Senior High School

Statistics and Probability

Quarter 3 – Module 2:

Mean and Variance of Discrete Random Variable

ALTERNATIVE DELIVERY MODE

ADM

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Senior High School

Statistics and Probability

Quarter 3 – Module 2: Mean and Variance of Discrete Random Variable

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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-by-step 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.

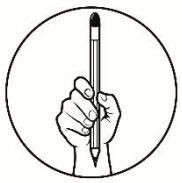
If you have any questions in using this SLM or any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator.

Thank you.

What I Need to Know

At the end of the lesson, the students are expected to:

1. Illustrate the mean and variance of a discrete random variable; **(M11/12SP-IIIb-2)**
2. Calculate the mean and the variance of a discrete random variable; **(M11/12SP-IIIb-2)**
3. Interpret the mean and the variance of a discrete random variable; **(M11/12SP-IIIb-3)** and
4. Solve problems involving mean and variance of probability distributions. **(M11/12SP-IIIb-4)**



What I Know

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

1. It is the central or average of its corresponding probability mass function.
   A. mean
   B. variance
   C. standard deviation
   D. probability

2. Determine the Mean or Expected Value of random variable below.

Tile	Number of times picked
1	$\frac{2}{15}$
2	$\frac{4}{15}$
3	$\frac{8}{15}$
4	$\frac{1}{15}$

   A. 2.53
   B. 2.54
   C. 2.55
   D. 2.56

3. What is the mean outcome if a pair of die is rolled once?
   A. 1.5
   B. 2.5
   C. 3.5
   D. 4.5

4. Find the mean of the probability distribution involving the random variable X that gives the number of heads that appear after tossing four coins once.
   A. 4
   B. 3
   C. 2
   D. 1

5. The probabilities that a printer produces 0,1,2, and 3 misprints are 42%, 28%, 18%, and 12% respectively. What is the mean value of the random variable?
   A. 1
   B. 2
   C. 3
   D. 4

6. The random variable X, representing the number of nuts in a chocolate bar has the following probability distribution. What is the mean?

Y	0	1	2	3	4
P(y)	$\frac{1}{10}$	$\frac{3}{10}$	$\frac{3}{10}$	$\frac{2}{10}$	$\frac{1}{10}$

A. 1.5
B. 1.3
C. 1.7
D. 1.9

7. These are two values that describe how scattered or spread out the scores are from the mean value of the random variable.

A. variance and standard deviation
B. mean and probability distribution
C. probability and statistics
D. mean and variance

For numbers 8 and 9.

Complete the table below using mean (μ) = 5. Write the answer in your answer sheets.

Probability Distribution Table of Random Variable X

X	2	4	6	8
P(x)	0.25	0.25	0.25	0.25
$(x-\mu)$	?	?	?	?
$(x-\mu)^2$	?	?	?	?

10. Compute for the variance and standard deviation of the **Probability Distribution table of the Random Variable X**.

A. Variance = 5; Standard Deviation = 2.24
B. Variance = 4; Standard Deviation = 3.24
C. Variance = 3; Standard Deviation = 4.24
D. Variance = 2; Standard Deviation = 5.24

Lesson 1 Mean of the Discrete Random Variable

Covid-19 is continuously spreading around the world, that is why reports regarding average infected people per country is being updated every day. For this kind of report, experts used Statistics and Probability to show reliable analysis in their data. In this lesson, you will learn how to compute the average or mean of a discrete probability distribution as well as the variance and standard deviation of a discrete random variable.

What's In

Let's find out if you are ready to learn this new lesson. Do the following, write your answer in your answer sheet.

A. Given the values of the variables X and Y, evaluate the following summations.

$X_1 = 5, Y_1 = 3$ $X_3 = 3, Y_3 = 1$

$X_2 = 4, Y_2 = 2$ $X_4 = 2, Y_4 = 0$

(1) $\sum X$ (3) $\sum(X + Y)$ (5) $\sum 4XY$

(2) $\sum XY$ (4) $\sum Y$

B. Construct a probability distribution of W representing the square of the number when a die is rolled once. Copy the table in your answer sheet then write your answer.

