CHAPTER

RANDOM VARIABLES

RANDOM VARIABLES

- Introduction
- Discrete probability distribution
- Continuous probability distribution
- Cumulative distribution function
- Expected value, variance and standard deviation

INTRODUCTION

- In an experiment of chance, outcomes occur randomly. We often summarize the outcome from a random experiment by a simple number.

Definition

- A ***variable*** is a symbol such as *X*, *Y*, *Z*, *x* or *H*, that assumes values for different elements. If the variable can assume only one value, it is called a constant.

- A ***random variable*** is a variable whose value is determined by the outcome of a random experiment.

Example

A balanced coin is tossed two times. List the elements of the sample space, the corresponding probabilities and the corresponding values ***X***, where ***X*** is the number of getting head.

Solution

Elements of sample space	Probability	X
HH	¼	2
HT	¼	1
TH	¼	1
TT	¼	0

Exercise

- The time to recharge the flash is tested in three cell phone cameras. The probability a camera passes the test is 0.8 and the camera perform independently. List the elements of the sample space, the corresponding probabilities and the corresponding values $\boldsymbol{X}$, where $\boldsymbol{X}$ denotes the number of camera passes the test.

Solution

X : the number of cameras that pass the test

Camera 1	Camera 2	Camera 3	Probability	X
Pass	Pass	Pass	0.512	3
Pass	Pass	Fail	0.128	2
Pass	Fail	Pass	0.128	2
Pass	Fail	Fail	0.032	1
Fail	Pass	Pass	0.128	2
Fail	Pass	Fail	0.032	1
Fail	Fail	Pass	0.032	1
Fail	Fail	Fail	0.008	0

TWO TYPES OF RANDOM VARIABLES

Discrete Random Variables

A random variable is **discrete** if its set of possible values consist of **discrete points** on the number line.

Continuous Random Variables

A random variable is **continuous** if its set of possible values consist of an **entire interval** on the number line.

EXAMPLES

Examples of discrete random variables:

- -number of scratches on a surface
- -number of defective parts among 1000 tested
- -number of transmitted bits received error

Examples of continuous random variables:

- -electrical current
- -length
- -time

DISCRETE PROBABILITY DISTRIBUTIONS

Definition:

- If *X* is a discrete random variable, the function given by ***f(x)=P(X=x)*** for each *x* within the range of *X* is called the **probability distribution** of *X*.

- Requirements for a discrete probability distribution:

1) The probability of each value of the discrete random variable is between 0 and 1, inclusive. That is, $0 \leq P(X = x) \leq 1$

2) The sum of all the probabilities is 1. That is, $\sum_{x \in S} P(X = x) = 1$

Example

- Check whether the distribution is a probability distribution.

X	**0**	**1**	**2**	**3**	**4**
P(X=x)	0.125	0.375	0.025	0.375	0.125

Solution

$$\sum_{0}^{4} P(X=x) = P(X=0)+P(X=1)+P(X=2)+P(X=3)+P(X=4)$$

$$= 0.125+0.375+0.025+0.375+0.125$$

$$= 1.025$$

$$\neq 1$$

- **so the distribution is not a probability distribution.**

Example

- Check whether the function given by

$$f(x) = \frac{x+2}{25} \text{ for } x=1,2,3,4,5$$

can serve as the probability distribution of a discrete random variable.

Solution

Solution

$$\sum_{1}^{5} f(x) = \sum_{1}^{5} \frac{x+2}{25}$$

$$= f(1) + f(2) + f(3) + f(4) + f(5)$$

$$= \frac{1+2}{25} + \frac{2+2}{25} + \frac{3+2}{25} + \frac{4+2}{25} + \frac{5+2}{25}$$

