed Pearson's sample correlation coefficient?

	a.	0.94	b. 0.04	c0.84	d0.94
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- 11. What is the strength of correlation?
  - a. weak positive c. strong negative
  - b. strong positive d. perfect negative
- 12. Based on the findings, which of the following best describes the result?
  - a. As the price of goods increases, the quantity of demand increases.
  - b. As the price of goods decreases, the quantity of demand decreases.
  - c. As the price of goods increases, the quantity of demand decreases.
  - d. As the price of goods increases, the quantity of demand remains the same.

For numbers 13-15, refer to the situation below:

A Mathematics teacher is interested in finding out if critical and scientific thinking exists among students who are good in Mathematics and Science. Thus, he conducted research and gathered scores of his respondents in Math and Science. The following data have been obtained:

Score in	Score in		
Mathematics	Science		
(X)	(Y)		
12	13		
10	9		
5	8		
7	8		
11	14		
6	7		

- 13. What is the computed Pearson's sample correlation coefficient?a. 0.87b. 0.78c. 0.52d. 0.23
- 14. What is the strength of correlation?
  - a. strong negative

- c. strong positive
- b. perfect positive
- d. weak positive
- 15. Based on the findings, which of the following best describes the result?
  - a. A student who is good in Mathematics is also good in Science.
  - b. A student who is good in Mathematics is not good in Science.
  - c. A student who is not good in Mathematics is good in Science.
  - d. There is no correlation between the performance of the students in Mathematics and Science.



Solve the following problems.

1. Compute the correlation coefficient of the following bivariate data. Then, give a conclusion based on the results.

Number	Selling	
of years	price	
owned	(Y)	
(X)		
1	23	
2	20	
3	17	
4	14	
5	11	

2. As shown in the table below, a person's heart rate during exercise changes as he gets older. Compute the Pearson's *r*, then interpret the result.

Age	Heart rate	
(years)	(beats per minute)	
20	135	
22	134	
24	132	
25	132	
27	129	
30	130	
35	130	

## What's More

### I.I vitvitoA

- 2. strong negative correlation 1. perfect negative correlation
- 3. strong positive correlation
- 4. weak positive correlation
- **S.I ViivitaA**

- perfect positive correlation 1. K. 1
- 2.A.0 no correlation

18

7. perfect positive correlation

5. weak negative correlation

6. no correlation

The proponent of Pearson's Sample Correlation Coefficient is KARL PEARSON. 4. L. -0.83 strong negative correlation weak positive correlation 3. R. 0.26

#### 6.1 ViivitoA

- 1. already given
- 2. There is a weak negative correlation between the engine size and fuel
- 3. There is a strong positive correlation between the number of hours spent efficiency.
- 4. There is a weak positive correlation between the number of hours spent studying and the performance in exam.
- 5. There is a strong positive correlation between educational attainment and studying and the performance in exam.
- the amount of income. 6. There is a weak negative correlation between educational attainment and the amount of income.

nl s'ishW			wəN ε'ish
The computed Pearson's r is -0.87.	Degree/ Strength of Correlation	Estimated r Value	Direction/ Trend of Correlation
What I Know	buons	86.0	ənitizoq
C 6 A I	buons	-0-22	อกเุรุธอิย
5' B 10' C	əldipilpən \on	əldipilpən \on I0000.0	
3' D 11' C	buons	52:0-	อกฺเฺาะมิอย
2' B 13' C	buons	0.98 strong	



12.

.4I

A

റ

## Answer Key

8' B

A .7

9' D

What I Наve Learned		What I Can Do
<ul> <li>1</li> <li>Chere is a perfect negative correlation between inducted is a perfect negative correlation between inducted.</li> <li>Chis implies that as number of years necesses, the selling price of the item fecteases.</li> <li>0.81</li> <li>Chere is a strong negative correlation between item set as a strong negative correlation between item item inplies that as you get older, your heart fate.</li> <li>Chis implies that as you get older, your heart reate.</li> <li>Chis implies that as you get older, your heart reate.</li> </ul>	1.1 1 1 1 1 1 2 2 1 1 1 1	I2' ∀ I4' C I3' ∀ I1' C I0' D 8' B 9' C 2' D 9' C 2' D 9' C 2' D 9' C 10' D 11' C 10' D 9' C 10' D 11' C 11' C 11' C
səitivitəA Isnoi	JibbA	fnəmzzəzzA

- 1. Correlation
- 2. Pearson's sample correlation coefficient / Pearson's r
- $1 \ge r \ge 1 ; 1, 1 .5$

Strength of Correlation from left to right

 perfect negative correlation, atrong negative correlation, weak positive correlation, atrong positive correlation, perfect positive correlation

- (Students' answers may vary.)

(Students' explanations may vary.) relationship population. әұз ui is strong enough to use to model the time we can say that the sample data computed r is significant, that's the is testing for significance. If the needs another statistical test and that whether the height is hereditary Generalizing 'uos shorter seq has taller son while a shorter person means that generally, a taller person height of the father and his son. It positive relationship between the Strong a strong that there is a strong The computed Pearson's r of

#### What's More

#### 4.1 VitvitoA

- 0 = r.1
- This means that there is no correlation between the numbers of hours a student exercises and the score in the test.
- 2. r = -0.59

This means that there is atrong negative correlation between age of tricycle and mileage it runs.

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