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</table>
Chapter 1: What are Statistics?

1. A teacher wishes to know whether the males in his/her class have more conservative attitudes than the females. A questionnaire is distributed assessing attitudes and the males and the females are compared. Is this an example of descriptive or inferential statistics?

Descriptive statistics

2. A cognitive psychologist is interested in comparing two ways of presenting stimuli on subsequent memory. Twelve subjects are presented with each method and a memory test is given. What would be the roles of descriptive and inferential statistics in the analysis of these data?

As far as descriptive statistics is concerned, we would be describing and analyzing the data from the sample (that is, the data only from the 12 subjects being tested). Inferential statistics comes in when we use the data from the sample to generalize to a larger population of people.
3. If you are told only that you scored in the 80th percentile, do you know from that description exactly how it was calculated? Explain.

There are at least three definitions of percentile, so you wouldn’t know exactly how it was calculated without further information.

4. A study is conducted to determine whether people learn better with spaced or massed practice. Subjects volunteer from an introductory psychology class. At the beginning of the semester 12 subjects volunteer and are assigned to the massed-practice condition. At the end of the semester 12 subjects volunteer and are assigned to the spaced-practice condition. This experiment involves two kinds of non-random sampling: (1) Subjects are not randomly sampled from some specified population and (2) subjects are not randomly assigned to conditions. Which of the problems relates to the generality of the results? Which of the problems relates to the validity of the results? Which problem is more serious?

Problem (1) relates to the generality of the results. Since the participants volunteered for the experiment in the first place, these students might like the idea of participating on a study related to studying. Therefore, they might like studying more than the average population and bias the results. Problem (2) relates to the validity of the results. Random assignment is crucial for an experiment to be valid. There could be systematic differences between students who volunteer at the beginning of the semester and those who volunteer at the end. This could lead one to mistake the treatment effect for this difference. Therefore, random assignment is more important than random sampling.

5. Give an example of an independent and a dependent variable.

(The answers can vary a lot)

6. Categorize the following variables as being qualitative or quantitative:

   Rating of the quality of a movie on a 7-point scale -- Quantitative
   Age -- Quantitative
   Country you were born in -- Qualitative
   Favorite Color -- Qualitative
   Time to respond to a question -- Quantitative
7. Specify the level of measurement used for the items in Question 6.
   - Rating of the quality of a movie on a 7 point scale—ordinal
   - Age—interval
   - Country you were born in—nominal
   - Favorite color—nominal
   - Time to respond to a question—ratio

8. Which of the following are linear transformations?
   - Converting from meters to kilometers x
   - Squaring each side to find the area
   - Converting from ounces to pounds x
   - Computing the square root of each person’s height
   - Multiplying all numbers by 2 and then adding 5 x
   - Converting temperature from Fahrenheit to Centigrade x

9. The formula for finding each student’s test grade \( g \) from his or her raw score \( s \) on a test is as follows: \( g = 16 + 3s \)

   Is this a linear transformation?
   - Yes

   If a student got a raw score of 20, what is his test grade?
   - 76

10. For the numbers 1, 2, 4, 16, compute the following:
    - \( \Sigma X = 23 \)
    - \( \Sigma X^2 = 277 \)
    - \( (\Sigma X)^2 = 529 \)

11. Which of the frequency polygons has a large positive skew? Which has a large negative skew?
12. What is more likely to have a skewed distribution: time to solve an anagram problem (where the letters of a word or phrase are rearranged into another word or phrase like “dear” and “read” or “funeral” and “real fun”) or scores on a vocabulary test?

Anagram

Questions from Case Studies

Angry Moods (AM) case study

13. (AM) Which variables are the participant variables? (They act as independent variables in this study.)

   Sports; gender

14. (AM) What are the dependent variables?

   Anger-In; Anger-Out; Control-In; Control-Out; Expression.

15. (AM) Is Anger-Out a quantitative or qualitative variable?

   Quantitative

Teacher Ratings (TR) case study

16. (TR) What is the independent variable in this study?

   Conditions
ADHD Treatment (AT) case study

17. (AT) What is the independent variable of this experiment? How many levels does it have?
   dosage; 4 levels

18. (AT) What is the dependent variable? On what scale (nominal, ordinal, interval, ratio) was it measured?
   d0, d15, d30, d60; ratio (although interval and ordinal should each get full credit since it is open to interpretation. That is, time is ratio but the psychological scale behind it may not be.)
Chapter 2: Graphing Distributions

1. Name some ways to graph quantitative variables and some ways to graph qualitative variables.
   
   Qualitative: bar chart, pie chart
   Quantitative: line graph, histogram, box plot

2. Based on the frequency polygon displayed below, the most common test grade was around what score? Explain.

   Around 85, since this is the highest point of the polygon.

3. An experiment compared the ability of three groups of participants to remember briefly presented chess positions. The data are shown below. The numbers represent the number of pieces correctly remembered from three chess positions. Create side-by-side box plots for these three groups. What can you say about the differences between these groups from the box plots?
Overall, the amount of pieces remembered seems to increase with experience. The tournament players have the greatest variability.

4. You have to decide between displaying your data with a histogram or with a stem and leaf display. What factor(s) would affect your choice?

The amount of data would be the deciding factor in this case. With more data, a histogram can be very useful since it shows the overall shape of the distribution. It, therefore, can be used to view a large set of data efficiently. A stem and leaf display, on the other hand, is better for smaller sets of data. Therefore, if choosing between these two methods, the main factor will be the amount of data we are dealing with.

5. In a box plot, what percent of the scores are between the lower and upper hinges?

Half of the scores are between the upper and lower hinges, or the area represented by the box. The upper hinge represents the 75th percentile and the
lower hinge represents the 25th percentile. Therefore, the area between the two represents the 50th percentile, half the results.

6. A student has decided to display the results of his project on the number of hours people in various countries slept per night. He compared the sleeping patterns of people from the US, Brazil, France, Turkey, China, Egypt, Canada, Norway, and Spain. He was planning on using a line graph to display this data. Is a line graph appropriate? What might be a better choice for a graph?

A line graph is not appropriate. A bar chart is a better choice.

7. For the data from the 1977 Stat. and Biom. 200 class for eye color, construct:
   a. pie graph
   b. horizontal bar graph
   c. vertical bar graph
   d. a frequency table with the relative frequency of each eye color

<table>
<thead>
<tr>
<th>Eye Color</th>
<th>Number of students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brown</td>
<td>11</td>
</tr>
<tr>
<td>Blue</td>
<td>10</td>
</tr>
<tr>
<td>Green</td>
<td>4</td>
</tr>
<tr>
<td>Gray</td>
<td>1</td>
</tr>
</tbody>
</table>

(Question submitted by J. Warren, UNH)

a) Pie Chart
b) Horizontal bar chart

```
Gray
Green
Blue
Brown
```

![Horizontal Bar Chart](image)

c. vertical bar graph

d. a frequency table with the relative frequency of each eye color

<table>
<thead>
<tr>
<th>Eye Color</th>
<th>Number of Students</th>
<th>Relative Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brown</td>
<td>11</td>
<td>0.42</td>
</tr>
<tr>
<td>Blue</td>
<td>10</td>
<td>0.38</td>
</tr>
</tbody>
</table>
8. A graph appears below showing the number of adults and children who prefer each type of soda. There were 130 adults and kids surveyed. Discuss some ways in which the graph below could be improved.

<table>
<thead>
<tr>
<th></th>
<th>Kids</th>
<th>Adults</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>4</td>
<td>0.15</td>
</tr>
<tr>
<td>Gray</td>
<td>1</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td>26</td>
<td>1</td>
</tr>
</tbody>
</table>

The data can be put in a 2-dimensional graph instead of a 3-dimensional graph; More distinctive colors can be used for kids and adults instead of the light blue and dark blue. (Not necessary for full credit). The Y axis should start at 0.

9. Which of the box plots on the graph has a large positive skew? Which has a large negative skew?
“B” has a large positive skew and “C” has a large negative skew.

**Question from Case Studies**

**Angry Moods (AM) case study**

10. (AM) Is there a difference in how much males and females use aggressive behavior to improve an angry mood? For the “Anger-Out” scores:
   a. Create parallel box plots.
   b. Create a back to back stem and leaf displays (You may have trouble finding a computer to do this so you may have to do it by hand. Use a fixed-width font such as Courier.)
11. (AM) Create parallel box plots for the Anger-In scores by sports participation.

12. (AM) Plot a histogram of the distribution of the Control-Out scores.
13. (AM) Create a bar graph comparing the mean Control-In score for the athletes and the non-athletes. What would be a better way to display this data?
A box-plot would be a better way since it would also provide information about the distribution of these data.

