Chapter 5

Discrete Random Variables

Discrete Random Variables

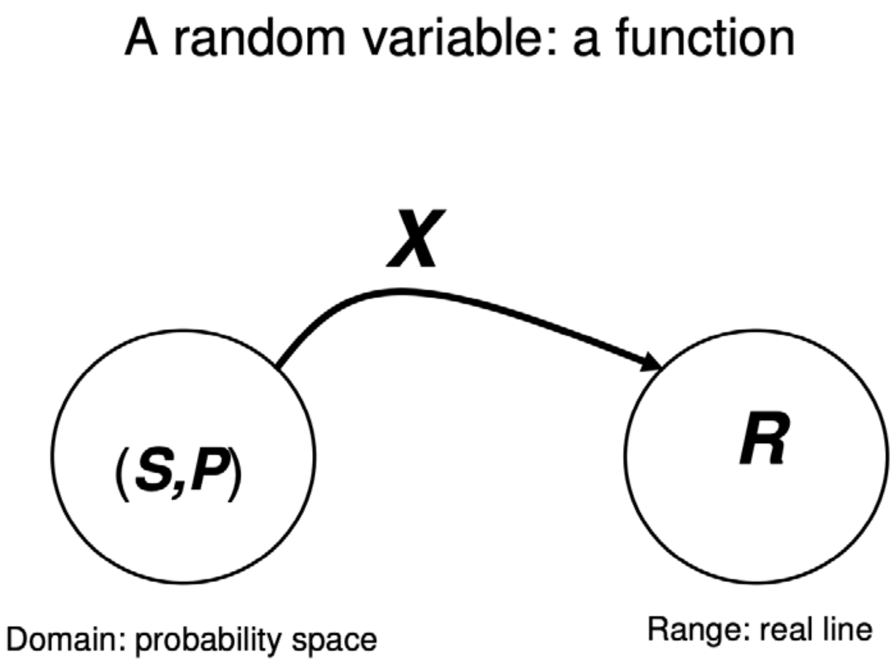
We often use what we call **random variables** to describe the important aspects of the outcomes of experiments. In this chapter we introduce two important types of random variables—**discrete random variables** and **continuous random variables**—and learn how to find probabilities concerning discrete random variables. As one application, we will begin to see how to use probabilities concerning discrete random variables to make statistical inferences about populations.

5.1 Two Types of Random Variables

- A **random variable** is a variable that assumes numerical values that are determined by the outcome of an experiment, where one and only one numerical value is assigned to each experimental outcome.

- Before an experiment is carried out, its outcome is **uncertain**. It follows that, because a random variable assigns a number to each experimental outcome, a random variable can be thought of as representing ***an uncertain numerical outcome.***

Random Variables



- A (real-valued) random variable, often denoted by X (or some other capital letter), is a function mapping a probability space (S, P) into the real line R.

Example

- Consider a random experiment in which a coin is tossed three times. Let X be the number of heads. Let H represent the outcome of a head and T the outcome of a tail.
- The possible outcomes for such an experiment:

TTT, TTH, THT, THH,
HTT, HTH, HHT, HHH

- Thus the possible values of X (number of heads) are 0,1,2,3.
- From the definition of a random variable, X as defined in this experiment, is a ***random variable***.

Two Types of Random Variables

- **Discrete random variable: Possible values can be counted or listed**
  - For example, the number of TV sets sold at the store in one day. Here *x* could be 0, 1, 2, 3, 4 and so forth.

- **Continuous random variable: May assume any numerical value in one or more intervals**
  - For example, the waiting time for a credit card authorization, the interest rate charged on a business loan

Example: Two Types of Random Variables

Question	Random Variable x	Type
Family size	x = Number of people in family reported on tax return	
Distance from home to store	x = Distance in miles from home to a store	
Own dog or cat	x = 1 if own no pet; = 2 if own dog(s) only; = 3 if own cat(s) only; = 4 if own dog(s) and cat(s)	

5.2 Discrete Probability Distributions

The **probability distribution** of a discrete random variable is a ***table, graph, or formula*** that gives the probability associated with each possible value that the variable can assume

Notation: Denote the values of the random variable by x and the value's associated probability by $p(x)$

Properties

1. For any value x of the random variable, $p(x) \geq 0$
2. The probabilities of all the events in the sample space must sum to 1, that is,

$$\sum_{\text{all } x} p(x) = 1$$

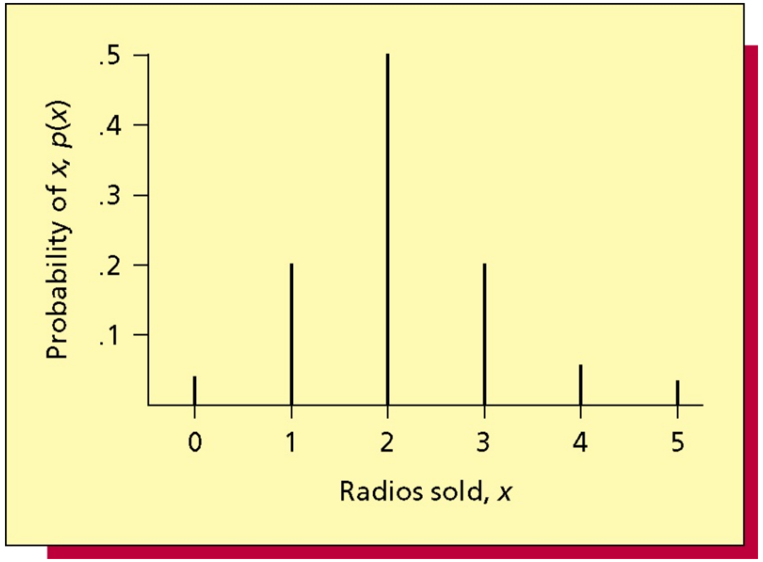
Example 5.3: Number of Radios
(Sold at Sound City in a Week)