$$= \frac{3}{25} + \frac{4}{25} + \frac{5}{25} + \frac{6}{25} + \frac{7}{25}$$

$$= \frac{25}{25}$$

$$= 1$$

 # so the given function is a probability distribution of a discrete random variable.

Example : Rolling a Die

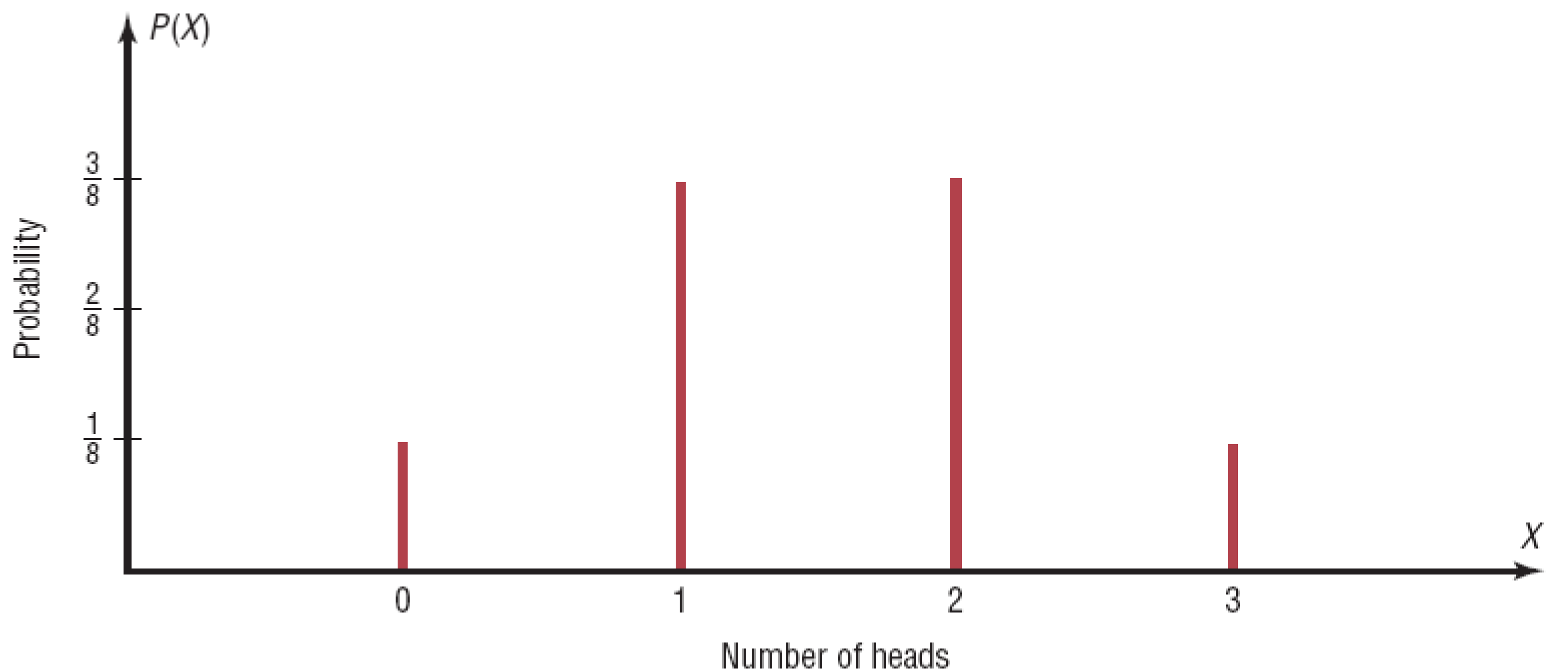
Construct a probability distribution for rolling a single die.

Outcome X	1	2	3	4	5	6
Probability $P(X)$	$\frac{1}{6}$	$\frac{1}{6}$	$\frac{1}{6}$	$\frac{1}{6}$	$\frac{1}{6}$	$\frac{1}{6}$

Example: Tossing Coins

Represent graphically the probability distribution for the sample space for tossing three coins.

Number of heads X	0	1	2	3
Probability $P(X)$	$\frac{1}{8}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{1}{8}$



Mean, Variance, Standard Deviation, and Expectation

MEAN: $\mu = \sum X \cdot P(X)$

VARIANCE:

$$\sigma^2 = \sum\left[X^2 \cdot P(X)\right] - \mu^2$$

Example: Rolling a Die

Find the mean of the number of spots that appear when a die is tossed.