14. (AM) Plot parallel box plots of the Anger Expression Index by sports participation. Does it look like there are any outliers? Which group reported expressing more anger?

There are no outliers in the data. Group 2 (non-athletes) on average report higher expressions of anger.
Flatulence (F) case study

15. (F) Plot a histogram of the variable “per day.”

16. (F) Create parallel box plots of “how long” as a function of gender. Why is the 25th percentile not showing? What can you say about the results?
The 25th percentile and 50th percentile are the same value.

17. (F) Create a stem and leaf plot of the variable “howlong.” What can you say about the shape of the distribution?

```
howlong
  3|0
  2|
  2|00
  1|
  1|0000000000
  0|555555555555
  0|111133
```

The distribution is positively skewed.

**Physicians' Reactions (PR) case study**

18. (PR) Create box plots comparing the time expected to be spent with the average-weight and overweight patients.
19. (PR) Plot histograms of the time spent with the average-weight and overweight patients.
Overweight

20. (PR) To which group does the patient with the highest expected time belong?
The overweight group has the patient with the highest expected time.

Smiles and Leniency (SL) case study

21. (SL) Create parallel boxplots for the four conditions.
22. (SL) Create back to back stem and leaf displays for the false smile and neutral conditions. (It may be hard to find a computer program to do this for you, so be prepared to do it by hand).

```
| 1910 |
| 018000 |
| 17105 |
| 000055160000005555 |
| 005100555 |
| 00000555555540055 |
| 0000551300000555 |
| 0055555512155 |
```

**ADHD Treatment (AT) case study**

23. (AT) Create a line graph of the data. Do certain dosages appear to be more effective than others?

Mean correct responses by dosage.
Children taking higher doses (D30 and D60) have a more correct responses on average.

24. (AT) Create a stem and leaf plot of the number of correct responses of the participants after taking the placebo (d0 variable). What can you say about the shape of the distribution?

\[
\begin{array}{c}
\text{D0} \\
7 | 1 \\
6 |
6 | 57 \\
5 | 234 \\
4 |
4 | 22 \\
3 | 66668 \\
3 | 12333444 \\
2 | 679 \\
\end{array}
\]

*Multiply stems by 10.0.*

The distribution is positively skewed.

25. (AT) Create box plots for the four conditions. You may have to rearrange the data to get a computer program to create the box plots.
SAT College GPA (SG) case study

26. (SG) Create histograms and stem and leaf displays of both high-school grade point average and university grade point average. In what way(s) do the distributions differ?
27. The April 10th issue of the Journal of the American Medical Association reports a study on the effects of anti-depressants. The study involved 340 subjects who were being treated for major depression. The subjects were randomly assigned to receive one of three treatments: St. John’s wort (an herb), Zoloft (Pfizer’s cousin of Lilly’s Prozac) or placebo for an 8-week period. The following are the mean scores (approximately) for the three groups of subjects.
over the eight-week experiment. The first column is the baseline. Lower scores mean less depression. Create a graph to display these means.

<table>
<thead>
<tr>
<th></th>
<th>Placebo</th>
<th>Wort</th>
<th>Zoloft</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 week</td>
<td>22.5</td>
<td>23.0</td>
<td>22.4</td>
</tr>
<tr>
<td>2 week</td>
<td>19.1</td>
<td>20.2</td>
<td>19.2</td>
</tr>
<tr>
<td>3 week</td>
<td>17.9</td>
<td>18.2</td>
<td>16.6</td>
</tr>
<tr>
<td>4 week</td>
<td>17.1</td>
<td>18.0</td>
<td>15.5</td>
</tr>
<tr>
<td>5 week</td>
<td>16.2</td>
<td>16.5</td>
<td>14.2</td>
</tr>
<tr>
<td>6 week</td>
<td>15.1</td>
<td>16.1</td>
<td>13.1</td>
</tr>
<tr>
<td>7 week</td>
<td>12.1</td>
<td>14.2</td>
<td>11.8</td>
</tr>
<tr>
<td>8 week</td>
<td>12.3</td>
<td>13.0</td>
<td>10.5</td>
</tr>
</tbody>
</table>

28. For the graph below, of heights of singers in a large chorus. What word starting with the letter “B” best describes the distribution?

Bimodal
29. Pretend you are constructing a histogram for describing the distribution of salaries for individuals who are 40 years or older, but are not yet retired. (a) What is on the Y-axis? Explain. (b) What is on the X-axis? Explain. (c) What would be the probable shape of the salary distribution? Explain why.

a) The Y-axis would be of the frequency of individuals.

b) Salary would be on the X-axis because this is the variable whose distribution is of interest.

c) I would expect the distribution to be positively skewed with a few wealthy CEOs earning well above the average salary.
Chapter 3: Summarizing Distributions

1. Make up a dataset of 12 numbers with a positive skew. Use a statistical program to compute the skew. Is the mean larger than the median as it usually is for distributions with a positive skew? What is the value for skew?

5 7 4 150
5 7 3 5
5 8 100 5

Yes the mean (25.33) is larger than the median (5). Skew = 2.27.

2. Repeat Problem 1 only this time make the dataset have a negative skew.

10 14 14 1
20 10 15 23
15 12 1 23

Yes the mean (14) is smaller than the median (13.17). Skew = -0.42.

3. Make up three data sets with 5 numbers each that have:
   (a) the same mean but different standard deviations.
   (b) the same mean but different medians.
   (c) the same median but different means.

   a)

<table>
<thead>
<tr>
<th>Dataset 1</th>
<th>Dataset 2</th>
<th>Dataset 3</th>
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<tbody>
<tr>
<td>5</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td>7</td>
<td>5</td>
</tr>
</tbody>
</table>
b)  

<table>
<thead>
<tr>
<th></th>
<th>Dataset 1</th>
<th>Dataset 2</th>
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<td>7</td>
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c)  

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<th>Dataset 2</th>
<th>Dataset 3</th>
</tr>
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<tbody>
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<td>4</td>
<td>2</td>
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<tr>
<td>5</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td>7</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

4. Find the mean and median for the following three variables:

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>7</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>1</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>1</td>
</tr>
</tbody>
</table>

A: mean = 4.8, median = 5  
B: mean = 4.2, median = 4  
C: mean = 3.2, median = 3

5. A sample of 30 distance scores measured in yards has a mean of 10, a variance of 9, and a standard deviation of 3  
(a) You want to convert all your distances from yards to feet, so you multiply each score in the sample by 3. What are the new mean, variance, and standard deviation?  
(b) You then decide that you only want to look at the distance past a certain point. Thus, after multiplying the
original scores by 3, you decide to subtract 4 feet from each of the scores. Now what are the new mean, variance, and standard deviation?

Mean=30, variance=81, SD=9.
Mean=26, variance=81, SD=9.

6. You recorded the time in seconds it took for 8 participants to solve a puzzle. These times appear below. However, when the data was entered into the statistical program, the score that was supposed to be 22.1 was entered as 21.2. You had calculated the following measures of central tendency: the mean, the median, and the mean trimmed 25%. Which of these measures of central tendency will change when you correct the recording error?

<table>
<thead>
<tr>
<th>Time (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.2</td>
</tr>
<tr>
<td>18.8</td>
</tr>
<tr>
<td>19.3</td>
</tr>
<tr>
<td>19.7</td>
</tr>
<tr>
<td>20.2</td>
</tr>
<tr>
<td>21.8</td>
</tr>
<tr>
<td>22.1</td>
</tr>
<tr>
<td>29.4</td>
</tr>
</tbody>
</table>

The mean and the trimmed mean will change since they are averages and include the incorrect data. For the trimmed mean, 29.4 and 21.8 would be trimmed leaving the incorrect 21.2 in the data. The median in this case will not change because it is independent of the botched data.

7. For the test scores in question #6, which measures of variability (range, standard deviation, variance) would be changed if the 22.1 data point had been erroneously recorded as 21.2?

The standard deviation and variance would change.

8. You know the minimum, the maximum, and the 25th, 50th, and 75th percentiles of a distribution. Which of the following measures of central tendency or variability can you determine?
mean, median, mode, trimean, geometric mean, range, interquartile range,
variance, standard deviation
median, trimean, interquartile range, range

9. For the numbers 1, 3, 4, 6, and 12:
Find the value (v) for which \( \Sigma (X-v)^2 \) is minimized.
Find the value (v) for which \( \Sigma |x-v| \) is minimized.
We are looking for the mean in the first case, which is \( \frac{1+3+4+6+12}{5} = 5.2 \)
In the second case, the answer is the median of 4.

