Key Concept

In this section we consider important characteristics of a binomial distribution including center, variation, and distribution. That is, given a particular binomial probability distribution we can find its mean, variance, and standard deviation. A strong emphasis is placed on interpreting and understanding those values.

For Any Discrete Probability Distribution: Formulas

<table>
<thead>
<tr>
<th>Mean</th>
<th>$\mu = \Sigma [x \cdot P(x)]$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variance</td>
<td>$\sigma^2 = [\Sigma x^2 \cdot P(x)] - \mu^2$</td>
</tr>
<tr>
<td>Std. Dev</td>
<td>$\sigma = \sqrt{[\Sigma x^2 \cdot P(x)] - \mu^2}$</td>
</tr>
</tbody>
</table>

Binomial Distribution: Formulas

Mean $\mu = n \cdot p$

Variance $\sigma^2 = n \cdot p \cdot q$

Std. Dev. $\sigma = \sqrt{n \cdot p \cdot q}$

Where
- $n$ = number of fixed trials
- $p$ = probability of success in one of the $n$ trials
- $q$ = probability of failure in one of the $n$ trials
Interpretation of Results

It is especially important to interpret results. The range rule of thumb suggests that values are unusual if they lie outside of these limits:

- Maximum usual values = $\mu + 2\sigma$
- Minimum usual values = $\mu - 2\sigma$

Recap

In this section we have discussed:
- Mean, variance, and standard deviation formulas for any discrete probability distribution.
- Mean, variance, and standard deviation formulas for the binomial probability distribution.
- Interpreting results.

In Exercises 5–8, assume that a procedure yields a binomial distribution with $n$ trials and the probability of success for one trial is $p$. Use the given values of $n$ and $p$ to find the mean and standard deviation. Also, use the range rule of thumb to find the minimum usual value $\mu - 2\sigma$ and the maximum usual value $\mu + 2\sigma$.

**238/6. Gender Selection** In an analysis of test results from the YSORT gender selection method, 152 babies are born and it is assumed that boys and girls are equally likely, so $n = 152$ and $p = 0.5$.

**238/8. Gallup Poll** A Gallup poll of 1236 adults showed that 14% believe that bad luck follows if your path is crossed by a black cat, so $n = 1236$ and $p = 0.14$. 

In Exercises 5–8, assume that a procedure yields a binomial distribution with $n$ trials and the probability of success for one trial is $p$. Use the given values of $n$ and $p$ to find the mean and standard deviation. Also, use the range rule of thumb to find the minimum usual value $\mu - 2\sigma$ and the maximum usual value $\mu + 2\sigma$. 

[Diagram and calculations]
238/10. Guessing Answers The final exam in a sociology course consists of 100 multiple-choice questions. Each question has 5 possible answers, and only 1 of them is correct. An unprepared student makes random guesses for all of the answers.

a. Find the mean and standard deviation for the number of correct answers for such students.

b. Would it be unusual for a student to pass the exam by guessing and getting at least 60 correct answers? Why or why not?

238/12. Are 24% of M&Ms Blue? Mars, Inc., claims that 24% of its M&M plain candies are blue. A sample of 100 M&Ms is randomly selected.

a. Find the mean and standard deviation for the numbers of blue M&Ms in such groups of 100.

b. Data Set 18 in Appendix B consists of a random sample of 100 M&Ms in which 27 are blue. Is this result unusual? Does it seem that the claimed rate of 24% is wrong?

239/17. Voting In a past presidential election, the actual voter turnout was 61%. In a survey, 1002 subjects were asked if they voted in the presidential election.

a. Find the mean and standard deviation for the numbers of actual voters in groups of 1002.

b. In the survey of 1002 people, 701 said that they voted in the last presidential election (based on data from ICR Research Group). Is this result consistent with the actual voter turnout, or is this result unlikely to occur with an actual voter turnout of 61%? Why or why not?

c. Based on these results, does it appear that accurate voting results can be obtained by asking voters how they acted?

239/18. Cell Phones and Brain Cancer In a study of 420,095 cell phone users in Denmark, it was found that 135 developed cancer of the brain or nervous system. If we assume that the use of cell phones has no effect on developing such cancer, then the probability of a person having such a cancer is 0.000340.

a. Assuming that cell phones have no effect on developing cancer, find the mean and standard deviation for the numbers of people in groups of 420,095 that can be expected to have cancer of the brain or nervous system.

b. Based on the results from part (a), is it unusual to find that among 420,095 people, there are 135 cases of cancer of the brain or nervous system? Why or why not?

c. What do these results suggest about the publicized concern that cell phones are a health danger because they increase the risk of cancer of the brain or nervous system?
Nine-year-old Emily Rosa conducted this test: A professional touch therapist put both hands through a cardboard partition and Emily would use a coin flip to randomly select one of the hands. Emily would place her hand just above the hand of the therapist, who was then asked to identify the hand that Emily had selected. The touch therapists believed that they could sense the energy field and identify the hand that Emily had selected. The trial was repeated 280 times. (Based on data from “A Close Look at Therapeutic Touch,” by Rosa et al., Journal of the American Medical Association, Vol. 279, No. 13.)

a. Assuming that the touch therapists have no special powers and made random guesses, find the mean and standard deviation for the numbers of correct responses in groups of 280 trials.

b. The professional touch therapists identified the correct hand 123 times in the 280 trials. Is that result unusual? What does the result suggest about the ability of touch therapists to select the correct hand by sensing an energy field?