W						
P(w)						

Notes to the Teacher

This contains helpful tips or strategies that will help you in guiding the learners.

What's New

Consider the outcomes of a coin tossed as a random event. The probability of getting tail is $\frac{1}{2}$ or 50%, and the probability of getting head is $\frac{1}{2}$ or 50% also, but it is hard to predict the outcome that will occur. In this lesson, you will learn how to determine the likeliness of the happening of an event.

Mean of a Discrete Random Variable
The Mean μ of a discrete random variable is the central value or average of its corresponding probability mass function. It is also called as the Expected Value. It is computed using the formula:

$$\mu = \sum XP(x)$$

Where x is the outcome and p(x) is the probability of the outcome.

What is It

Examples:

1. Determine the mean or Expected Value of random variable below.

X	0	1	2	3	4
P(x)	$\frac{1}{5}$	$\frac{1}{5}$	$\frac{1}{5}$	$\frac{1}{5}$	$\frac{1}{5}$

Solution:

$\mu = \sum [xP(x)]$

$= \sum [0(\frac{1}{5}) + 1(\frac{1}{5}) + 2(\frac{1}{5}) + 3(\frac{1}{5}) + 4(\frac{1}{5})]$

$= \sum [0 + \frac{1}{5} + \frac{2}{5} + \frac{3}{5} + \frac{4}{5}]$

$= \frac{10}{5}$ or 2

Therefore, mean is 2 for the above random variable.

2. Find the mean of the random variable Y representing the number of red color chocolates per 160-gram pack of colored chocolate packages that has the following probability distribution.

Y	4	5	6	7
P(y)	0.10	0.37	0.33	0.20

Solution

$\mu = \sum [XP(x)]$

$= \sum [4(0.10) + 5(0.37) + 6(0.33) + 7(0.20)]$

$= \sum [0.40 + 1.85 + 1.98 + 1.40]$

$= 5.63$

So, the mean of the probability distribution is 5.63. This implies that the average number of red chocolates per 160-gram is 5.63.

3. The probabilities that a customer will buy 1, 2, 3, 4, or 5 items in a grocery store are $\frac{3}{10}$, $\frac{1}{10}$, $\frac{1}{10}$, $\frac{2}{10}$, and $\frac{3}{10}$, respectively. What is the average number of items that a customer will buy?

To solve the above problem, we will follow 3 steps below.

STEPS IN FINDING THE MEAN

Step 1: Construct the probability distribution for the random variable X representing the number of items that the customer will buy.

Step 2: Multiply the value of the random variable X by the corresponding probability.

Step 3: Add the results obtained in Step 2. Results obtained is the mean of the probability distribution.

Solution:

<table>
<tr><th>Steps</th><th>Solution</th></tr>
<tr><td>1. Construct the probability distribution for the random variable X representing the number of items that the customer will buy.</td><td>
<table>
<tr><th>Number of Items X</th><th>Probability P(x)</th></tr>
<tr><td>1</td><td>$\frac{3}{10}$</td></tr>
<tr><td>2</td><td>$\frac{1}{10}$</td></tr>
<tr><td>3</td><td>$\frac{1}{10}$</td></tr>
<tr><td>4</td><td>$\frac{2}{10}$</td></tr>
<tr><td>5</td><td>$\frac{3}{10}$</td></tr>
</table>
</td></tr>
<tr><td>2. Multiply the value of the random variable X by the corresponding probability.</td><td>
<table>
<tr><th>Number of Items X</th><th>Probability P(x)</th><th>X · P(x)</th></tr>
<tr><td>1</td><td>$\frac{3}{10}$</td><td>$\frac{3}{10}$</td></tr>
<tr><td>2</td><td>$\frac{1}{10}$</td><td>$\frac{2}{10}$</td></tr>
<tr><td>3</td><td>$\frac{1}{10}$</td><td>$\frac{3}{10}$</td></tr>
<tr><td>4</td><td>$\frac{2}{10}$</td><td>$\frac{8}{10}$</td></tr>
<tr><td>5</td><td>$\frac{3}{10}$</td><td>$\frac{15}{10}$</td></tr>
</table>
</td></tr>
</table>