- Let *x* be the random variable of the number of radios sold per week
  - *x* has values *x* = 0, 1, 2, 3, 4, 5
- Given sales history over past 100 weeks
  - Let f be the number of weeks (of the past 100) during which *x* number of radios were sold
  - Records tell us that
    - f(0)=3 No radios have been sold in 3 of the weeks
    - f(1)=20 One radios has been sold in 20 of the weeks
    - f(2)=50 Two radios have been sold in 50 of the weeks
    - f(3)=20 Three radios have been sold in 20 of the weeks
    - f(4)=5 Four radios have been sold in 4 of the weeks
    - f(5)=2 Five radios have been sold in 2 of the weeks
    - No more than five radios were sold in any of the past 100 weeks

Frequency distribution of sales history over past 100 weeks

# Radios, x	*Frequency*	*Relative Frequency*	*Probability, p(x)*
0	f(0) =3	3/100 = 0.03	$p(0) = 0.03$
1	f(1) =20	20/100 = 0.20	$p(1) = 0.20$
2	f(2) =50	0.50	$p(2) = 0.50$
3	f(3) =20	0.20	$p(3) = 0.20$
4	f(4) = 5	0.05	$p(4) = 0.05$
5	f(5) = 2	0.02	$P(5) = 0.02$
	100	1.00	1.00

- Interpret the relative frequencies as probabilities
  - So for any value x, $f(x)/n = p(x)$
  - Assuming that sales remain stable over time



- **What is the chance that two radios will be sold in a week?**
  - $P(x = 2) = 0.50$
- **What is the chance that fewer than 2 radios will be sold in a week?**
  - $p(x < 2) = p(x = 0 \text{ or } x = 1)$

    $= p(x = 0) + p(x = 1)$

    $= 0.03 + 0.20 = 0.23$

Using the addition rule for the mutually exclusive values of the random variable.

- **What is the chance that three or more radios will be sold in a week?**
  - $p(x \geq 3) = p(x = 3, 4, \text{ or } 5)$

    $= p(x = 3) + p(x = 4) + p(x = 5)$

    $= 0.20 + 0.05 + 0.02 = 0.27$

Example 5.2

Expected Value of a Discrete Random Variable

- Suppose that the experiment described by a random variable x is *repeated an indefinitely large number* of times.
- If the values of the random variable x observed on the repetitions are recorded, we would obtain *the population of all possible observed values* of the random variable x.
- This population has a **mean**, which we denote as μ_x and which we sometimes call the **expected value** of x. In order to calculate μ_x, we multiply each value of x by its probability $p(x)$ and then sum the resulting products over all possible values of x.

Expected Value of a Discrete Random Variable

- The **mean or expected value** of a discrete random variable x is:

$$\mu_x = \sum_{All\ x} xp(x)$$

- μ_x is the value expected to occur *in the long run* and on average

Example 5.3: Number of Radios Sold at Sound City in a Week

- How many radios should be expected to be sold in a week?
  - Calculate the **expected value** of the number of radios sold, m_X

Radios, x	*Probability, p(x)*	*x p(x)*
0	$p(0) = 0.03$	$0 \times 0.03 = 0.00$
1	$p(1) = 0.20$	$1 \times 0.20 = 0.20$
2	$p(2) = 0.50$	$2 \times 0.50 = 1.00$
3	$p(3) = 0.20$	$3 \times 0.20 = 0.60$
4	$p(4) = 0.05$	$4 \times 0.05 = 0.20$
5	$p(5) = 0.02$	$5 \times 0.02 = 0.10$
	1.00	**2.10**

- On average, expect to sell 2.1 radios per week

Example 5.6

EXAMPLE 5.4 The Life Insurance Case: Setting a Policy Premium

An insurance company sells a \$20,000 whole life insurance policy for an annual premium of \$300. Actuarial tables show that a person who would be sold such a policy with this premium has a .001 probability of death during a year. Let x be a random variable representing the insurance company's profit made on one of these policies during a year. The probability distribution of x is

x, Profit	$p(x)$, Probability of x
\$300 (if the policyholder lives)	.999
\$300 − \$20,000 = −\$19,700 (a \$19,700 loss if the policyholder dies)	.001

The expected value of x (expected profit per year) is

$$\begin{aligned}\mu_x &= \$300(.999) + (-\$19{,}700)(.001) \\ &= \$280\end{aligned}$$

This says that if the insurance company sells a very large number of these policies, it will average a profit of \$280 per policy per year. Because insurance companies actually do sell large numbers of policies, it is reasonable for these companies to make profitability decisions based on expected values.

