1.16
a. The population of interest is all the students in the class. The variable of interest is the GPA of a student in the class.
b. Since GPA is measured on a numerical scale, it is quantitative.
c. Since the population of interest is all the students in the class and you obtained the GPA of every member of the class, this set of data would be a census.
d. Assuming the class had more than 10 students in it, the set of 10 GPAs would represent a sample. The set of ten students in only a subset of the entire class.
e. This average would have 100% reliability as an “estimate” of the class average, since it is the average of interest.
f. The average GPA of 10 members of the class will not necessarily be the same as the average GPA of the entire class. The reliability of the estimate will depend on how large the class is and how representative the sample is of the entire population.
g. In order for the sample to be a random sample, every member of the class must have an equal chance of being selected.

1.18
a. Flight capability can have only 2 possible outcomes: volant or flightless. Thus, it is qualitative.
b. Habitat type can have only 3 possible outcomes: aquatic, ground terrestrial, or aerial terrestrial. Thus, it is qualitative.
c. Nesting site can have only 4 possible outcomes, ground, cavity within ground, tree, or cavity above ground. Thus, it is qualitative.
d. Nest density can have only 2 possible outcomes: high or low. Thus, it is qualitative.
e. Diet can have only 4 possible outcomes: fish, vertebrates, vegetables, or invertebrates. Thus, it is qualitative.
f. Body mass is measured in grams, a meaningful number. Thus, it is quantitative.
g. Extinct status can have only 3 possible outcomes: extinct, absent from island, or present. Thus, it is qualitative.

1.20
a. The 500 surgical patients represent a sample. There are many more than 500 surgical patients.
b. Yes, the sample is representative. It says that the surgical patients were randomly selected.
c. The variable measures on each patient was the status of herbal or alternative medicines. These data are qualitative because each response was either “yes” or “no”.
2.16 Using MINITAB, a bar graph is:

Most of the types of papers found were interviews. There were about twice as many interviews as all other types combined.

2.35 a. Using MINITAB, the stem-and-leaf display of the data is:

**Stem-and-Leaf Display: SCORE**

<table>
<thead>
<tr>
<th>Leaf Unit</th>
<th>N = 169</th>
</tr>
</thead>
<tbody>
<tr>
<td>Score</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>7 2</td>
</tr>
<tr>
<td>3</td>
<td>7 8</td>
</tr>
<tr>
<td>4</td>
<td>8 4</td>
</tr>
<tr>
<td>15</td>
<td>8 6</td>
</tr>
<tr>
<td>56</td>
<td>9 6</td>
</tr>
<tr>
<td>100</td>
<td>9 5</td>
</tr>
</tbody>
</table>

b. From the stem-and-leaf display, we see that there are only 4 observations with sanitation scores less than the acceptable score of 86. The proportion of ships that have an accepted sanitation standard would be (169 - 4) / 169 = .976.

c. The sanitation score of 84 is in bold in the stem-and-leaf display in part a.

2.68 a. The mean number of ant species discovered is:

\[
\bar{x} = \frac{\sum x}{n} = \frac{3 + 3 + ... + 4}{11} = \frac{141}{11} = 12.82
\]
The median is the middle number once the data have been arranged in order: 3, 3, 4, 4, 4, 5, 5, 5, 7, 49, 52.

The median is 5.

The mode is the value with the highest frequency. Since both 4 and 5 occur 3 times, both 4 and 5 are modes.

b. For this case, we would recommend that the median is a better measure of central tendency than the mean. There are 2 very large numbers compared to the rest. The mean is greatly affected by these 2 numbers, while the median is not.

c. The mean total plant cover percentage for the Dry Steppe region is:

\[
\bar{x} = \frac{\sum x}{n} = \frac{40 + 52 + \ldots + 27}{5} = \frac{202}{5} = 40.4
\]

The median is the middle number once the data have been arranged in order: 27, 40, 40, 43, 52.

The median is 40.

The mode is the value with the highest frequency. Since 40 occurs 2 times, 40 is the mode.

d. The mean total plant cover percentage for the Gobi Desert region is:

\[
\bar{x} = \frac{\sum x}{n} = \frac{30 + 16 + \ldots + 14}{6} = \frac{168}{6} = 28
\]

The median is the mean of the middle 2 numbers once the data have been arranged in order: 14, 16, 22, 30, 30, 56.

The median is \( \frac{22 + 30}{2} = \frac{52}{2} = 26 \).

The mode is the value with the highest frequency. Since 30 occurs 2 times, 30 is the mode.

e. Yes, the total plant cover percentage distributions appear to be different for the 2 regions. The percentage of plant coverage in the Dry Steppe region is much greater than that in the Gobi Desert region.

3.10 a. If the simple events are equally likely, then

\[
P(1) = P(2) = P(3) = \ldots = P(10) = \frac{1}{10}
\]
Therefore,

\[ P(A) = P(4) + P(5) + P(6) = \frac{1}{10} + \frac{1}{10} + \frac{1}{10} = \frac{3}{10} = .3 \]

\[ P(B) = P(6) + P(7) = \frac{1}{10} + \frac{2}{10} = \frac{3}{10} = .3 \]

b. \[ P(A) = P(4) + P(5) + P(6) = \frac{1}{20} + \frac{1}{20} + \frac{3}{20} = \frac{5}{20} = .25 \]

\[ P(B) = P(6) + P(7) = \frac{3}{10} + \frac{6}{10} = \frac{3}{10} = .3 \]

3.34 a. The simple events of this sample space could be represented by pairs where the first symbol would represent the gene obtained from the mother; the second symbol, the father.

\[ S = \{BB, Bb, bB, bb\} \]

Each of these are equally likely, and the only way a child could have blue eyes would be if "bb" is the child's genetic pair, which has a probability of 1/4.

b. For convenience, let us say that it is the mother whose gene pair is Bb. The only possible simple events here would be:

\[ S = \{Bb, bb\} \]

Again, each of these are equally likely, so that the probability of blue eyes in this case is 1/2.

c. Since the BB parent would donate a "B" gene, the child could not have blue eyes; the probability would be 0.