Outcome X	1	2	3	4	5	6
Probability $P(X)$	$\frac{1}{6}$	$\frac{1}{6}$	$\frac{1}{6}$	$\frac{1}{6}$	$\frac{1}{6}$	$\frac{1}{6}$

$$\mu = \sum X \cdot P(X)$$

$$= 1 \cdot \tfrac{1}{6} + 2 \cdot \tfrac{1}{6} + 3 \cdot \tfrac{1}{6} + 4 \cdot \tfrac{1}{6} + 5 \cdot \tfrac{1}{6} + 6 \cdot \tfrac{1}{6}$$

$$= \tfrac{21}{6} = \boxed{3.5}$$

Example: Rolling a Die

Compute the variance and standard deviation for the probability distribution in Example 5–5.

Outcome X	1	2	3	4	5	6
Probability $P(X)$	$\frac{1}{6}$	$\frac{1}{6}$	$\frac{1}{6}$	$\frac{1}{6}$	$\frac{1}{6}$	$\frac{1}{6}$

$$\sigma^2 = \sum\left[X^2 \cdot P(X)\right] - \mu^2$$

$$\sigma^2 = 1^2 \cdot \tfrac{1}{6} + 2^2 \cdot \tfrac{1}{6} + 3^2 \cdot \tfrac{1}{6} + 4^2 \cdot \tfrac{1}{6}$$

$$+ 5^2 \cdot \tfrac{1}{6} + 6^2 \cdot \tfrac{1}{6} - (3.5)^2$$

$$\sigma^2 = \boxed{2.9}, \quad \sigma = \boxed{1.7}$$

Example: On Hold for Talk Radio

A talk radio station has four telephone lines. If the host is unable to talk (i.e., during a commercial) or is talking to a person, the other callers are placed on hold. When all lines are in use, others who are trying to call in get a busy signal. The probability that 0, 1, 2, 3, or 4 people will get through is shown in the distribution. Find the variance and standard deviation for the distribution.

X	0	1	2	3	4
$P(X)$	0.18	0.34	0.23	0.21	0.04

Example: On Hold for Talk Radio

X	0	1	2	3	4
$P(X)$	0.18	0.34	0.23	0.21	0.04

$$\mu = 0(0.18) + 1(0.34) + 2(0.23) + 3(0.21) + 4(0.04) = 1.6$$

$$\sigma^2 = 0^2(0.18) + 1^2(0.34) + 2^2(0.23) + 3^2(0.21) + 4^2(0.04) - (1.6)^2$$

$$\sigma^2 = \boxed{1.2}, \quad \sigma = \boxed{1.1}$$

Expectation

- The **expected value**, or **expectation**, of a discrete random variable of a probability distribution is the theoretical average of the variable.
- The expected value is, by definition, the mean of the probability distribution.

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

Example: Winning Tickets

One thousand tickets are sold at $1 each for four prizes of $100, $50, $25, and $10. After each prize drawing, the winning ticket is then returned to the pool of tickets. What is the expected value if you purchase two tickets?

Gain *X*	$98	$48	$23	$8	- $2
Probability *P(X)*	$\frac{2}{1000}$	$\frac{2}{1000}$	$\frac{2}{1000}$	$\frac{2}{1000}$	$\frac{992}{1000}$

$$E(X) = \$98 \cdot \tfrac{2}{1000} + \$48 \cdot \tfrac{2}{1000} + \$23 \cdot \tfrac{2}{1000}$$

$$+ \$8 \cdot \tfrac{2}{1000} + (-\$2) \cdot \tfrac{992}{1000} = \boxed{-\$1.63}$$

Example: Winning Tickets

One thousand tickets are sold at \$1 each for four prizes of \$100, \$50, \$25, and \$10. After each prize drawing, the winning ticket is then returned to the pool of tickets. What is the expected value if you purchase two tickets?