Next, suppose that we wish to find the premium that the insurance company must charge for a \$20,000 policy if the company wishes the average profit per policy per year to be greater than \$0. If we let *prem* denote the premium the company will charge, then the probability distribution of the company's yearly profit x is

x, Profit	$p(x)$, Probability of x
prem (if policyholder lives)	.999
prem − \$20,000 (if policyholder dies)	.001

The expected value of x (expected profit per year) is

$$\begin{aligned}\mu_x &= prem(.999) + (prem - 20{,}000)(.001)\\ &= prem - 20\end{aligned}$$

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In order for this expected profit to be greater than zero, the premium must be greater than \$20. If, as previously stated, the company charges \$300 for such a policy, the \$280 charged in excess of the needed \$20 compensates the company for commissions paid to salespeople, administrative costs, dividends paid to investors, and other expenses.

Variance and Standard Deviation

- The **variance** of a discrete random variable is:

$$\sigma_X^2 = \sum_{All\, x} (x - \mu_X)^2 p(x)$$

- The **variance** is the average of the squared deviations of the different values of the random variable from the expected value.
- The **standard deviation** is the square root of the variance

$$\sigma_X = \sqrt{\sigma_X^2}$$

- The variance and standard deviation measure the spread of the values of the random variable from their expected value

Example 5.7: Number of Radios

Sold at Sound City in a Week

Calculate the **variance and standard deviation** of the number of radios sold at Sound City in a week

Radios, x	*Probability, p(x)*	$(x - \mu_X)^2 \; p(x)$
0	$p(0) = 0.03$	$(0 – 2.1)^2 (0.03) = 0.1323$
1	$p(1) = 0.20$	$(1 – 2.1)^2 (0.20) = 0.2420$
2	$p(2) = 0.50$	$(2 – 2.1)^2 (0.50) = 0.0050$
3	$p(3) = 0.20$	$(3 – 2.1)^2 (0.20) = 0.1620$
4	$p(4) = 0.05$	$(4 – 2.1)^2 (0.05) = 0.1805$
5	$p(5) = 0.02$	$(5 – 2.1)^2 (0.02) = 0.1682$
	1.00	**0.8900**

Standard deviation

$$\sigma_X = \sqrt{0.89} = 0.9434$$

Variance

$$\sigma_X^2 = 0.89$$

$$[\mu_x \pm 2\sigma_x] = [2.1 \pm 2(.9434)]$$
$$= [.2132,\ 3.9868]$$

As illustrated in Figure 5.2, there are three values of x ($x = 1$, $x = 2$, and $x = 3$) that lie in the interval [.2132, 3.9868]. Therefore, the probability that x will lie in the interval [.2132, 3.9868] is the probability that x will equal 1 or 2 or 3, which is $p(1) + p(2) + p(3) = .20 + .50 + .20 = .90$. This says that in 90 percent of all weeks, the number of TrueSound-XL radios sold at Sound City will be within (plus or minus) two standard deviations of the mean weekly sales of the TrueSound-XL radio at Sound City.

In general, consider any random variable with mean μ_x and standard deviation σ_x. Then, Chebyshev's Theorem (see Chapter 3, page 116) tells us that, for any value of k that is greater than 1, the probability is at least $1 - 1/k^2$ that x will be within (plus or minus) k standard deviations of μ_x and thus will lie in the interval $[\mu_x \pm k\sigma_x]$. For example, setting k equal to 2, the probability is at least $1 - 1/2^2 = 1 - 1/4 = 3/4$ that x will lie in the interval $[\mu_x \pm 2\sigma_x]$.

5.3 The Binomial Distribution

The Binomial Experiment:

1. Experiment consists of n identical trials
2. Each trial results in either “success” or “failure”
3. Probability of success, p, is constant from trial to trial
4. Trials are independent

Note: The probability of failure, q, is $1 - p$ and is constant from trial to trial

If x is the total number of successes in n trials of a binomial experiment, then x is a **binomial random variable**

The Binomial Distribution

- Example: Suppose that historical sales records indicate that 40 percent of all customers who enter a discount department store make a purchase. What is the probability that two of the next three customers will make a purchase?

- S: the customer makes a purchase
- F: the customer does not make a purchase
- p=0.4

The Binomial Distribution

The sample space of the experiment:

SSS SSF SFS FSS FFS FSF SFF FFF

What is the probability that two of the next three customers will make a purchase?