10. Your younger brother comes home one day after taking a science test. He says
that someone at school told him that “60% of the students in the class scored
above the median test grade.” What is wrong with this statement? What if he had
said “60% of the students scored below the mean?”
The median is the middle value, therefore, he should have said that 50% scored
above. If he had said 60% scored below the mean, it was possibly correct,
because the distribution of the scores might be positively skewed.

11. An experiment compared the ability of three groups of participants to
remember briefly-presented chess positions. The data are shown below. The
numbers represent the number of pieces correctly remembered from three chess
positions. Compare the performance of each group. Consider spread as well as
central tendency.

<table>
<thead>
<tr>
<th>Non-players</th>
<th>Beginners</th>
<th>Tournament players</th>
</tr>
</thead>
<tbody>
<tr>
<td>22.1</td>
<td>32.5</td>
<td>40.1</td>
</tr>
<tr>
<td>22.3</td>
<td>37.1</td>
<td>45.6</td>
</tr>
<tr>
<td>26.2</td>
<td>39.1</td>
<td>51.2</td>
</tr>
<tr>
<td>29.6</td>
<td>40.5</td>
<td>56.4</td>
</tr>
<tr>
<td>31.7</td>
<td>45.5</td>
<td>58.1</td>
</tr>
<tr>
<td>33.5</td>
<td>51.3</td>
<td>71.1</td>
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<tr>
<td>38.9</td>
<td>52.6</td>
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<td>39.7</td>
<td>55.7</td>
<td>75.9</td>
</tr>
<tr>
<td>43.2</td>
<td>55.9</td>
<td>80.3</td>
</tr>
<tr>
<td>43.2</td>
<td>57.7</td>
<td>85.3</td>
</tr>
</tbody>
</table>
Non-players: mean = 33.04, sd = 8.03
Beginners: mean = 46.79, sd = 9.03
Tournament Players: mean = 63.89, sd = 15.62
Tournament players recalled a higher number of positions on average than the other two groups, but this group also had the highest degree of variability in the level of recall.

12. True/False: A bimodal distribution has two modes and two medians.
   False

13. True/False: The best way to describe a skewed distribution is to report the mean.
   False

14. True/False: When plotted on the same graph, a distribution with a mean of 50 and a standard deviation of 10 will look more spread out than will a distribution with a mean of 60 and a standard deviation of 5.
   True

15. Compare the mean, median, trimean in terms of their sensitivity to extreme scores.
   The mean is far more sensitive to extreme values than both the trimean and the median.

16. If the mean time to respond to a stimulus is much higher than the median time to respond, what can you say about the shape of the distribution of response times?
   The shape of the distribution is positively skewed, which results in higher means than medians.

17. A set of numbers is transformed by taking the log base 10 of each number. The mean of the transformed data is 1.65. What is the geometric mean of the untransformed data?
   $10^{1.65} = 44.67$
18. Which measure of central tendency is most often used for returns on investment?

   The geometric mean.

19. The histogram is in balance on the fulcrum. What are the mean, median, and mode of the distribution (approximate where necessary)?

   mean=4.5, median is a number somewhat less than 4.5, mode=1; positive skew.

Questions from case studies

Angry Moods (AM) case study

20. (AM) Does Anger-Out have a positive skew, a negative skew, or no skew?

   In this experiment, anger-out has a slight positive skew.

21. (AM) What is the range of the Anger-In scores? What is the interquartile range?

   Range = 21, Interquartile range = 7

22. (AM) What is the overall mean Control-Out score? What is the mean Control-Out score for the athletes? What is the mean Control-Out score for the non-athletes?

   Overall mean = 23.69; Athletes mean = 24.68; Non-athletes = 23.23
23. (AM) What is the variance of the Control-In scores for the athletes? What is the variance of the Control-In scores for the non-athletes?

Athlete variance = 20.48; Non-athlete variance = 22.82

*Flatulence (F) case study*

24. (F) Based on a histogram of the variable “perday”, do you think the mean or median of this variable is larger? Calculate the mean and median to see if you are right.

The mean will be larger.

Mean = 3.82; median = 3
**Stroop (S) case study**

25. (S) Compute the mean for “words”.
   \[
   \text{Mean} = 16.085
   \]

26. (S#2) Compute the mean and standard deviation for "colors".
   \[
   \text{Mean} = 20.23; \text{SD} = 3.73
   \]

**Physicians’ Reactions (PR) case study**

27. (PR) What is the mean expected time spent for the average-weight patients?
   What is the mean expected time spent for the overweight patients?
   \[
   \text{Average weight mean} = 31.36; \text{overweight mean} = 24.74
   \]

28. (PR) What is the difference in means between the groups? By approximately how many standard deviations do the means differ?
   \[
   \text{Difference} = 6.62; \text{they differ by 0.68 standard deviations}
   \]

**Smiles and Leniency (SL) case study**

29. (SL) Find the mean, median, standard deviation, and interquartile range for the leniency scores of each of the four groups.
   \[
   \text{False smile: mean} = 5.37; \text{SD} = 1.83; \text{Median} = 5.5, \text{IQR} = 3
   \]
   \[
   \text{Felt smile: mean} = 4.91; \text{SD} = 1.68; \text{Median} = 4.75; \text{IQR} = 2.625
   \]
   \[
   \text{Miserable smile: mean} = 4.91; \text{SD} = 1.45; \text{median} = 4.75; \text{IQR} = 1.5
   \]
   \[
   \text{Neutral: mean} = 4.12; \text{SD} = 1.52; \text{median} = 4; \text{IQR} = 2.25
   \]

**ADHD Treatment (AT) case study**

30. (AT) What is the mean number of correct responses of the participants after taking the placebo (0 mg/kg)?
   \[
   \text{Mean} = 39.75
   \]

31. (AT) What are the standard deviation and the interquartile range of the d0 condition?
   \[
   \text{SD} = 11.32; \text{IQR} = 13.5
   \]
Chapter 4: Describing Bivariate Data

1. Describe the relationship between variables A and C. Think of things these variables could represent in real life.

There is a negative relationship between A and C. There is a negative relationship between price and many of the products that we buy.

2. Make up a data set with 10 numbers that has a positive correlation.

<table>
<thead>
<tr>
<th>x</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
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<tr>
<td>2</td>
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<td>3</td>
<td>3</td>
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<tr>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>
3. Make up a data set with 10 numbers that has a negative correlation.

<table>
<thead>
<tr>
<th>x</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td>2</td>
</tr>
<tr>
<td>10</td>
<td>1</td>
</tr>
</tbody>
</table>

4. If the correlation between weight (in pounds) and height (in feet) is 0.58, find:
   (a) the correlation between weight (in pounds) and height (in yards) 
   (b) the correlation between weight (in kilograms) and height (in meters).
The correlation for both (a) and (b) is still 0.58 because linear transformations do not affect the value of Pearson’s correlation, and both of the above instances are linear transformations.

5. Would you expect the correlation between High School GPA and College GPA to be higher when taken from your entire high school class or when taken from only the top 20 students? Why?

The correlation will probably be higher if we compared the GPA of the entire high school class, because the range restriction in the top 20 students will lead to a smaller correlation.

6. For a certain class, the relationship between the amount of time spent studying and the test grade earned was examined. It was determined that as the amount of time they studied increased, so did their grades. Is this a positive or negative association?

This is a positive association because as one variable increases, so does the other.

7. For this same class, the relationship between the amount of time spent studying and the amount of time spent socializing per week was also examined. It was determined that the more hours they spent studying, the fewer hours they spent socializing. Is this a positive or negative association?

This is a negative association.

8. For the following data:
   a. Find the deviation scores for Variable A that correspond to the raw scores of 2 and 8.
   b. Find the deviation scores for Variable B that correspond to the raw scores of 5 and 4.
   c. Just from looking at these scores, do you think these variables are positively or negatively correlated? Why?
   d. Now calculate the correlation. Were you right?
The calculated mean of Variable A is 6; the mean of Variable B is 4.

a) 2-6=-4; 8-6=2
b) 5-4=1; 4-4=0
c) These scores are negatively correlated because the negative value (deviation score) of A (-4;2) is associated with the positive value of B (1;0); thus, making the product AB negative.

d) \( r = -0.867 \)

9. Students took two parts of a test, each worth 50 points. Part A has a variance of 25, and Part B has a variance of 49. The correlation between the test scores is 0.6. (a) If the teacher adds the grades of the two parts together to form a final test grade, what would the variance of the final test grades be? (b) What would the variance of Part A - Part B be?

a) \( A + B = 25 + 49 + 2 \times 0.6 \times 5 \times 7 = 116 \).
b) \( A + B = 25 + 49 - 2 \times 0.6 \times 5 \times 7 = 32 \).