Alternate Approach

Gain *X*	\$100	\$50	\$25	\$10	\$0
Probability *P(X)*	$\frac{2}{1000}$	$\frac{2}{1000}$	$\frac{2}{1000}$	$\frac{2}{1000}$	$\frac{992}{1000}$

$$E(X) = \$100 \cdot \frac{2}{1000} + \$50 \cdot \frac{2}{1000} + \$25 \cdot \frac{2}{1000}$$

$$+ \$10 \cdot \frac{2}{1000} + \$0 \cdot \frac{992}{1000} - \$2 = \boxed{-\$1.63}$$

CONTINUOUS PROBABILITY DISTRIBUTIONS

Definition:

- A function with values ***f(x),*** defined over the set of all numbers, is called a **probability density function** of the continuous random variable *X* if and only if

$$P(a \le X \le b) = \int_a^b f(x)\, dx$$

for any real constant a and b with $a \le b$

[redacted]

Requirements for a probability density function of a continuous random variable *X*:

1) $f(x) \geq 0$ for $-\infty \leq x \leq \infty$

2) $\int_{-\infty}^{\infty} f(x)\, dx = 1$. That is the total area under graph is 1.

[redacted]

Example:

Consider the function

$$f(x) = \begin{cases} 6x(x-1) & \text{if } 0 \le x \le 1 \\ 0 & otherwise \end{cases}$$

(a) Find $P(X \le -3)$

(b) Find $P\left(0.5 \le X \le 0.8\right)$

Example

Let X be a continuous random variable with the following probability density function

$$f(x) = \begin{cases} c(2x^3 + 5) & , \quad -1 \le x \le 1 \\ 0 & , \quad \text{otherwise} \end{cases}$$

1) Evaluate c

2) Find $P(0 \le X \le 1)$

Solution

a)

$$P(-1 \le X \le 1) = \int_{-1}^{1} c(2x^3 + 5)\,dx$$

$$= c\int_{-1}^{1} (2x^3 + 5)\,dx$$

$$= c\left(\frac{2x^4}{4} + 5x\right)\Big|_{-1}^{1}$$

$$= c\left[\left(\frac{2(1)^4}{4} + 5(1)\right) - \left(\frac{2(-1)^4}{4} + 5(-1)\right)\right]$$

$$= c\left[\left(\frac{11}{2}\right) - \left(-\frac{9}{2}\right)\right]$$

$$= c(10)$$

$$= 1$$

$$\therefore \; c = \frac{1}{10}$$

b)

$$P(0 \le X \le 1) = \int_0^1 \frac{1}{10}\left(2x^3 + 5\right)dx$$

$$= \frac{1}{10}\left(\frac{2x^4}{4} + 5x\right)\Bigg|_0^1$$

$$= \frac{1}{10}\left[\left(\frac{2(1)^4}{4} + 5(1)\right) - \left(\frac{2(0)^4}{4} + 5(0)\right)\right]$$

$$= \frac{1}{10}\left(\frac{11}{2}\right)$$

$$= \frac{11}{20}$$

$$= 0.55$$

Example

Let *X* be a continuous random variable with the following

$$f(x) = \begin{cases} \frac{3}{4}(x^2+1), & 0 \le x \le 1 \\ 0, & otherwise \end{cases}$$

a) Verify whether this distribution is a probability density function

b) Find $P(0 \le X \le 0.5)$

c) Find $P(0.5 \le X \le 2)$

Answer;

a) The distribution is probability density function if it fulfill the following requirements,

1) All f(x)≥0

2) If $$\int_{-\infty}^{\infty} f(x)dx = 1$$

In this problem,

1) First requirement

f(0)=3/4≥0, f(1)=3/2≥0, f(x)=0, otherwise

\- **All f(x)≥0**

Must write the conclusion so that we know the first requirement is fulfill!

2) Second requirement

$$\int_{-\infty}^{0} 0dx + \int_{0}^{1} \frac{3}{4}(x^2+1)dx + \int_{1}^{\infty} 0dx$$

$$= \frac{3}{4}[\frac{x^3}{3} + x]_0^1$$

$$= \frac{3}{4}[\frac{4}{3}]$$

$$= 1$$

- $$\int_{-\infty}^{\infty} f(x)dx = 1$$

Must write the conclusion so that we know the second requirement is fulfill!

Write last conclusion to answer the question!

Since all requirements all fulfill, the distribution is probability density function.

