

Ch 4.1 Discrete Random Variable

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Random Variable

Random Variable: is a variable (X) that has a single numerical value, determined by chance, for each outcome of a procedure.

Probability distribution: is a table, formula or graph that gives the probability of each value of the random variable.

A **Discrete Random Variable** has a collection of values that is finite or countable similar to discrete data.

A **Continuous Random Variable** as infinitely many values and the collection of values is not countable.

Ex : X = the number of times “four” shows up after tossing a die 10 times is a discrete random variable.

X = weight of a student randomly selected from a class. X is a continuous random variable

X = the method a friend contacts you online. X is not a random variable. (X is not numerical)

A Probability Distribution (PDF) for a Discrete Random Variable is a table, graph or formula that gives Probability of each value of X .

A Probability Distribution Function (PDF or PD) satisfies the following requirements:

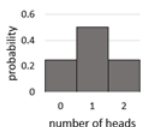
1. The value X is numerical, not categorical and each $P(x)$ is associated with the corresponding probability.
2. $\sum P(X) = 1$. A $\sum P(X) = 0.999$ or 1.01 is acceptable as a result of rounding.
3. $0 \leq P(x) \leq 1$ for all $P(x)$ in the PDF.

Ex1: PDF for number of heads in a two-coin toss are given as a table and a graph.

Table

x	P(x)
0	0.25
1	0.5
2	0.25

graph



Both are valid PDF because $\sum P(X) = 1$

and each value of $P(X)$ is between 0 and 1.

Ex2: The number of medical tests a patient receives after entering a hospital is given by the PDF below

x	1	2	3	4
p(x)	0.02	0.18	0.3	0.4

a) Is the table a valid PDF?

The table is not a probability distribution because $\sum P(x) = 0.02 + 0.18 + 0.3 + 0.4 = 0.9$ is not 1

b) Define the random variable x .

x = no. of medical tests a patient receives after entering a hospital.

c) Explain why the $x = 0$ is not in the PDF?

A patient always receives at least one medical test in the hospital.

Parameters of a Probability distribution:

Mean μ for a probability distribution:

$$E(x) = \mu = \sum x \cdot P(x)$$

Variance σ^2 for a probability distribution:

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

Standard deviation for a probability distribution:

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

To calculate Mean, variance and standard deviation of a probability distribution by technology:

Use Libretext statistics calculator:

https://stats.libretexts.org/Bookshelves/Ancillary_Materials/02%3A_Interactive_Statistics/10%3A_Expected_Value_and_Standard_Deviation_Calculator?adaptView

Enter Number of outcomes, each X and P(X), calculate.

round off rule: one more decimal place than for E(x)

Two decimal places for σ and σ^2 .

Expected value = the long-term outcome of average of x when the procedure is repeated infinitely many times. Round to one decimal place.

Non-significant values of X.

1. The range of X from $\mu - 2 \cdot \sigma$ to $\mu + 2 \cdot \sigma$ are non-significant. (Range of rule of Thumb)
2. X that are outside of $\mu - 2 \cdot \sigma$ to $\mu + 2 \cdot \sigma$ are significant that is unlikely to occur.

Ex1: X = no. of year a new hire will stay with the company. P(x) = Prob. that a new hire will stay for x year.

x	P(x)
0	0.12
1	0.18
2	0.3
3	0.15
4	0.1
5	0.1
6	0.05

a) Find mean, variance, st. deviation and determine the Expected number of years a new hire will stay.

Use easycalculation.com statistics discrete random variable calculator,

Enter number of outcomes = 7. Mean = 2.4, $\sigma^2 = 2.73$, $\sigma = 1.65$

The Expected no. of year a new hire will stay is 2.4 years.

b) Find probability that a new hire will stay for 4 years or more.

Add P(4), P(5) and P(6) = P(4 or more) = $0.1 + 0.1 + 0.05 = 0.25$

c) Find probability that a new hire will stay for between 3 or 5 years inclusive.

P(3 to 5 inclusive) = $0.15 + 0.1 + 0.1 = 0.35$

d) Find the probability that a new hire will stay for 2 years or fewer.

P(2 or fewer) = $0.12 + 0.18 + 0.30 = 0.6$

e) Find the range of non-significant year of stay.

$2.4 - 2(1.65)$ to $2.4 + 2(1.65)$ is -0.9 to 5.7

Ex2: Given x = of number of textbooks a student buy per semester. What is the expected number of textbooks?

x	$P(x)$
1	0.02
2	0.03
3	0.45
4	0.45
5	0.03
6	0.02

a) Find mean, variance and standard deviation.

Use easycalculation.com statistics discrete random variable calculator, Enter number of outcomes = 6

$$E(x) = \mu = 3.5, \quad \sigma^2 = 0.61, \quad \sigma = 0.78$$

Expected number of textbook is 3.5 books.

b) Find Probability that a student buys at least 5 textbook.

$$P(\text{at least } 5) = P(5 \text{ or more}) = 0.03 + 0.02 = 0.05,$$

c) Find probability that x is at most 2.

$$P(\text{at most } 2) = P(2 \text{ or fewer}) = 0.02 + 0.03 = 0.05$$

c) Find the range non-significant.

Range of non-significant is $3.5 - 2(0.78)$ to $2.5 + 2(0.78)$ is 1.94 to 5.06.

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