10. True/False: The correlation in real life between height and weight is \( r=1 \).

   False

11. True/False: It is possible for variables to have \( r=0 \) but still have a strong association.

   True if the relationship is nonlinear

12. True/False: Two variables with a correlation of 0.3 have a stronger linear relationship than two variables with a correlation of -0.7.

   False
13. True/False: After polling a certain group of people, researchers found a 0.5 correlation between the number of car accidents per year and the driver’s age. This means that older people get in more accidents.
   True

14. True/False: The correlation between R and T is the same as the correlation between T and R.
   True

15. True/False: To examine bivariate data graphically, the best choice is two side by side histograms.
   False

16. True/False: A correlation of r=1.2 is not possible.
   True

Questions from Case Studies

Angry Moods (AM) case study

17. (AM) What is the correlation between the Control-In and Control-Out scores?
   \( r = 0.72 \)

18. (AM) Would you expect the correlation between the Anger-Out and Control-Out scores to be positive or negative? Compute this correlation.
   I would expect the relationship to be negative.
   \( r = -0.583 \)

Flatulence (F) case study

19. (F) Is there a relationship between the number of male siblings and embarrassment in front of romantic interests? Create a scatterplot and compute r.
   \( r = -0.301, p = 0.084 \)
Stroop (S) case study

20. (S) Create a scatterplot showing “words” on the X-axis and “colors” on the Y-axis.
21. (S) Compute the correlation between “colors” and “words.”
   \[ r = .701 \]

22. (S) Sort the data by color-naming time. Choose only the 23 fastest color-namers.
   (a) What is the new correlation?
   (b) What is the technical term for the finding that this correlation is smaller than the correlation for the full dataset?
      a) \[ r = 0.25 \]
      b) Range restriction of one variable reduces the correlation of that variable with other variables.

**Animal Research (AR) case study**

23. (AR) What is the overall correlation between the belief that animal research is wrong and belief that animal research is necessary?
   \[ r = -.654 \]
24. (AT) What is the correlation between the participants’ correct number of responses after taking the placebo and their correct number of responses after taking 0.60 mg/kg of MPH? 

\[ r = .8 \]
Chapter 5: Probability

1. (a) What is the probability of rolling a pair of dice and obtaining a total score of 9 or more? (b) What is the probability of rolling a pair of dice and obtaining a total score of 7?
   - a) $10/36 = 0.278$
   - b) $6/36 = 0.167$

2. A box contains four black pieces of cloth, two striped pieces, and six dotted pieces. A piece is selected randomly and then placed back in the box. A second piece is selected randomly. What is the probability that:
   - a. both pieces are dotted?
   - b. the first piece is black and the second piece is dotted?
   - c. one piece is black and one piece is striped?
   - a) $1/4$
   - b) $1/6$
   - c) $1/9$

3. A card is drawn at random from a deck. (a) What is the probability that it is an ace or a king? (b) What is the probability that it is either a red card or a black card?
   - a) $2/13$
   - b) 1

4. The probability that you will win a game is 0.45. (a) If you play the game 80 times, what is the most likely number of wins? (b) What are the mean and variance of a binomial distribution with $p = 0.45$ and $N = 80$?
   - a) 36
   - b) 36 and $(.45)(.55)(80) = 4.45$

5. A fair coin is flipped 9 times. What is the probability of getting exactly 6 heads?
   - 0.164
6. When Susan and Jessica play a card game, Susan wins 60% of the time. If they play 9 games, what is the probability that Jessica will have won more games than Susan?

   Binomial distribution with p = .6 and N = 9, the probability of 4 or less? It is 0.267

7. You flip a coin three times. (a) What is the probability of getting heads on only one of your flips? (b) What is the probability of getting heads on at least one flip?
   a) 0.375
   b) 0.875

8. A test correctly identifies a disease in 95% of people who have it. It correctly identifies no disease in 94% of people who do not have it. In the population, 3% of the people have the disease. What is the probability that you have the disease if you tested positive?

   \[ p(D|T) = \frac{0.95 \times 0.03}{(0.95 \times 0.03) + (0.06 \times 0.97)} = 0.329 \]

9. A jar contains 10 blue marbles, 5 red marbles, 4 green marbles, and 1 yellow marble. Two marbles are chosen (without replacement). (a) What is the probability that one will be green and the other red? (b) What is the probability that one will be blue and the other yellow?
   a) 0.084
   b) 0.053

10. You roll a fair die five times, and you get a 6 each time. What is the probability that you get a 6 on the next roll?

    1/6

11. You win a game if you roll a die and get a 2 or a 5. You play this game 60 times.
    a. What is the probability that you win between 5 and 10 times (inclusive)?
    b. What is the probability that you will win the game at least 15 times?
    c. What is the probability that you will win the game at least 40 times?
    d. What is the most likely number of wins.
e. What is the probability of obtaining the number of wins in d?

Explain how you got each answer or show your work.

a) The probability that you will win between 5 and 10 times is 0.0032
b) The probability that you will win at least 15 times is 0.937
c) The probability that you will win at least 40 times is <0.00005
d) The most likely number of wins is 20
e) The probability of winning 20 times is 0.1087

12. In a baseball game, Tommy gets a hit 30% of the time when facing this pitcher. Joey gets a hit 25% of the time. They are both coming up to bat this inning.

a. What is the probability that Joey or Tommy (but not both) will get a hit?
b. What is the probability that neither player gets a hit?
c. What is the probability that they both get a hit?

a) (.3) + (.25) - (.3)(.25) = 0.475
b) 0.525
c) (.3)(.25) = 0.075

13. An unfair coin has a probability of coming up heads of 0.65. The coin is flipped 50 times. What is the probability it will come up heads 25 or fewer times? (Give answer to at least 3 decimal places).

0.021

14. You draw two cards from a deck, what is the probability that:

a. both of them are face cards (king, queen, or jack)?
b. you draw two cards from a deck and both of them are hearts?

a) (12/52)(11/51) = 0.04978
b) (13/52)(12/51) = 0.05882

15. True/False: You are more likely to get a pattern of HTHHHTHTTH than HHHHHHHHHTT when you flip a coin 10 times.

False
16. True/False: Suppose that at your regular physical exam you test positive for a relatively rare disease. You will need to start taking medicine if you have the disease, so you ask your doctor about the accuracy of the test. It turns out that the test is 98% accurate. The probability that you have Disease X is therefore 0.98 and the probability that you do not have it is .02. Explain your answer.

False, the base rate or prior probability should be taken into account. Also, the false positive rate has to be known.

Questions from Case Studies

Diet and Health (DH) case study

17. (DH)
   a. What percentage of people on the AHA diet had some sort of illness or death?
   b. What is the probability that if you randomly selected a person on the AHA diet, he or she would have some sort of illness or death?
   c. If 3 people on the AHA diet are chosen at random, what is the probability that they will all be healthy?
      a) 21.12%
      b) 0.212
      c) 0.489

18. (DH)
   a. What percentage of people on the Mediterranean diet had some sort of illness or death?
   b. What is the probability that if you randomly selected a person on the Mediterranean diet, he or she would have some sort of illness or death?
   c. What is the probability that if you randomly selected a person on the Mediterranean diet, he or she would have cancer?
   d. If you randomly select five people from the Mediterranean diet, what is the probability that they would all be healthy?
      a) 9.602%
b) 0.096
c) 0.023
d) 0.601

The following questions are from ARTIST (reproduced with permission)

19. Five faces of a fair die are painted black, and one face is painted white. The die is rolled six times. Which of the following results is more likely?
   a. Black side up on five of the rolls; white side up on the other roll
   b. Black side up on all six rolls
   c. a and b are equally likely
   b

20. One of the items on the student survey for an introductory statistics course was “Rate your intelligence on a scale of 1 to 10.” The distribution of this variable for the 100 women in the class is presented below. What is the probability of randomly selecting a women from the class who has an intelligence rating that is LESS than seven (7)?

<table>
<thead>
<tr>
<th>Intelligence Rating</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
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</tr>
<tr>
<td>6</td>
<td>24</td>
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<tr>
<td>7</td>
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<tr>
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<td>23</td>
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<tr>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>10</td>
<td>1</td>
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</tbody>
</table>

   a. \( (12 + 24)/100 = .36 \)
   b. \( (12 + 24 + 38)/100 = .74 \)
c. \( \frac{38}{100} = .38 \)
d. \( \frac{23 + 2 + 1}{100} = .26 \)
e. None of the above.