$b) P(0 \le X \le 0.5)$

$$= \int_0^{0.5} \frac{3}{4}(x^2+1)dx$$

$$= \frac{3}{4}\int_0^{0.5}(x^2+1)dx$$

$$= \frac{3}{4}\left[\frac{x^3}{3}+x\right]_0^{0.5}$$

$$= \frac{3}{4}\left[\left(\frac{0.5^3}{3}+0.5\right)-0\right] \qquad = 0.40625$$

$$c)P(0.5 \le X \le 2)$$

$$= \int_{0.5}^{1} \frac{3}{4}(x^2+1)dx + \int_{1}^{2} 0dx$$

$$= \frac{3}{4}\int_{0.5}^{1}(x^2+1)dx + 0$$

$$= \frac{3}{4}\left[\frac{x^3}{3}+x\right]_{0.5}^{1}$$

$$= \frac{3}{4}\left[(\frac{1^3}{3}+1)-(\frac{0.5^3}{3}+0.5)\right] \qquad = 0.59375$$

EXERCISE

1. A random variable x can assume 0,1,2,3,4. A probability distribution is shown here:

X	0	1	2	3	4
P(X)	0.1	0.3	0.3	?	0.1

(b) Find $P(X = 3)$

(c) Find $P(X \geq 2)$

2. Let $f(x)=\begin{cases}12.5x-1.25 & , \ 0.1\le x\le 0.5\\ 0 & , \ \text{otherwise}\end{cases}$

Find $P(0.2 \le X \le 0.3)$

3. Let $f(x)=\begin{cases}\mathrm{e}^{-x+6} & , \ x>6\\ 0 & , \ \text{otherwise}\end{cases}$

(a)Find $P(X>6)$

(b) Find $P(6 \le \mathrm{X} < 8)$

CUMULATIVE DISTRIBUTION FUNCTION

- The cumulative distribution function of a **discrete random variable *X*** , denoted as ***F(x)***, is

$$F(x) = P(X \le x) = \sum_{t \le x} f(t) \quad \text{for } -\infty < x < \infty$$

- For a discrete random variable *X*, *F(x)* satisfies the following properties:

$$\text{1) } 0 \le F(x) \le 1$$
$$\text{2) If } x \le y, \text{ then } F(x) \le F(y)$$

- If the range of a random variable *X* consists of the values $x_1 < x_2 < x_3 < \ldots < x_n$, then $f(x_1) = F(x_1)$ and

$$f(x_i) = F(x_i) - F(x_{i-1}) \quad \text{for } i = 2, 3, \ldots, n$$

[redacted]

- The cumulative distribution function of a **continuous random variable *X*** is

$$F(x) = P(X \le x) = \int_{-\infty}^{x} f(t)\, dt \text{ for } -\infty < x < \infty$$

Let $F(x)$ be the distribution function for a continuous random variable X. Then $f(x) = \dfrac{dF(x)}{dx} = F'(x)$ wherever the derivative exists.

Example

Given the probability function $f(x) = \frac{5-x}{10}$ for $x = 1, 2, 3, 4,$

find $F(x)$

Solution

x	**1**	**2**	**3**	**4**
f(x)	4/10	3/10	2/10	1/10
F(x)	4/10	7/10	9/10	1

Example

If X has the probability density

$$f(x) = \begin{cases} k \cdot e^{-3x} & \text{for } x > 0 \\ 0 & \text{elsewhere} \end{cases}$$

Find

i) k

ii) $F(x)$

iii) $P(0.5 \le x \le 1)$

Solution

i) $\int_{-\infty}^{\infty} f(x)\ dx = 1$

$$\int_{0}^{\infty} k \cdot e^{-3x}\ dx = k\left(\frac{e^{-3x}}{-3}\right)\Bigg|_{0}^{\infty}$$

$$= k\left(0 - \left(\frac{1}{-3}\right)\right)$$

$$= \frac{k}{3} = 1$$

$$\therefore\ k = 3$$

ii) for $x \leq 0$,

$$F(x) = \int_{-\infty}^{x} 0 \, dt = 0$$

for $x > 0$,

$$F(x) = \int_{-\infty}^{0} 0 \, dt + \int_{0}^{x} 3e^{-3t} \, dt$$

$$= 0 + 3\int_{0}^{x} e^{-3t} \, dt$$

$$= 3\left(\frac{e^{-3t}}{-3}\right)\Bigg|_{0}^{x}$$

$$= -1\left(e^{-3x} - e^{0}\right) = 1 - e^{-3x}$$

$$\therefore \quad F(x) = \begin{cases} 0 & \text{for } x \leq 0 \\ 1 - e^{-3x} & \text{for } x > 0 \end{cases}$$