$P(SSF)$=P(S)P(S)P(F)=(0.4)(0.4)(0.6)=$(0.4)^2(0.6)$
$P(SFS)$=P(S)P(F)P(S)=(0.4)(0.6)(0.4)=$(0.4)^2(0.6)$
$P(FSS)$=P(F)P(S)P(S)=(0.6)(0.4)(0.4)=$(0.4)^2(0.6)$

$$P(SSF)+P(SFS)+P(FSS) = 3(0.4)^2(0.6) = 0.288$$

The Binomial Distribution

For a binomial random variable x, the probability of x successes in n trials is given by the binomial distribution:

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

- Note: $n!$ is read as "n factorial" and $n! = n \times (n-1) \times (n-2) \times \ldots \times 1$
  - For example, $5! = 5 \times 4 \times 3 \times 2 \times 1 = 120$
- Also, $0! = 1$
- Factorials are not defined for negative numbers or fractions

The Binomial Distribution

- What does the equation mean?
  - The equation for the binomial distribution consists of the product of two factors

$$p(x) = \boxed{\frac{n!}{x!(n-x)!}} \times \boxed{p^x q^{n-x}}$$

Number of ways to get *x* successes and (*n*–*x*) failures in *n* trials

The chance of getting *x* successes and (*n*–*x*) failures in a particular arrangement

Example Purchase at a Discount Store

- P(Purchase) = 0.4
- Want probability that exactly 3 of next 5 customers make purchase

$$
\begin{aligned}
p(3) &= \frac{5!}{3!\,(5-3)!}(.4)^3(.6)^{5-3} = \frac{5!}{3!\,2!}(.4)^3(.6)^2 \\
&= \frac{5\cdot 4\cdot 3\cdot 2\cdot 1}{(3\cdot 2\cdot 1)(2\cdot 1)}(.4)^3(.6)^2 \\
&= 10(.064)(.36) \\
&= .2304
\end{aligned}
$$

Binomial Probability Table

(a) A Table for $n = 4$ Trials

P=0.10

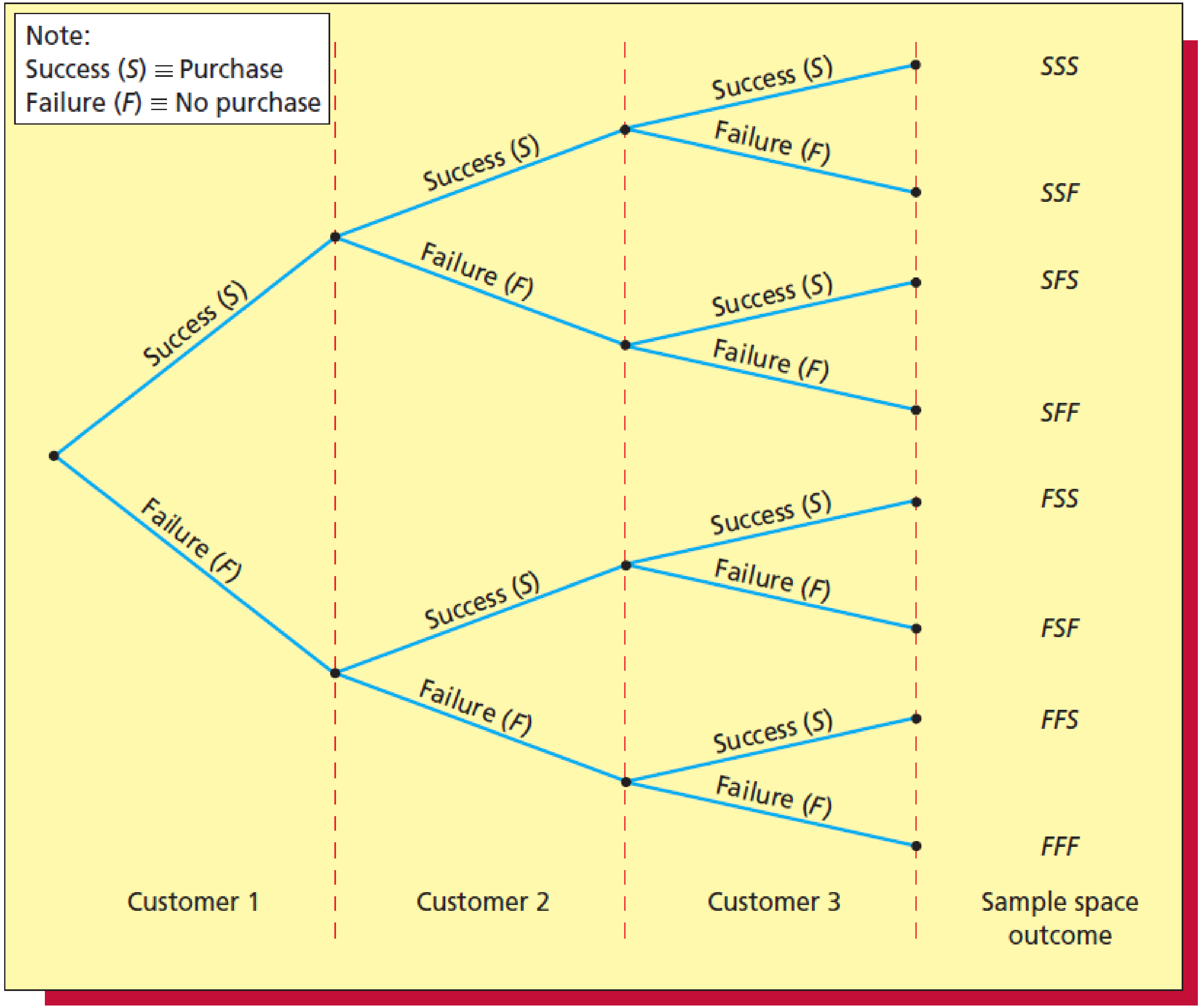
Values of p (.05 to .50)