3. Add the results obtained in Step 2. Results obtained is the **mean (μ)** of the probability distribution.

Number of Items X	**Probability P(x)**	**X • P(x)**
1	$\frac{3}{10}$	$\frac{3}{10}$
2	$\frac{1}{10}$	$\frac{2}{10}$
3	$\frac{1}{10}$	$\frac{3}{10}$
4	$\frac{2}{10}$	$\frac{8}{10}$
5	$\frac{3}{10}$	$\frac{15}{10}$
	TOTAL	$\frac{31}{10} = 3.1$

Using the formula:

$$\mu = \sum XP(x) = \frac{31}{10} = 3.1$$

So, the mean of the probability distribution is 3.1. This implies that the average number of items that the customer will buy is 3.1.

Lesson 2 Variance and Standard Deviation of the Discrete Random Variable

The variance and standard deviation describe the amount of spread, dispersion, or variability of the items in a distribution. How can we describe the spread or dispersion in a probability distribution? In this lesson, you will learn how to compute the variance and standard deviation of a discrete probability distribution.

Now, let us find out how can we find the variance and standard deviation of a discrete probability distribution.

What's New

Variance and Standard Deviation of a Random Variable
The variance and standard deviation are two values that describe how scattered or spread out the scores are from the mean value of the random variable. The variance, denoted as σ^2, is determined using the formula:

$$\sigma^2 = \sum(x - \mu)^2 p(x)$$

The standard deviation σ is the square root of the variance, thus,

$$\sigma = \sqrt{\sum(x - \mu)^2 p(x)}$$

σ^2 - variance
μ - mean
σ – standard deviation
p(x) – probability of the outcome

What is It

Let's try!

Let's have examples:

1. The number of cars sold per day at a local car dealership, along with its corresponding probabilities, is shown in the succeeding table. Compute the variance and the standard deviation of the probability distribution by following the given steps. Write your answer in your answer sheets.

Number of Cars Sold X	**Probability P(x)**
0	10%
1	20%
2	30%
3	20%
4	20%

In solving the problem, let's follow the steps below.

STEPS IN FINDING THE VARIANCE AND STANDARD DEVIATION

1. Find the mean of the probability distribution.

2. Subtract the mean from each value of the random variable X.

3. Square the result obtained in Step 2.

4. Multiply the results obtained in Step 3 by the corresponding probability.

5. Get the sum of the results obtained in Step 4. Results obtained is the value of the variance of probability distribution.

Now let's solve the problem.

STEPS

1. Find the mean of the probability distribution using the formula:

$\mu = \sum XP(x)$

SOLUTION

Number of Car Sold X	**Probability P(x)**	**X· P(x)**
0	0.1	0
1	0.2	0.2
2	0.3	0.6
3	0.2	0.6
4	0.2	0.8
	TOTAL	2.2

$\mu = \sum XP(x) = 2.2$

STEPS

2. Subtract the mean from each value of the random variable X.

SOLUTION

X	**P(x)**	**X . P(x)**	**X - μ**
0	0.1	0	0 – 2.2 = -2.2
1	0.2	0.2	1 – 2.2 = -1.2
2	0.3	0.6	2 – 2.2 = - 0.2
3	0.2	0.6	3 – 2.2 = 0.8
4	0.2	0.8	4 – 2.2 = 1.8

STEPS

3. Square the results obtained in Step 2.

SOLUTION

X	**P(x)**	**X . P(x)**	**X - μ**	**$(X - \mu)^2$**
0	0.1	0	-2.2	4.84
1	0.2	0.2	-1.2	1.44
2	0.3	0.6	-0.2	0.04
3	0.2	0.6	0.8	0.64
4	0.2	0.8	1.8	3.24