Summary is important!!!

iii) $P(0.5 \le X \le 1) = F(1) - F(0.5)$

$$= \left(1 - e^{-3(1)}\right) - \left(1 - e^{-3(0.5)}\right)$$

$$= \left(1 - e^{-3}\right) - \left(1 - e^{-1.5}\right)$$

$$= 0.173$$

EXERCISE :

Given the probability density function of a random variable X as follows;

$$f(x) = \begin{cases} \frac{3}{8}x^2, & 0 \le x \le 2 \\ 0, & otherwise \end{cases}$$

i) Find the cumulative distribution function, F(X)

ii) Find $P(1 \le X \le 2)$

How to change CDF to PDF

Given

$$F(x) = \begin{cases} 0 & x < 0 \\ \frac{x^3}{8} & 0 \le x < 2 \\ 1 & x > 2 \end{cases}$$

Find $f(x)$.

Solution:

$$\frac{d}{dx}\left(F(x)\right) = \frac{d}{dx}\left(\frac{x^3}{8}\right) = \frac{3x^2}{8}$$

$$f(x) = \frac{3x^2}{8}$$

EXPECTED VALUE, VARIANCE AND STANDARD DEVIATION

Expected Value

- The **mean** of a random variable X is also known as the **expected value** of X as $\mu = \mu_X = E(X)$

If X is a **discrete random variable**,

$$\mu_X = E(X) = \sum_{x \in S} x f(x) = \sum_{x \in S} x P(X = x)$$

If X is a **continuous random variable**,

$$\mu_X = E(X) = \int_{-\infty}^{\infty} x f(x)$$

Variance

$Var(X) = \sigma^2 = \sigma_X^2 = E((X-\mu)^2)$, where

$Var(X) = \sum_{x \in S} (X-\mu)^2 P(X=x)$, in the discrete case,

$Var(X) = \int_{-\infty}^{\infty} (X-\mu)^2 f(x)dx$, in the continuous case when it exists.

$Var(X)$ exists if and only if $\mu = E(X)$ and $E(X^2)$ both exist, and then $Var(X) = E(X^2) - (E(X))^2$

Standard Deviation

The standard deviation is $\sigma = \sigma_X = \sqrt{Var(X)} = \sqrt{\sigma_X^2}$

Properties of Expected Values

- For any constant *a* and *b,*

i) $E(a) = a$

ii) $E(bX) = bE(X)$

iii) $E(aX + b) = aE(X) + b$

$iv) E\left(X + Y\right) = E\left(X\right) + E\left(Y\right)$

Properties of Variances

For any constant *a* and *b*,

i) $Var(a) = 0$

ii) $Var(bX) = b^2 Var(X)$

iii) $Var(aX + b) = a^2 Var(X)$

Example

Find the mean, variance and standard deviation of the probability function

$$f(x) = \frac{x}{10} \quad \text{for } x = 1, 2, 3, 4$$

Solution

Mean:

$$E(X) = \sum_{i=1}^{n} x \cdot f(x)$$

$$= \sum_{i=1}^{4} x \cdot \frac{x}{10}$$

$$= 1 \cdot \frac{1}{10} + 2 \cdot \frac{2}{10} + 3 \cdot \frac{3}{10} + 4 \cdot \frac{4}{10}$$

$$= \frac{30}{10} = 3$$

Variance:

$$E\left(X^2\right)=\sum_{i=1}^{n} x^2\cdot f\left(x\right)$$

$$=\sum_{i=1}^{4} x^2\cdot\frac{x}{10}$$

$$=1^2\cdot\frac{1}{10}+2^2\cdot\frac{2}{10}+3^2\cdot\frac{3}{10}+4^2\cdot\frac{4}{10}$$

$$=10$$

$$Var(X)=E(X^2)-(E(X))^2$$

$$=10-3^2=1$$

$$\sigma_X=\sqrt{Var(X)}=1$$

Example

Let X be a continuous random variable with the Following probability density function

$$f(x) = \begin{cases} \frac{3}{4}x(2-x), & 0 \le x \le 2 \\ 0 & , \quad \text{otherwise} \end{cases}$$

