Chapter 9 Discrete Probability Distributions

I. Understanding probability distributions

A. A **random variable** measures a numerical event, the value of which, is determined by chance.

B. The experimental outcomes described in chapter 8 are random variables. Examples include flipping a coin and customer buying habits based upon gender.

C. **Random variables** are either discrete or continuous.

1. **Discrete:** Only finite values, such as the countable numbers, can exist on the x-axis. Examples include tire defects and the number correct on a true or false exam.
2. **Continuous**: Measurement may assume any value associated with an uninterrupted scale. Examples include the exact weight of a one-pound box of cookies and the average length of computer parts.

D. A **probability distribution** lists all the probability values associated with a random variable (x).

E. Example: In chapter 3, Linda found that 36, 18, and 6 tapes were rented for \$2, \$3, and \$4 respectively.

1. The amount received is a discrete random variable with possible values (outcomes) of \$2, \$3, and \$4.
2. Below is the probability distribution associated with tape rental fees.

Discrete Probability Distribution					
Rental Fees (x)	Number of Tapes Rented	Probability P(x)	$[x \bullet P(x)]$	x^2	$[x^2 \bullet P(x)]$
\$2.00	36	36/60 = .60	\$1.20	4	\$2.40
3.00	18	18/60 = .30	0.90	9	2.70
4.00	6	6/60 = .10	0.40	16	1.60
	60	1.0	\$2.50		\$6.70

Note: This distribution is similar to a frequency distribution with P(x) replacing f.

F. The mean and variance of a discrete probability distribution

1. Random variable parameter calculations are similar to grouped data parameter calculations. However, division is not necessary for random variable calculations because the observations total 1.0 (100%).
2. The mean of random variable x is called the expected value of x or E(x).
3. The variance of x is V(x).

$E(x) = \Sigma[x \bullet P(x)] = \$2.50$

See chart calculations

$$V(x) = [\Sigma x^2 \bullet P(x)] - [E(x)]^2$$
$$= \$6.70 - (\$2.50)^2$$
$$= \$6.70 - \$6.25 = \$.45$$

Note: These formulas may be written using Greek letters with μ for E(x) and σ^2 for V(x).

II. The binomial probability distribution

A. Binomial experiments have the following characteristics.

1. The experiment consists of a fixed number of trials. Two mutually-exclusive outcomes result from each trial.
2. Defined as success and failure, each set of outcomes can be counted and represent an independent event.
3. The probability of success and the probability of failure must be constant with P(F) = 1 - P(S).

B. Binomial experiments include flipping a coin, counting product defects, and marketing response rates.

C. Determining the binomial distribution requires calculating $P(x) = \frac{n!}{x!(n-x)!}p^x q^{n-x}$ where:

n is number of trials	x is number of successes	p is probability of success	q, the probability of failure, is 1 - p

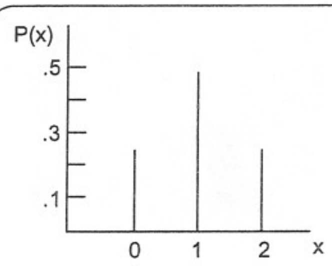
1. The page 46 coin flipping experiment, solved with a contingency table and a decision tree, is a binomial experiment. The probability of having exactly one head with two tosses is calculated below.
2. n = 2, x = 1 (head), p = .5, q = .5 **Note:** 0! = 1, $x^0 = 1$, and $x^1 = x$

$$P(x) = \frac{n!}{X!(n-x)!} p^x q^{n-x}$$

$$P(1) = \frac{2!}{1!(2-1)!}(.5^1 .5^{2-1})$$

$$= \frac{2 \times 1}{1(1)}(.5^1 .5^{2-1})$$

$$= 2 \times .5 \times .5 = .5$$



The Binomial Probability Distribution for n = 2 and p = .5	
# of Heads (x)	P(x)
0	.25
1	.50
2	.25
Total	1.00