4. Multiply the results obtained in Step 3 by the corresponding probability.

X	P(x)	X·P(x)	X-μ	$(X - \mu)^2$	$(X - \mu)^2 \cdot P(x)$
0	0.1	0	-2.2	4.84	0.484
1	0.2	0.2	-1.2	1.44	0.288
2	0.3	0.6	-0.2	0.04	0.012
3	0.2	0.6	0.8	0.64	0.128
4	0.2	0.8	1.8	3.24	0.648

5. Get the sum of the results obtained in Step 4. The result is the value of the variance. So, the formula is:

$\sigma^2 = \sum(x - \mu)^2 p(x)$

X	P(x)	X·P(x)	X-μ	$(X - \mu)^2$	$(X - \mu)^2 \cdot P(x)$
0	0.1	0	-2.2	4.84	0.484
1	0.2	0.2	-1.2	1.44	0.288
2	0.3	0.6	-0.2	0.04	0.012
3	0.2	0.6	0.8	0.64	0.128
4	0.2	0.8	1.8	3.24	0.648
				TOTAL	1.56

$\sigma^2 = \sum(x - \mu)^2 p(x) = 1.56$

To Solve for Standard Deviation:

Get the square root of the variance

$\sigma^2 = \sum(x - \mu)^2 p(x)$

$= 1.56$

$\sigma = \sqrt{1.56}$

$= 1.25$

So, the variance of the number of cars sold per day is 1.56 and the standard deviation is 1.25.

2. When three coins are tossed once, the probability distribution for the random variable X representing the number of heads that occur is given below. Compute the variance and standard deviation of the probability distribution.

Solution:

Follow the steps in finding variance and standard deviation of the probability distribution.

STEPS

1. Find the mean of the probability distribution using the formula $\mu = \sum XP(x)$

SOLUTION

Number of Heads X	**Probability P(x)**	**X · P(x)**
0	$\frac{1}{8}$	0
1	$\frac{3}{8}$	$\frac{3}{8}$
2	$\frac{3}{8}$	$\frac{3}{8}$
3	$\frac{1}{8}$	$\frac{1}{8}$
	TOTAL	$\frac{12}{8} = 1.5$

$$\mu = \sum \boldsymbol{XP(x)} = \frac{\mathbf{12}}{\mathbf{8}} = \mathbf{1.5}$$

2. Subtract the mean from each value of the random variable X.

X	**P(x)**	**X · P(x)**	**X - μ**
0	$\frac{1}{8}$	0	0 – 1.5 = -1.5
1	$\frac{3}{8}$	$\frac{3}{8}$	1 – 1.5 = -0.5
2	$\frac{3}{8}$	$\frac{6}{8}$	2 – 1.5 = 0.5
3	$\frac{1}{8}$	$\frac{3}{8}$	3 – 1.5 = 1.5

3. Square the results obtained in Step 2.

X	P(x)	X·P(x)	X - μ	$(X - \mu)^2$
0	$\frac{1}{8}$	0	-1.5	2.25
1	$\frac{3}{8}$	$\frac{3}{8}$	-0.5	0.25
2	$\frac{3}{8}$	$\frac{6}{8}$	0.5	0.25
3	$\frac{1}{8}$	$\frac{3}{8}$	1.5	2.25

4. Multiply the results obtained in Step 3 by the corresponding probability.

X	P(x)	X·P(x)	X-μ	$(X - \mu)^2$	$(X - \mu)^2 \cdot P(x)$
0	$\frac{1}{8}$	0	-1.5	2.25	2.25/8 = 0.28
1	$\frac{3}{8}$	$\frac{3}{8}$	-0.5	0.25	0.75/8 = 0.09
2	$\frac{3}{8}$	$\frac{6}{8}$	0.5	0.25	0.75/8 = 0.09
3	$\frac{1}{8}$	$\frac{3}{8}$	1.5	2.25	2.25/8 = 0.28