Number of Successes	.05	**.10**	.15	.20	.25	.30	.35	.40	.45	.50	Number of Successes
0	.8145	.6561	.5220	.4096	.3164	.2401	.1785	.1296	.0915	.0625	4
1	.1715	.2916	.3685	.4096	.4219	.4116	.3845	.3456	.2995	.2500	3
2	.0135	.0486	.0975	.1536	.2109	.2646	.3105	.3456	.3675	.3750	2
3	.0005	.0036	.0115	.0256	.0469	.0756	.1115	.1536	.2005	.2500	1
4	.0000	.0001	.0005	.0016	.0039	.0081	.0150	.0256	.0410	.0625	0
	.95	.90	.85	.80	.75	.70	.65	.60	.55	.50	

Values of p (.50 to .95)

P(x=2) = 0.0486

Table 5.7 (a)



Note:
Success (S) ≡ Purchase
Failure (F) ≡ No purchase
Success (S)
Failure (F)
Success (S)
Failure (F)
Success (S)
Failure (F)
Success (S)
Failure (F)
Success (S)
Failure (F)
Success (S)
Failure (F)
Success (S)
Failure (F)
SSS
SSF
SFS
SFF
FSS
FSF
FFS
FFF
Customer 1
Customer 2
Customer 3
Sample space outcome

The Binomial Distribution

A **binomial experiment** has the following characteristics:

1. The experiment consists of n *identical trials.*
2. Each trial results in a **success** or a **failure.**
3. The probability of a success on any trial is p and remains constant from trial to trial. This implies that the probability of failure, q, on any trial is $1 - p$ and remains constant from trial to trial.
4. The trials are **independent** (that is, the results of the trials have nothing to do with each other).

Furthermore, if we define the random variable

$$x = \text{the total number of successes in } n \text{ trials of a binomial experiment}$$

then we call x a **binomial random variable,** and the probability of obtaining x successes in n trials is

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

Example 5.10

The Phe-Mycin Case: Drug Side Effects

Antibiotics occasionally cause nausea as a side effect. A major drug company has developed a new antibiotic called Phe-Mycin. The company claims that, at most, 10 percent of all patients treated with Phe-Mycin would experience nausea as a side effect of taking the drug. Suppose that we randomly select $n = 4$ patients and treat them with Phe-Mycin. Each patient will either experience nausea (which we arbitrarily call a success) or will not experience nausea (a failure). We will assume that p, the true probability that a patient will experience nausea as a side effect, is .10, the maximum value of p claimed by the drug company. Furthermore, it is reasonable to assume that patients' reactions to the drug would be independent of each other. Let x denote the number of patients among the four who will experience nausea as a side effect. It follows that x is a binomial random variable, which can take on any of the potential values 0, 1, 2, 3, or 4. That is, anywhere between none of the patients and all four of the patients could potentially experience nausea as a side effect. Furthermore, we can calculate the probability associated with each possi-

Example 5.10: Incidence of Nausea

- The company claims that, at most, 10 percentage of all patients treated with Phe-Mycin would experience nausea as a side effect of taking the drug.
- x = number of patients who will experience nausea following treatment with Phe-Mycin out of the 4 patients tested
- Find the probability that 2 of the 4 patients treated will experience nausea

Given: $n = 4$, $p = 0.1$, with $x = 2$
Then: $q = 1 - p = 1 - 0.1 = 0.9$ and

$$p(x = 2) = \frac{4!}{2!(4-2)!}(0.1)^2(0.9)^{4-2}$$

$$= 6(0.1)^2(0.9)^2 = 0.0486$$

Example: Binomial Distribution

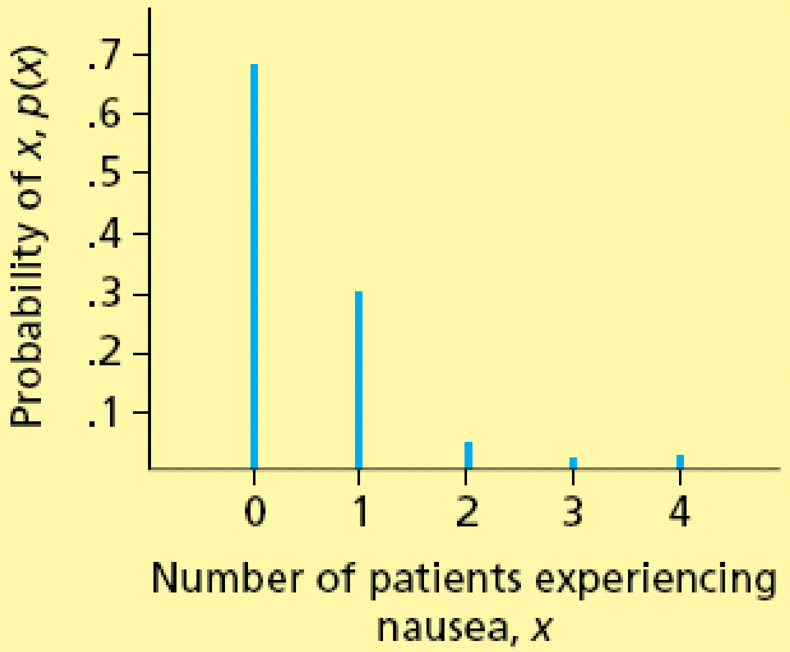
$n = 4$, $p = 0.1$

(a) MINITAB output of the binomial distribution

```
Binomial with n = 4 and p = 0.1

x       P( X = x )
0           0.6561
1           0.2916
2           0.0486
3           0.0036
4           0.0001
```