Find

a) $E(X)$

b) $Var(X)$

Solution

$$\text{a) } E(X) = \int_{-\infty}^{\infty} x \cdot f(x)\, dx$$

$$= \int_{0}^{2} x \cdot \frac{3}{4} x (2 - x)\, dx$$

$$= \frac{3}{4} \int_{0}^{2} x^{2} (2 - x)\, dx$$

$$= \frac{3}{4} \int_{0}^{2} 2x^{2} - x^{3}\, dx$$

$$= \frac{3}{4} \left(\frac{2x^{3}}{3} - \frac{x^{4}}{4} \right) \Bigg|_{0}^{2}$$

$$= \frac{3}{4} \left[\left(\frac{2(2^{3})}{3} - \frac{2^{4}}{4} \right) - 0 \right]$$

$$= \frac{3}{4} \left(\frac{4}{3} \right) = 1$$

b) $E\left(X^2\right) = \int_{-\infty}^{\infty} x^2 \cdot f\left(x\right) dx$

$$= \int_0^2 x^2 \cdot \frac{3}{4} x \left(2 - x\right) dx$$

$$= \frac{3}{4} \int_0^2 x^3 \left(2 - x\right) dx$$

$$= \frac{3}{4} \int_0^2 2x^3 - x^4 \ dx$$

$$= \frac{3}{4} \left(\frac{2x^4}{4} - \frac{x^5}{5} \right) \Bigg|_0^2$$

$$= \frac{3}{4} \left[\left(\frac{2\left(2^4\right)}{4} - \frac{2^5}{5} \right) - 0 \right]$$

$$= \frac{3}{4} \left(\frac{8}{5} \right) = \frac{6}{5}$$

$$Var(X) = E(X^2) - (E(X))^2$$

$$= \frac{6}{5} - 1^2 = \frac{1}{5}$$

Example:

Let X and Y be random variables with $E(X)=7, E(Y)=-5.$

Find $E(4X-2Y+6)$

Hint: Use this properties!

i) $E(a)=a$

ii) $E(bX)=bE(X)$

iii) $E(aX+b)=aE(X)+b$

iv) $E(X+Y)=E(X)+E(Y)$

Ans: 44

Exercise:

1. The number of holes, X that can be drilled per bit while drilling into limestone is given in table below:

X	1	2	3	4	5	6	7	8
P(X=x)	0.02	0.03	0.05	0.2	0.4	0.2	0.07	y

   (a) Find y. (Ans: 0.03)

   (b) Find $E[X], E[X^2]$. (Ans: 4.96, 26.34)

   (c) Find $Var(X), \sigma_x$. (Ans: 1.7384, 1.3185)

2. Let X and Y be random variables with

$$E(X)=3, E(X^2)=25, E(Y)=10, E(Y^2)=164$$

   (a) Find $E(3X+Y-8)$ (Ans: 11)

   (b) Find $Var(3X+Y-8)$ (Ans: 208)

EXERCISE:

1. The table below represents the number of CDs sold for a certain month and their probability distribution. Find the value of A and B if expected value E(X) = 104. (Ans: 0.1,0.2)

X	80	90	100	110	120	130
P(X=x)	A	0.2	B	0.3	0.1	0.1

2. Given

$$f(x) = \begin{cases} \dfrac{3+7x}{3c} & x = 1,2,3 \\ 0 & \text{elsewhere} \end{cases}$$

(a) Find the value c (Ans: 17)

(b) Build a cumulative frequency distribution table.

3. The temperature readings from a thermocouple in a furnace fluctuate according to a cumulative distribution function.

$$F(x)=\begin{cases}0 & x<800^{\circ}C\\ 0.1x-80 & 800^{\circ}C\le x<810^{\circ}C\\ 1 & x>810^{\circ}C\end{cases}$$

Determine $P(X<805), P(800<X\le 805), P(X>808)$

(Ans: 0.5, 0.5, 0.2)