3.44 The experiment consists of rolling a pair of fair dice. The simple events are:

\[
\begin{array}{cccccccc}
1,1 & 2,1 & 3,1 & 4,1 & 5,1 & 6,1 \\
1,2 & 2,2 & 3,2 & 4,2 & 5,2 & 6,2 \\
1,3 & 2,3 & 3,3 & 4,3 & 5,3 & 6,3 \\
1,4 & 2,4 & 3,4 & 4,4 & 5,4 & 6,4 \\
1,5 & 2,5 & 3,5 & 4,5 & 5,5 & 6,5 \\
1,6 & 2,6 & 3,6 & 4,6 & 5,6 & 6,6 \\
\end{array}
\]

Since each die is fair, each simple event is equally likely. The probability of each simple event is 1/36.
a.  
\[A = \{(1, 6), (2, 5), (3, 4), (4, 3), (5, 2), (6, 1)\}\]
\[B = \{(1, 4), (2, 4), (3, 4), (4, 4), (5, 4), (6, 4), (4, 1), (4, 2), (4, 3), (4, 5), (4, 6)\}\]
\[A \cap B = \{(3, 4)\}\]
\[A \cup B = \{(1, 4), (2, 4), (3, 4), (4, 4), (5, 4), (6, 4), (4, 1), (4, 2), (4, 3), (4, 5), (4, 6), (1, 6), (2, 6), (6, 1)\}\]

b.  
\[P(A) = \frac{6}{36} = \frac{1}{6}\]
\[P(B) = \frac{11}{36}\]
\[P(A \cap B) = \frac{1}{36}\]
\[P(A \cup B) = \frac{15}{36} = \frac{5}{12}\]
\[P(A') = 1 - \frac{1}{6} = \frac{5}{6}\]

c.  
\[P(A \cup B) = P(A) + P(B) - P(A \cap B) = \frac{1}{6} + \frac{11}{36} - \frac{1}{36} = \frac{6 + 11 - 2}{36} = \frac{15}{36} = \frac{5}{12}\]

d.  
\[A \text{ and } B \text{ are not mutually exclusive. To be mutually exclusive, } P(A \cap B) \text{ must be 0.}\]
\[\text{Here, } P(A \cap B) = \frac{1}{18}\]

3.46

a.  
\[P(A') = P(E_1) + P(E_2) = .2 + .3 = .5\]

b.  
\[P(B') = P(E_1) + P(E_2) + P(E_4) = .10 + .06 + .06 = .22\]

c.  
\[P(A' \cap B) = P(E_2) + P(E_4) = .2 + .3 = .5\]

d.  
\[P(A \cup B) = P(E_1) + P(E_2) + P(E_4) + P(E_5) + P(E_6) + P(E_7) = .18 + .05 + .2 + .06 + .06 + .20 = .69\]

e.  
\[P(A \cap B) = P(E_1) + P(E_2) + P(E_4) = .05 + .20 + .06 = .31\]

f.  
\[P(A' \cup B') = P(E_1) + P(E_2) + P(E_4) + P(E_5) = .13 + .06 + .20 + .30 = .69\]

\[g. \ A \text{ and } B \text{ are mutually exclusive if } P(A \cap B) = 0. \text{ Here, } P(A \cap B) = .31.\]
3.56  

a. The possible outcomes for this provider are:  

(Yes, <50), (Yes, ≥50), (No, <50), (No, ≥ 50)  

b. We can find reasonable probabilities the 4 sample points by dividing each frequency by the total sample size of 358. The estimates of the probabilities are:  

<table>
<thead>
<tr>
<th>Permit Drug at Home</th>
<th>Less than 50</th>
<th>50 or more</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>.475</td>
<td>.363</td>
<td>.838</td>
</tr>
<tr>
<td>No</td>
<td>.134</td>
<td>.028</td>
<td>.162</td>
</tr>
<tr>
<td>Totals</td>
<td>.609</td>
<td>.391</td>
<td>1.000</td>
</tr>
</tbody>
</table>

c. Define the following event:  

A: {Provider permits home use of abortion drug}  

B: {Provider has case load of less than 50 abortions}  

\[ P(A) = .838 \]

d. \[ P(A \cup B) = P(A) + P(B) - P(A \cap B) = .838 + .609 - .475 = .972 \]

e. \[ P(A \cap B) = .475 \]

3.72  

a. \[ P(A) = P(E_1) + P(E_3) = .22 + .15 = .37 \]

b. \[ P(B) = P(E_2) + P(E_3) + P(E_4) = .31 + .15 + .22 = .68 \]

c. \[ P(A \cap B) = P(E_3) = .15 \]

d. \[ P(A\mid B) = \frac{P(A \cap B)}{P(B)} = \frac{.15}{.68} = \frac{15}{68} = .221 \]

e. \[ P(B \cap C) = 0 \]

f. \[ P(C\mid B) = \frac{P(B \cap C)}{P(B)} = \frac{0}{.68} = 0 \]

g. \[ P(A)P(B) = .37(.68) = .2516 \neq P(A \cap B) = .15. \text{ Thus, A and B are not independent.} \]

\[ P(A)P(C) = .37(.32) = .1184 \neq P(A \cap C) = .22. \text{ Thus, A and C are not independent.} \]

\[ P(B)P(C) = .68(.32) = .2176 \neq P(B \cap C) = 0. \text{ Thus, B and C are not independent.} \]