(b) A graph of the distribution



Example 5.11 Incidence of Nausea

after Treatment

x = number of patients who will experience nausea following treatment with Phe-Mycin out of the 4 patients tested

Find the probability that at least 3 of the 4 patients treated will experience nausea

Set $x = 3$, $n = 4$, $p = 0.1$, so $q = 1 - p = 1 - 0.1 = 0.9$

Then:

$$
\begin{aligned}
p(x \geq 3) &= p(x = 3 \text{ or } 4) \\
&= p(x = 3) + p(x = 4) \\
&= 0.0036 + .0001 = 0.0037
\end{aligned}
$$

Using the addition rule for the mutually exclusive values of the binomial random variable

Rare Events

Company claims that, at most, 10 percentage of all patients treated with Phe-Mycin would experience nausea. ***Is this claim right?***

- Suppose at least three of four sampled patients ***actually*** did experience nausea following treatment
  - If $p = 0.1$ is believed, then there is a chance of only 37 in 10,000 of observing this result
  - So this is very unlikely!
    - But it actually occurred
  - So, this is very strong evidence that p does not equal 0.1
    - There is very strong evidence that p is actually greater than 0.1

The Phe-Mycin Case: Drug Side Effects

Suppose that we wish to investigate whether p, the probability that a patient will experience nausea as a side effect of taking Phe-Mycin, is greater than .10, the maximum value of p claimed by the drug company. This assessment will be made by assuming, for the sake of argument, that p equals .10, and by using sample information to weigh the evidence against this assumption and in favor of the conclusion that p is greater than .10. Suppose that when a sample of $n = 4$ randomly selected patients is treated with Phe-Mycin, three of the four patients experience nausea. Because the fraction of patients in the sample that experience nausea is $3/4 = .75$, which is far greater than .10, we have some evidence contradicting the assumption that p equals .10. To evaluate the strength of this evidence, we calculate the probability that at least 3 out of 4 randomly

$$\begin{aligned} P(x \geq 3) &= P(x = 3 \text{ or } x = 4) \\ &= P(x = 3) + P(x = 4) \\ &= .0036 + .0001 \\ &= .0037 \end{aligned}$$

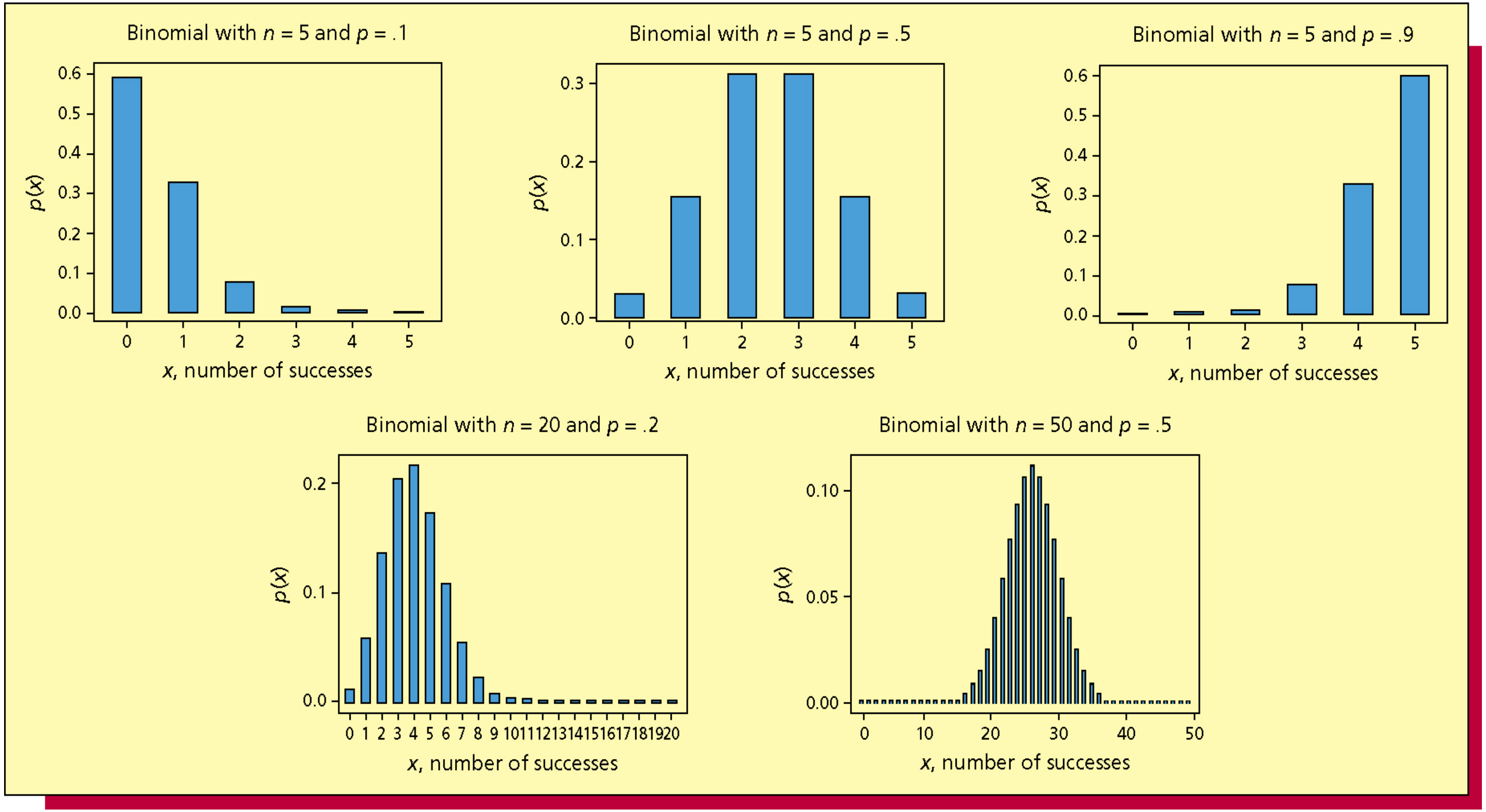
This probability says that, if p equals .10, then in only .37 percent of all possible samples of four randomly selected patients would at least three of the four patients experience nausea as a side effect. This implies that, if we are to believe that p equals .10, then we must believe that we have observed a sample result that is so rare that it can be described as a 37 in 10,000 chance. Because observing such a result is very unlikely, we have very strong evidence that p does not equal .10 and is, in fact, greater than .10.