21. You roll 2 fair six-sided dice. Which of the following outcomes is most likely to occur on the next roll? A. Getting double 3. B. Getting a 3 and a 4. C. They are equally likely. Explain your choice.

C. The dice are independent of each other so any combination of numbers is as likely as any other.

22. If Tahnee flips a coin 10 times, and records the results (Heads or Tails), which outcome below is more likely to occur, A or B? Explain your choice.

<table>
<thead>
<tr>
<th>Throw Number</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A</strong></td>
<td>H</td>
<td>T</td>
<td>T</td>
<td>H</td>
<td>T</td>
<td>H</td>
<td>H</td>
<td>T</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td><strong>B</strong></td>
<td>H</td>
<td>T</td>
<td>H</td>
<td>T</td>
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<td>H</td>
<td>H</td>
<td>T</td>
<td>T</td>
</tr>
</tbody>
</table>

Both A and B are equally likely. Past coin flips do not influence future flips so all sequences are equally likely.

23. A bowl has 100 wrapped hard candies in it. 20 are yellow, 50 are red, and 30 are blue. They are well mixed up in the bowl. Jenny pulls out a handful of 10 candies, counts the number of reds, and tells her teacher. The teacher writes the number of red candies on a list. Then, Jenny puts the candies back into the bowl, and mixes them all up again. Four of Jenny’s classmates, Jack, Julie, Jason, and Jerry do the same thing. They each pick ten candies, count the reds, and the teacher writes down the number of reds. Then they put the candies back and mix them up again each time. The teacher’s list for the number of reds is most likely to be (please select one):

a. 8,9,7,10,9
b. 3,7,5,8,5
c. 5,5,5,5,5
d. 2,4,3,4,3
e. 3,0,9,2,8
24. An insurance company writes policies for a large number of newly-licensed drivers each year. Suppose 40% of these are low-risk drivers, 40% are moderate risk, and 20% are high risk. The company has no way to know which group any individual driver falls in when it writes the policies. None of the low-risk drivers will have an at-fault accident in the next year, but 10% of the moderate-risk and 20% of the high-risk drivers will have such an accident. If a driver has an at-fault accident in the next year, what is the probability that he or she is high-risk?

0.50

Consider 1,000 drivers: 400 are low risk, 400 are moderate risk, and 200 are high risk. The moderate risk drivers get in .10 x 400 = 40 accidents, and the high risk get in .20 x 200 = 40 accidents. The proportion of accidents from a high risk driver is: 40/(40 + 40) = 1/2 = .0.50.

25. You are to participate in an exam for which you had no chance to study, and for that reason cannot do anything but guess for each question (all questions being of the multiple choice type, so the chance of guessing the correct answer for each question is 1/d, d being the number of options (distractors) per question; so in case of a 4-choice question, your guess chance is 0.25). Your instructor offers you the opportunity to choose amongst the following exam formats: I. 6 questions of the 4-choice type; you pass when 5 or more answers are correct; II. 5 questions of the 5-choice type; you pass when 4 or more answers are correct; III. 4 questions of the 10-choice type; you pass when 3 or more answers are correct. Rank the three exam formats according to their attractiveness. It should be clear that the format with the highest probability to pass is the most attractive format. Which would you choose and why?

II = 0.007
I = 0.005
III = 0.004

Exam type II has the highest probability of passing when guessing.

26. Consider the question of whether the home team wins more than half of its games in the National Basketball Association. Suppose that you study a simple
random sample of 80 professional basketball games and find that 52 of them are won by the home team.

a. Assuming that there is no home court advantage and that the home team therefore wins 50% of its games in the long run, determine the probability that the home team would win 65% or more of its games in a simple random sample of 80 games.

b. Does the sample information (that 52 of a random sample of 80 games are won by the home team) provide strong evidence that the home team wins more than half of its games in the long run? Explain.
   a) 0.005
   b) Yes, because the probability of winning that percentage of games or more is very small at 0.005.

27. A refrigerator contains 6 apples, 5 oranges, 10 bananas, 3 pears, 7 peaches, 11 plums, and 2 mangos.

a. Imagine you stick your hand in this refrigerator and pull out a piece of fruit at random. What is the probability that you will pull out a pear?

b. Imagine now that you put your hand in the refrigerator and pull out a piece of fruit. You decide you do not want to eat that fruit so you put it back into the refrigerator and pull out another piece of fruit. What is the probability that the first piece of fruit you pull out is a banana and the second piece you pull out is an apple?

c. What is the probability that you stick your hand in the refrigerator one time and pull out a mango or an orange?
   a) 0.068
   b) 0.031
   c) 0.159
Chapter 6: Research Design

1. To be a scientific theory, the theory must be potentially ______________
   disconfirmable

2. What is the difference between a faith-based explanation and a scientific explanation?
   Faith based explanations cannot be disconfirmed by data

3. What does it mean for a theory to be parsimonious?
   The theory has relatively few constructs and is not overly complicated.

4. Define reliability in terms of parallel forms.
   Reliability is the correlation between parallel forms.

5. Define true score.
   The true score is the score without error of measurement. It is the average of repeated administration of parallel forms (assuming no practice effect)

6. What is the reliability if the true score variance is 80 and the test score variance is 100?
   .80

7. What statistic relates to how close a score on one test will be to a score on a parallel form?
   standard error of measurement

8. What is the effect of test length on the reliability of a test?
   The longer the test, the higher the reliability (all else being equal).

   Predictive validity does not involve assessing correlations with a set of variables thought to measure a trait. Construct validity is more theoretically based.
10. What is the theoretical maximum correlation of a test with a criterion if the test has a reliability of .81?
   .90

11. An experiment solicits subjects to participate in a highly stressful experiment. What type of sampling bias is likely to occur?
   biased

12. Give an example of survivorship bias not presented in this text.
   There are many possibilities.

13. Distinguish "between-subject" variables from "within-subjects" variables.
   Between subject variables use different subjects for different conditions whereas within-subject variables compare the same subjects in different conditions.

14. Of the variables "gender" and "trials," which is likely to be a between-subjects variable and which a within-subjects variable?
   gender is likely to be between subjects and trials is likely to be within-subjects

15. Define interaction.
   There is an interaction when the effect of one independent variable differs depending on the level of another independent variable. Other definitions are possible.

16. What is counterbalancing used for?
   To make sure factors such as the order of presentation is not confounded with the treatment.

17. How does randomization deal with the problem of pre-existing differences between groups?
   Differences will occur, but they will not be systematic and the effects of unmeasured variables can be assessed in inferential statistics by considering differences between subjects in the same condition.

18. Give an example of the "third-variable problem" other than those in this text.
There are many possibilities.
Chapter 7: Normal Distributions

1. If scores are normally distributed with a mean of 35 and a standard deviation of 10, what percent of the scores is:
   a. greater than 34?
   b. smaller than 42?
   c. between 28 and 34?
   
   a) 53.98%
   b) 75.8%
   c) 21.82%

2. What are the mean and standard deviation of the standard normal distribution?
   (b) What would be the mean and standard deviation of a distribution created by multiplying the standard normal distribution by 8 and then adding 75?
   
   a) The mean of a standard normal distribution is 0 and the standard deviation is 1.
   b) The mean would be 8 x 0 + 75 = 75. The standard deviation would be 8 x 1 = 8.