5. Get the sum of the results obtained in Step 4. The result is the value of the **variance (σ^2)**. The formula is:

$\sigma^2 = \sum(x - \mu)^2 p(x)$

X	P(x)	X·P(x)	X-μ	$(X - \mu)^2$	$(X - \mu)^2 \cdot P(x)$
0	$\frac{1}{8}$	0	-1.5	2.25	0.28
1	$\frac{3}{8}$	$\frac{3}{8}$	-0.5	0.25	0.09
2	$\frac{3}{8}$	$\frac{6}{8}$	0.5	0.25	0.09
3	$\frac{1}{8}$	$\frac{3}{8}$	1.5	2.25	0.28
				TOTAL	0.74

$\sigma^2 = \sum(x - \mu)^2 p(x) = 0.74$

To solve for Standard Deviation

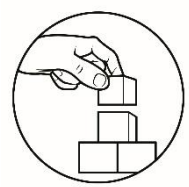
$\sigma^2 = \sum(x - \mu)^2 p(x)$

$= 0.74$

$\sigma = \sqrt{0.74}$

$= 0.86$

The mean in tossing 3 coins with probability of Head will show up is 0.86 and the variance is 0.74, then the standard deviation is 0.86.



What's More

A. Determine the mean or expected value of each Random Variable. Write your answer in your answer sheets.

1.

s	3	4	12	20
P(s)	0.1	0.5	0.2	0.2

2.

t	5	10	20
P(t)	50%	12%	38%

3.

w	1/12	1/6	1/3	1/2
P(w)	1/2	1/10	1/5	1/5

4. Find the mean of the probability distribution of the random variable X, which can take only the values 1, 2, and 3, given that P(1) =$\frac{10}{33}$, P(2) = $\frac{1}{3}$, and P(3) =$\frac{12}{33}$.

5. The probabilities of a machine manufacturing 0, 1, 2, 3, 4, and 5 defective parts in one day are 0.75, 0.17, 0.04, 0.025, 0.01, and 0.005 respectively. Find the mean of the probability distribution.

B. Determine the Variance and Standard Deviation of each random variable. Write your answer in your answer sheets.

1.

x	1	2	3	4	5
P(x)	$\frac{1}{5}$	$\frac{1}{5}$	$\frac{1}{5}$	$\frac{1}{5}$	$\frac{1}{5}$

2.

z	2	4	6	8
P(z)	0.6	0.1	0.2	0.1

3.

m	1	3	5	7
P(m)	40%	25%	15%	20%

4. The random variable X, representing the number of nuts in a chocolate bar has the following probability distribution. Compute the variance and standard deviation.

X	1	2	3	4	5
P(x)	$\frac{1}{10}$	$\frac{3}{10}$	$\frac{3}{10}$	$\frac{2}{10}$	$\frac{1}{10}$

5. The number of items sold per day in a sari-sari store, with its corresponding probabilities, is shown in the table below. Find the variance and standard deviation of the probability distribution.

Number of Items Sold X	Probability P(x)
19	0.20
20	0.20
21	0.30
22	0.20
23	0.10

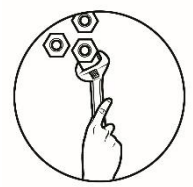
.

What I Have Learned

Answer the following questions in your own understanding.

1. How to compute the mean of a discrete random variable? State the 3 steps. Write your answer in your answer sheets.

2. How to find the variance and standard deviation of a discrete random variable? Write your answer in your answer sheets.



What I Can Do

Make a study about how many sheets of paper you consumed weekly in answering your Self Learning Modules. Record the quantity (total number of sheets) per subject, then construct a probability distribution. Compute the mean, variance, and the standard deviation of the probability distribution you made. Interpret the result, then find out how many weeks you will consume 50 sheets of pad paper.