Next, suppose that we consider what our conclusion would have been if only one of the four randomly selected patients had experienced nausea. Because the sample fraction of patients who experienced nausea is $1/4 = .25$, which is greater than .10, we would have some evidence to contradict the assumption that p equals .10. To evaluate the strength of this evidence, we calculate the probability that at least one out of four randomly selected patients would experience nausea as a side effect of being treated with Phe-Mycin if, in fact, p equals .10. Using the binomial probabilities in Table 5.4(a), we have

$$
\begin{aligned}
P(x \geq 1) &= P(x = 1 \text{ or } x = 2 \text{ or } x = 3 \text{ or } x = 4) \\
&= P(x = 1) + P(x = 2) + P(x = 3) + P(x = 4) \\
&= .2916 + .0486 + .0036 + .0001 \\
&= .3439
\end{aligned}
$$

This probability says that, if p equals .10, then in 34.39 percent of all possible samples of four randomly selected patients, at least one of the four patients would experience nausea. Because it is not particularly difficult to believe that a 34.39 percent chance has occurred, we would not have much evidence against the claim that p equals .10.

Several Binomial Distributions



Mean and Variance of a Binomial Random Variable

If x is a binomial random variable with **parameters** n and p (so $q = 1 – p$), then

$$\text{mean } \mu_X = np$$

$$\text{variance } \sigma_X^2 = npq$$

$$\text{standard deviation } \sigma_X = \sqrt{npq}$$

Example Television Manufacturer

- p = 0.95
- q = 0.05
- n = 8

$$\mu_x = np = 8(.95) = 7.6$$

$$\sigma_x^2 = npq = 8(.95)(.05) = .38$$

$$\sigma_X = \sqrt{\sigma_x^2} = \sqrt{.38} = .6164$$

Binomial Distribution EXAMPLE:

- Pat Statsdud is registered in a statistics course and intends to rely on luck to pass the next quiz.
- The quiz consists on 10 multiple choice questions with 5 possible choices for each question, only one of which is the correct answer.
- Pat will guess the answer to each question
- Find the following probabilities
  - Pat gets no answer correct
  - Pat gets two answer correct?
  - Pat fails the quiz
  - ➢ If all the students in Pat's class intend to guess the answers to the quiz, what is the mean and the standard deviation of the quiz mark?

- Solution
  - Checking the conditions
    - An answer can be either correct or incorrect.
    - There is a fixed finite number of trials (n=10)
    - Each answer is independent of the others.
    - The probability p of a correct answer (.20) does not change from question to question.