3. The normal distribution is defined by two parameters. What are they?
   The mean and standard deviation.

4. What proportion of a normal distribution is within one standard deviation of the mean? (b) What proportion is more than 2.0 standard deviations from the mean?
   (c) What proportion is between 1.25 and 2.1 standard deviations above the mean?
   
   a) 0.68
   b) 0.05
   c) 0.088

5. A test is normally distributed with a mean of 70 and a standard deviation of 8.
   (a) What score would be needed to be in the 85th percentile? (b) What score would be needed to be in the 22nd percentile?
   
   a) 78.3
6. Assume a normal distribution with a mean of 70 and a standard deviation of 12. What limits would include the middle 65% of the cases? 
   \[58.78, 81.22\]

7. A normal distribution has a mean of 20 and a standard deviation of 4. Find the Z scores for the following numbers: (a) 28 (b) 18 (c) 10 (d) 23
   a) 2
   b) -0.5
   c) -2.5
   d) 0.75

8. Assume the speed of vehicles along a stretch of I-10 has an approximately normal distribution with a mean of 71 mph and a standard deviation of 8 mph. 
   a. The current speed limit is 65 mph. What is the proportion of vehicles less than or equal to the speed limit?
   b. What proportion of the vehicles would be going less than 50 mph?
   c. A new speed limit will be initiated such that approximately 10% of vehicles will be over the speed limit. What is the new speed limit based on this criterion?
   d. In what way do you think the actual distribution of speeds differs from a normal distribution?
      a) 0.2266 of drivers are less than or equal to the speed limit.
      b) 0.0043 of drivers are going below 50 mph.
      c) The new speed limit would be 81.25 mph, or just 81 mph by rounded off.
      d) Positively skewed

9. A variable is normally distributed with a mean of 120 and a standard deviation of 5. One score is randomly sampled. What is the probability it is above 127? 
   0.081

10. You want to use the normal distribution to approximate the binomial distribution. Explain what you need to do to find the probability of obtaining exactly 7 heads out of 12 flips.
Since the normal distribution is continuous you would look the probability of the range 6.5 - 7.5. Probability of getting exactly 7 heads is 0.1932

11. A group of students at a school takes a history test. The distribution is normal with a mean of 25, and a standard deviation of 4. (a) Everyone who scores in the top 30% of the distribution gets a certificate. What is the lowest score someone can get and still earn a certificate? (b) The top 5% of the scores get to compete in a statewide history contest. What is the lowest score someone can get and still go onto compete with the rest of the state?

   a) 27.08
   b) 31.56

12. Use the normal distribution to approximate the binomial distribution and find the probability of getting 15 to 18 heads out of 25 flips. Compare this to what you get when you calculate the probability using the binomial distribution. Write your answers out to four decimal places.

   Normal approximation: 0.2037
   Binomial: 0.2049.

13. True/false: For any normal distribution, the mean, median, and mode will be equal.

   True

14. True/false: In a normal distribution, 11.5% of scores are greater than Z = 1.2.

   True

15. True/false: The percentile rank for the mean is 50% for any normal distribution.

   True

16. True/false: The larger the n, the better the normal distribution approximates the binomial distribution.

   True

17. True/false: A Z-score represents the number of standard deviations above or below the mean.
True

18. True/false: Abraham de Moivre, a consultant to gamblers, discovered the normal distribution when trying to approximate the binomial distribution to make his computations easier.

True

Answer questions 19 - 21 based on the graph below:

![Graph of two normal distributions](image)

19. True/false: The standard deviation of the blue distribution shown below is about 10.

False

20. True/false: The red distribution has a larger standard deviation than the blue distribution.

True

21. True/false: The red distribution has more area underneath the curve than the blue distribution does.

False

Questions from Case Studies

Angry Moods (AM) case study

22. For this problem, use the Anger Expression (AE) scores.
   a. Compute the mean and standard deviation.
b. Then, compute what the 25th, 50th and 75th percentiles would be if the
distribution were normal.
c. Compare the estimates to the actual 25th, 50th, and 75th percentiles.
Mean: 37
SD: 12.94
No credit lost if the difference is not computed.

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*Physicians’ Reactions (PR) case study*

23. (PR) For this problem, use the time spent with the overweight patients. (a) Compute the mean and standard deviation of this distribution. (b) What is the probability that if you chose an overweight participant at random, the doctor would have spent 31 minutes or longer with this person? (c) Now assume this distribution is normal (and has the same mean and standard deviation). Now what is the probability that if you chose an overweight participant at random, the doctor would have spent 31 minutes or longer with this person?

a) mean = 24.74; SD = 9.65
b) .053
c) .2578

The following questions are from ARTIST (reproduced with permission)
24. A set of test scores are normally distributed. Their mean is 100 and standard deviation is 20. These scores are converted to standard normal z scores. What would be the mean and median of this distribution?

a. 0
b. 1
c. 50
d. 100

a.

25. Suppose that weights of bags of potato chips coming from a factory follow a normal distribution with mean 12.8 ounces and standard deviation .6 ounces. If the manufacturer wants to keep the mean at 12.8 ounces but adjust the standard deviation so that only 1% of the bags weigh less than 12 ounces, how small does he/she need to make that standard deviation?

0.3439

26. A student received a standardized (z) score on a test that was -.57. What does this score tell about how this student scored in relation to the rest of the class? Sketch a graph of the normal curve and shade in the appropriate area.

The student’s score was below the class average.

27. Suppose you take 50 measurements on the speed of cars on Interstate 5, and that these measurements follow roughly a Normal distribution. Do you expect the standard deviation of these 50 measurements to be about 1 mph, 5 mph, 10 mph, or 20 mph? Explain.
The standard deviation is likely to be 5mph. The average speed is likely to be close to the speed limit and most cars are likely to be traveling within 5mph of this speed limit.

28. Suppose that combined verbal and math SAT scores follow a normal distribution with mean 896 and standard deviation 174. Suppose further that Peter finds out that he scored in the top 3% of SAT scores. Determine how high Peter’s score must have been.

1223

29. Heights of adult women in the United States are normally distributed with a population mean of $\mu = 63.5$ inches and a population standard deviation of $\sigma = 2.5$. A medical researcher is planning to select a large random sample of adult women to participate in a future study. What is the standard value, or $z$-value, for an adult woman who has a height of 68.5 inches?

$z = \frac{68.5-63.5}{2.5} = 2$

30. An automobile manufacturer introduces a new model that averages 27 miles per gallon in the city. A person who plans to purchase one of these new cars wrote the manufacturer for the details of the tests, and found out that the standard deviation is 3 miles per gallon. Assume that in-city mileage is approximately normally distributed.

a. What is the probability that the person will purchase a car that averages less than 20 miles per gallon for in-city driving?

b. What is the probability that the person will purchase a car that averages between 25 and 29 miles per gallon for in-city driving?

a) 0.0098
b) 0.4950
Chapter 8: Advanced Graphs

1. What are Q-Q plots useful for?

   They are useful for checking the validity of a distributional assumption

2. For the following data, plot the theoretically expected z score as a function of the actual z score (a Q-Q plot).

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3. For the data in problem 2, describe how the data differ from a normal distribution.

   It is very skewed to the right (positive skew).
4. For the “SAT and College GPA” case study data, create a contour plot looking at University GPA as a function of Math SAT and High School GPA. Naturally, you should use a computer to do this.
5. For the “SAT and College GPA” case study data, create a 3D plot using the variables University GPA, Math SAT, and High School GPA. Naturally, you should use a computer to do this.
Chapter 9: Sampling Distribution

1. A population has a mean of 50 and a standard deviation of 6. (a) What are the mean and standard deviation of the sampling distribution of the mean for N = 16? (b) What are the mean and standard deviation of the sampling distribution of the mean for N = 20?
   a) 50 and 1.5
   b) 50 and 1.34

2. Given a test that is normally distributed with a mean of 100 and a standard deviation of 12, find:
   a. the probability that a single score drawn at random will be greater than 110
   b. the probability that a sample of 25 scores will have a mean greater than 105
   c. the probability that a sample of 64 scores will have a mean greater than 105
   d. the probability that the mean of a sample of 16 scores will be either less than 95 or greater than 105
   a) 0.2023
   b) 0.0186
   c) 0.0004
   d) 0.0955

3. What term refers to the standard deviation of a sampling distribution?
   The term “standard error” refers to the standard deviation of the sampling distribution.

4. (a) If the standard error of the mean is 10 for N = 12, what is the standard error of the mean for N = 22? (b) If the standard error of the mean is 50 for N = 25, what is it for N = 64?
   a) 7.39
   b) 31.25
5. A questionnaire is developed to assess women’s and men’s attitudes toward using animals in research. One question asks whether animal research is wrong and is answered on a 7-point scale. Assume that in the population, the mean for women is 5, the mean for men is 4, and the standard deviation for both groups is 1.5. Assume the scores are normally distributed. If 12 women and 12 men are selected randomly, what is the probability that the mean of the women will be more than 2 points higher than the mean of the men?

The standard error of the difference between means is 0.612, and the probability is 0.0512.

6. If the correlation between reading achievement and math achievement in the population of fifth graders were 0.60, what would be the probability that in a sample of 28 students, the sample correlation coefficient would be greater than 0.65?

0.34

7. If numerous samples of N = 15 are taken from a uniform distribution and a relative frequency distribution of the means is drawn, what would be the shape of the frequency distribution?

The shape of the relative frequency distribution of the means will be quite close to a normal distribution.

8. A normal distribution has a mean of 20 and a standard deviation of 10. Two scores are sampled randomly from the distribution and the second score is subtracted from the first. What is the probability that the difference score will be greater than 5? Hint: Read the Variance Sum Law section of Chapter 3.