Assessment

Find the mean, variance, and standard deviation of the following probability distribution then interpret the computed values. Write your answer in your answer sheets.

1. Variable z representing the number of male teachers per Elementary school.

z	2	3	4	5	6
P(z)	40%	32%	11%	9%	8%

2. The number of mobile phones sold per day at a retail store varies as shown in the given probability distribution below. Find the expected number of mobile phones that will be sold in one day.

x	30	33	38	40	50
P(x)	0.2	0.2	0.35	0.23	0.02

3. Number of monthly absences of Juan Dela Cruz based on his previous records of absences as presented in the probability distribution below.

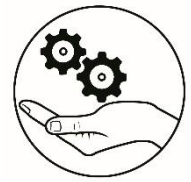
Number of Absences (X)	Percent P(x)
3	25%
4	30%
5	30%
6	15%

4. The number of computers sold per day at a local computer store, along with its corresponding probabilities, is shown in the table below.

Number of Computer Sold X	Probability P(x)
0	0.1
2	0.2
5	0.3
7	0.2
9	0.2

5. The number of inquiries received per day by the office of Admission in SHS X last enrolment is shown below.

Number of Inquiries X	Probability P(x)
22	0.08
25	0.19
26	0.36
28	0.25
29	0.07
30	0.05



Additional Activities

Observe yourself in a day. Find out how many hours you spend in the following activities: house chores, answering Self Learning Modules, planting/gardening, using social media like Facebook, messenger, tiktok, Instagram, and YouTube, listening to music, watching television, and sleeping. Record your data. Construct a probability distribution, then compute the mean (μ), variance (σ^2), and standard deviation (σ) of the probability distribution that you made.

Additional Activities

Student's answers may vary

What I have Learned

Student's answers may vary

Assessment

1. Mean (μ) = 3.13
   Variance (σ^2) = 1.5732
   Standard Deviation (σ) = 1.25
2. Mean (μ) = 35.7
   Variance (σ^2) = 18.15
   Standard Deviation (σ) = 4.26
3. Mean (μ) = 3.35
   Variance (σ^2) = 2.0274
   Standard Deviation (σ) = 1.42
4. Mean (μ) = 5.1
   Variance (σ^2) = 8.29
   Standard Deviation (σ) = 2.88
5. Mean (μ) = 26.4
   Variance (σ^2) = 3.74
   Standard Deviation (σ) = 1.93

What's In

A. (1) 14
   (2) 26
   (3) 20
   (4) 6
   (5) 104

B.

W	1	4	9	16	25	36
P(w)	1/6	1/6	1/6	1/6	1/6	1/6

What's More

A.

1. 8.7
2. 11.3
3. 0.225
4. 2.06
5. 0.39

B.

1. Variance (σ^2) = 2
   Standard Deviation (σ) = $\sqrt{2}$ = 1.414
2. Variance (σ^2) = 4.64
   Standard Deviation (σ) = $\sqrt{4.64}$ =2.15
3. Variance (σ^2) = 25.29
   Standard Deviation (σ) = $\sqrt{25.29}$ = 5.029
4. Variance (σ^2) = 1.289
   Standard Deviation (σ) = $\sqrt{1.289}$ = 1.135
5. Variance (σ^2) = 1.56
   Standard Deviation (σ) = $\sqrt{1.56}$ = 1.249

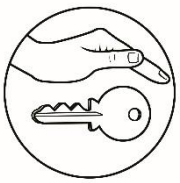
What I Can Do

Student's answers may vary

What I Know

1. A
2. A
3. C
4. C
5. A
6. D
7. A
8. -3, -1, 1, 3
9. 9, 1, 1, 4
10. A

Answer Key



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Canlapan, Raymond B., Statistics and Probability Module, Diwa Learning Systems Inc. 4/F SEDCCO 1 Bldg. 120 Thailand corner Legaspi Streets, Legaspi Village, 1229 Makati City, Philippines

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