Determining the binomial probabilities:

Let X = the number of correct answers

$$P(X = 0) = \frac{10!}{0!(10-0)!}(.20)^0(.80)^{10-0} = .1074$$

$$P(X = 2) = \frac{10!}{2!(10-2)!}(.20)^2(.80)^{10-2} = .3020$$

Determining the binomial probabilities:
Pat fails the test if the number of correct answers is less than 5, which means less than or equal to 4.

$$P(X \le 4) = p(0) + p(1) + p(2) + p(3) + p(4)$$
$$= .1074 + .2684 + .3020 + .2013 + .0881$$
$$= .9672$$

The mean and the standard deviation of the quiz mark?

$$\boldsymbol{\mu} = np = 10(.2) = 2.$$
$$\sigma = [np(1-p)]^{1/2} = [10(.2)(.8)]^{1/2} = 1.26$$

5.4 The Poisson Distribution (Optional)

- Consider the number of times an event occurs over an interval of time and assume
  1. The probability of occurrence is the same for any intervals of equal length
  2. The occurrence in any interval is independent of an occurrence in any non-overlapping interval
- If x = the number of occurrences in an interval, then x is a Poisson random variable

$$p(x) = \frac{e^{-\mu}\,\mu^{x}}{x!}$$

Poisson Probability Table

x, Number of Occurrences	μ, Mean Number of Occurrences									
	.1	.2	.3	**.4**	.5	.6	.7	.8	.9	1.0
0	.9048	.8187	.7408	.6703	.6065	.5488	.4966	.4493	.4066	.3679
1	.0905	.1637	.2222	.2681	.3033	.3293	.3476	.3595	.3659	.3679
2	.0045	.0164	.0333	.0536	.0758	.0988	.1217	.1438	.1647	.1839
3	.0002	.0011	.0033	.0072	.0126	.0198	.0284	.0383	.0494	.0613
4	.0000	.0001	.0003	.0007	.0016	.0030	.0050	.0077	.0111	.0153
5	.0000	.0000	.0000	.0001	.0002	.0004	.0007	.0012	.0020	.0031
6	.0000	.0000	.0000	.0000	.0000	.0000	.0001	.0002	.0003	.0005

Table 5.5

Poisson Probability Calculations

$$p(x) = \frac{e^{-\mu} \mu^{x}}{x!}$$

$$p(0) = \frac{e^{-.4}(.4)^{0}}{0!} = .6703$$

$$p(1) = \frac{e^{-.4}(.4)^{1}}{1!} = .2681$$

$$p(2) = \frac{e^{-.4}(.4)^{2}}{2!} = .0536$$

$$p(3) = \frac{e^{-.4}(.4)^{3}}{3!} = .0072$$

$$p(4) = \frac{e^{-.4}(.4)^{4}}{4!} = .0007$$

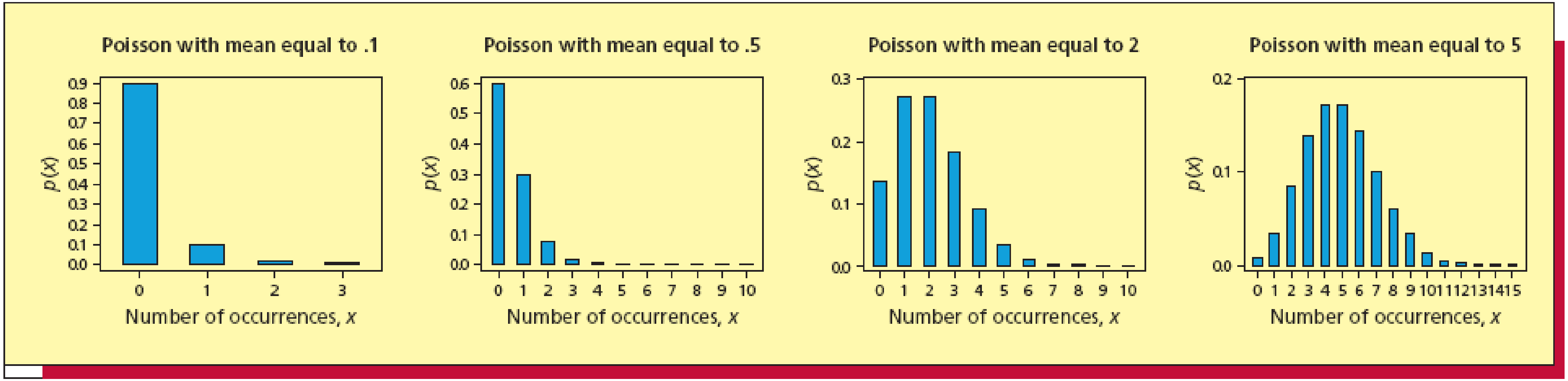
$$p(5) = \frac{e^{-.4}(.4)^{5}}{5!} = .0001$$

Mean and Variance of a Poisson Random Variable

- Mean $\mu_x = \mu$
- Variance $\sigma^2_x = \mu$
- Standard deviation σ_x is square root of variance σ^2_x

Several Poisson Distributions

Figure 5.9



Summary

Chapter Summary

In this chapter we began our study of **random variables.** We learned that **a random variable represents an uncertain numerical outcome.** We also learned that a random variable whose values can be listed is called a **discrete random variable,** while the values of a **continuous random variable** correspond to one or more intervals on the real number line. We saw that a **probability distribution** of a discrete random variable is a table, graph, or formula that gives the probability associated with each of the random variable's possible values. We also discussed several descriptive measures of a discrete random variable—its **mean** (or **expected value**), its **variance,** and its **standard deviation.** We continued this chapter by studying two important, commonly used discrete probability distributions—the **binomial distribution** and the **Poisson distribution**—and we demonstrated how these distributions can be used to make statistical inference [illegible]

Thank you!