.3632

9. What is the shape of the sampling distribution of r? In what way does the shape depend on the size of the population correlation?

The shape of the sampling distribution of r is skewed: if the correlation is positive then the distribution will be negatively skewed and if the correlation is negative then the distribution will be positively skewed. The shape depends on the size of the population correlation in that as the correlation increases (in either the positive or negative direction), the skew becomes more pronounced. So, the
greater the absolute value of the population correlation, the more pronounced the skew.

10. If you sample one number from a standard normal distribution, what is the probability it will be 0.5?
   0.00

11. A variable is normally distributed with a mean of 120 and a standard deviation of 5. Four scores are randomly sampled. What is the probability that the mean of the four scores is above 127?
   .0026

12. The correlation between self esteem and extraversion is .30. A sample of 84 is taken. a. What is the probability that the correlation will be less than 0.10? b. What is the probability that the correlation will be greater than 0.25?
   a) 0.03
   b) 0.69

13. The mean GPA for students in School A is 3.0; the mean GPA for students in School B is 2.8. The standard deviation in both schools is 0.25. The GPAs of both schools are normally distributed. If 9 students are randomly sampled from each school, what is the probability that:
   a. the sample mean for School A will exceed that of School B by 0.5 or more?
   b. the sample mean for School B will be greater than the sample mean for School A?
   a) .0055
   b) .0448

14. In a city, 70% of the people prefer Candidate A. Suppose 30 people from this city were sampled.
   a. What is the mean of the sampling distribution of p?
   b. What is the standard error of p?
   c. What is the probability that 80% or more of this sample will prefer Candidate A?
For this problem, p is .70 and N is 30.

a) 0.70.

b) 0.08.

c) 0.12 gets half credit but a better answer is .1595 from the binomial distribution or .1596 from the normal distribution correcting for continuity. Basically, instead of finding the area greater than equal to .8, you find the area greater than or equal to .7833 which is .8 - .5/30. This is discussed in the normal distribution chapter but not the sampling distribution chapter.

15. When solving problems where you need the sampling distribution of r, what is the reason for converting from r to z’?

The reason for converting from r to z’ is that transforming r to z’ makes it normally distributed with a known standard error.

16. In the population, the mean SAT score is 1000. Would you be more likely (or equally likely) to get a sample mean of 1200 if you randomly sampled 10 students or if you randomly sampled 30 students? Explain.

It would be more likely with a sample of 10. The sample mean tends towards the population as sample size increases.

17. True/false: The standard error of the mean is smaller when N = 20 than when N = 10.

True

18. True/false: The sampling distribution of r = .8 becomes normal as N increases.

False

19. True/false: You choose 20 students from the population and calculate the mean of their test scores. You repeat this process 100 times and plot the distribution of the means. In this case, the sample size is 100.

False

20. True/false: In your school, 40% of students watch TV at night. You randomly ask 5 students every day if they watch TV at night. Every day, you would find that 2 of the 5 do watch TV at night.
False

21. True/false: The median has a sampling distribution.

True

22. True/false: Refer to the figure below. The population distribution is shown in black, and its corresponding sampling distribution of the mean for N = 10 is labeled “A.”

False

Questions from Case Studies

Angry Moods (AM) case study

23. (AM)
   a. How many men were sampled?
   b. How many women were sampled?
      a) 30
      b) 48

24. (AM) What is the mean difference between men and women on the Anger-Out scores?
25. (AM) Suppose in the population, the Anger-Out score for men is two points higher than it is for women. The population variances for men and women are both 20. Assume the Anger-Out scores for both genders are normally distributed. Given this information about the population parameters:
(a) What is the mean of the sampling distribution of the difference between means?
(b) What is the standard error of the difference between means?
(c) What is the probability that you would have gotten this mean difference (see #24) or less in your sample?
   a) 2
   b) 1.041
   c) 0.123

Animal Research (AR) case study

26. (AR) How many people were sampled to give their opinions on animal research?
   34

27. (AR) What is the correlation in this sample between the belief that animal research is wrong and belief that animal research is necessary?
   -.654

28. (AR) Suppose the correlation between the belief that animal research is wrong and the belief that animal research is necessary is -.68 in the population.
   (a) Convert -.68 to z’.
   (b) Find the standard error of this sampling distribution.
   (c) In a new sample, what is the probability that you would get the correlation found in the original sample (see #27) or a lower correlation (closer to -1)?
   a) -.829
   b) 0.1796
   c) .603
Chapter 10: Estimation

1. When would the mean grade in a class on a final exam be considered a statistic? When would it be considered a parameter?
   If the class is a sample from a population of classes then it is a statistic. If the class is considered the whole population then it is a parameter.

2. Define bias in terms of expected value.
   A statistic is unbiased if its expected value is the parameter it is estimating. Otherwise it is biased.

3. Is it possible for a statistic to be unbiased yet very imprecise? How about being very accurate but biased?
   Yes to both questions.

4. Why is a 99% confidence interval wider than a 95% confidence interval?
   In order to have a higher degree of confidence you have to include a larger proportion of the population.

5. When you construct a 95% confidence interval, what are you 95% confident about?
   That the interval contains the parameter.

6. What is the difference in the computation of a confidence interval between cases in which you know the population standard deviation and cases in which you have to estimate it?
   When the population standard deviation is not known, confidence intervals are calculated based on the t distribution.

7. Assume a researcher found that the correlation between a test he or she developed and job performance was 0.55 in a study of 28 employees. If correlations under .35 are considered unacceptable, would you have any reservations about using this test to screen job applicants?
   $Z' = 0.618$
S.E. = 0.2
For 95% confidence interval,
Lower limit = 0.618 - (1.96)(0.2) = 0.23
Upper limit = 0.618 + (1.96)(0.2) = 1.01
Converting back to r:
Since the 95% confidence interval extends from 0.23 to 0.77, you cannot be
confident that the correlation is over 0.35.
The answer could also be in terms of a one-tailed test with the null hypothesis
that the population correlation is less than or equal to 0.35.

8. What is the effect of sample size on the width of a confidence interval?
The larger the sample size, the smaller the width.

9. How does the t distribution compare with the normal distribution? How does
this difference affect the size of confidence intervals constructed using z
relative to those constructed using t? Does sample size make a difference?
The t distribution has longer tails (leptokurtic). The larger the sample size, the
closer t is to z.

10. The effectiveness of a blood-pressure drug is being investigated. How might an
experimenter demonstrate that, on average, the reduction in systolic blood
pressure is 20 or more?
The experimenter could calculate the confidence interval for the mean blood
pressure difference and determine if the lower limit of the interval is at 20 or
more.

11. A population is known to be normally distributed with a standard deviation of
2.8. (a) Compute the 95% confidence interval on the mean based on the
following sample of nine: 8, 9, 10, 13, 14, 16, 17, 20, 21. (b) Now compute the
99% confidence interval using the same data.
a) for the 95% confidence interval,
the lower limit: 128/9-2.8/sqrt(9)(1.96) = 12.39
the upper limit: 128/9+2.8/sqrt(9)(1.96) = 16.05
b) for the 99% confidence interval,
the lower limit: $128/9-2.8/sqrt(9)*2.58 = 11.81$
the upper limit: $128/9+2.8/sqrt(9)*2.58 = 16.63$

12. A person claims to be able to predict the outcome of flipping a coin. This person is correct 16/25 times. Compute the 95% confidence interval on the proportion of times this person can predict coin flips correctly. What conclusion can you draw about this test of his ability to predict the future? (.43, .85)

13. What does it mean that the variance (computed by dividing by N) is a biased statistic?

   It means that the expected value is not the population variance. Or, the long-term average value of the statistic is not the parameter. Or that the mean of the sampling distribution of the sample variance is not the population variance.

14. A confidence interval for the population mean computed from an N of 16 ranges from 12 to 28. A new sample of 36 observations is going to be taken. You can’t know in advance exactly what the confidence interval will be because it depends on the random sample. Even so, you should have some idea of what it will be. Give your best estimation.

   Assuming a 95% CI:

   Standard error for N = 16 is: $8/1.96 = 4.082$
   Pop standard deviation = 16.327
   Standard error for N = 36 is: $16.327/sqrt(36) = 2.721$

   New 95% CI:

   $20 - (1.96)(2.721) = 14.667$
   $20 + (1.96)(2.721) = 25.333$

15. You take a sample of 22 from a population of test scores, and the mean of your sample is 60. (a) You know the standard deviation of the population is 10. What is the 99% confidence interval on the population mean. (b) Now assume that you do not know the population standard deviation, but the standard deviation in your sample is 10. What is the 99% confidence interval on the mean now?
16. You read about a survey in a newspaper and find that 70% of the 250 people sampled prefer Candidate A. You are surprised by this survey because you thought that more like 50% of the population preferred this candidate. Based on this sample, is 50% a possible population proportion? Compute the 95% confidence interval to be sure.

Standard error of \( p = 0.029 \)
Correction for continuity = 0.002

Lower limit = \( 0.7 - (1.96)(0.029) - 0.002 = 0.641 \)
Upper limit = \( 0.7 + (1.96)(0.029) - 0.002 = 0.759 \)

It is very unlikely that 50% is a population proportion.

17. Heights for teenage boys and girls were calculated. The mean height for the sample of 12 boys was 174 cm and the variance was 62. For the sample of 12 girls, the mean was 166 cm and the variance was 65. Assuming equal variances and normal distributions in the population, (a) What is the 95% confidence interval on the difference between population means? (b) What is the 99% confidence interval on the difference between population means? (c) Do you think it is very unlikely that the mean difference in the population is about 5? Why or why not?

a) for the 95% confidence interval,
the lower limit: \( (174-166) - \sqrt{(62+65)/12} \times 2.074 = 1.25 \)
the upper limit: \( (174-166) + \sqrt{(62+65)/12} \times 2.074 = 14.75 \)

b) for the 99% confidence interval,
the lower limit: \( (174-166) - \sqrt{(62+65)/12} \times 2.819 = -1.17 \)
the upper limit: \( (174-166) + \sqrt{(62+65)/12} \times 2.819 = 17.17 \)

c) It is not unlikely that the mean difference in the population could be about 5 since 5 is in the interval.

18. You were interested in how long the average psychology major at your college studies per night, so you asked 10 psychology majors to tell you the amount
they study. They told you the following times: 2, 1.5, 3, 2, 3.5, 1, 0.5, 3, 2, 4.
(a) Find the 95% confidence interval on the population mean. (b) Find the 90% confidence interval on the population mean.

a) (1.45, 3.05)
b) (1.61, 2.89)

19. True/false: As the sample size gets larger, the probability that the confidence interval will contain the population mean gets higher.

False

20. True/false: You have a sample of 9 men and a sample of 8 women. The degrees of freedom for the t value in your confidence interval on the difference between means is 16.

False

21. True/false: Greek letters are used for statistics as opposed to parameters.

False

22. True/false: In order to construct a confidence interval on the difference between means, you need to assume that the populations have the same variance and are both normally distributed.

True

23. True/false: The red distribution represents the t distribution and the blue distribution represents the normal distribution.
Questions from Case Studies

**Angry Moods (AM) case study**

24. (AM) Is there a difference in how much males and females use aggressive behavior to improve an angry mood? For the “Anger-Out” scores, compute a 99% confidence interval on the difference between gender means.

(-1.803, 3.395)

25. (AM) Calculate the 95% confidence interval for the difference between the mean Anger-In score for the athletes and non-athletes. What can you conclude?

(0.598, 4.986)

The population mean difference is more than 0.

26. (AM) Find the 95% confidence interval on the population correlation between the Anger-Out and Control-Out scores.

(-.713, -.414)
**Flatulence (F) case study**

27. (F) Compare men and women on the variable “perday.” Compute the 95% confidence interval on the difference between means.

\((-0.98, 3.09)\)

28. (F) What is the 95% confidence interval of the mean time people wait before farting in front of a romantic partner.

\((0.558, 0.97)\)

**Animal Research (AR) case study**

29. (AR) What percentage of the women studied in this sample strongly agreed (gave a rating of 7) that using animals for research is wrong?

41%

30. (AR) Use the proportion you computed in #29. Compute the 95% confidence interval on the population proportion of women who strongly agree that animal research is wrong.

\((0.353, 0.467)\)

31. (AR) Compute a 95% confidence interval on the difference between the gender means with respect to their beliefs that animal research is wrong.

\((0.288, 2.653)\)

**ADHD Treatment (AT) case study**

32. (AT) What is the correlation between the participants’ correct number of responses after taking the placebo and their correct number of responses after taking 0.60 mg/kg of MPH? Compute the 95% confidence interval on the population correlation.

\((0.586, 0.91)\)

**Weapons and Aggression (WA) case study**

33. (WA) Recall that the hypothesis is that a person can name an aggressive word more quickly if it is preceded by a weapon word prime than if it is preceded by
a neutral word prime. The first step in testing this hypothesis is to compute the
difference between (a) the naming time of aggressive words when preceded by
a neutral word prime and (b) the naming time of aggressive words when
preceded by a weapon word prime separately for each of the 32 participants.
That is, compute an - aw for each participant.
a. (WA) Would the hypothesis of this study be supported if the difference were
positive or if it were negative?
b. What is the mean of this difference score?
c. What is the standard deviation of this difference score?
d. What is the 95% confidence interval of the mean difference score?
e. What does the confidence interval computed in (d) say about the hypothesis.
a) Positive
b) 7.16
c) 18.203
d) (0.59, 13.72)
e) The hypothesis appears to be correct, lower limit of the confidence interval
is above 0.

Diet and Health (DH) case study

34. (DH) Compute a 95% confidence interval on the proportion of people who are
healthy on the AHA diet.

<table>
<thead>
<tr>
<th></th>
<th>Cancers</th>
<th>Deaths</th>
<th>Nonfatal illness</th>
<th>Healthy</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>AHA</td>
<td>15</td>
<td>24</td>
<td>25</td>
<td>239</td>
<td>303</td>
</tr>
<tr>
<td>Mediterranean</td>
<td>7</td>
<td>14</td>
<td>8</td>
<td>273</td>
<td>302</td>
</tr>
<tr>
<td>Total</td>
<td>22</td>
<td>38</td>
<td>33</td>
<td>512</td>
<td>605</td>
</tr>
</tbody>
</table>

The following questions are from ARTIST (reproduced with permission)
(.786, .792)
35. Suppose that you take a random sample of 10,000 Americans and find that 1,111 are left-handed. You perform a test of significance to assess whether the sample data provide evidence that more than 10% of all Americans are left-handed, and you calculate a test statistic of 3.70 and a p-value of .0001. Furthermore, you calculate a 99% confidence interval for the proportion of left-handers in America to be (.103,.119). Consider the following statements: The sample provides strong evidence that more than 10% of all Americans are left-handed. The sample provides evidence that the proportion of left-handers in America is much larger than 10%. Which of these two statements is the more appropriate conclusion to draw? Explain your answer based on the results of the significance test and confidence interval.

The first statement is closer to true. The lower limit of the confidence interval is just marginally above 10%.

36. A student wanted to study the ages of couples applying for marriage licenses in his county. He studied a sample of 94 marriage licenses and found that in 67 cases the husband was older than the wife. Do the sample data provide strong evidence that the husband is usually older than the wife among couples applying for marriage licenses in that county? Explain briefly and justify your answer.

95% CI for proportion of older husbands
(.703, .722)
If husbands do not tend to be older the proportion would be at .5 or less. The CI is above this proportion so the sample does provide strong evidence that husbands tend to be older.

37. Imagine that there are 100 different researchers each studying the sleeping habits of college freshmen. Each researcher takes a random sample of size 50
from the same population of freshmen. Each researcher is trying to estimate the mean hours of sleep that freshmen get at night, and each one constructs a 95% confidence interval for the mean. Approximately how many of these 100 confidence intervals will NOT capture the true mean?

a. None
b. 1 or 2
c. 3 to 7
d. about half
e. 95 to 100
f. other
c
1. An experiment is conducted to test the claim that James Bond can taste the difference between a Martini that is shaken and one that is stirred. What is the null hypothesis?

James Bond cannot taste the difference between a Martini that is shaken and one that is stirred.

2. The following explanation is incorrect. What three words should be added to make it correct?

The probability value is the probability of obtaining a statistic as different (add three words here) from the parameter specified in the null hypothesis as the statistic obtained in the experiment. The probability value is computed assuming that the null hypothesis is true.

The three words should be “or more different” after “The probability value is the probability of obtaining a statistic as different.”

3. Why do experimenters test hypotheses they think are false?

Providing data that supports a hypothesis does not mean that it is true, just that there is no evidence that contradicts it. Providing evidence that is contrary to a hypothesis allows you to reject that hypothesis as false.

4. State the null hypothesis for:

a. An experiment testing whether echinacea decreases the length of colds.

b. A correlational study on the relationship between brain size and intelligence.

c. An investigation of whether a self-proclaimed psychic can predict the outcome of a coin flip.

d. A study comparing a drug with a placebo on the amount of pain relief. (A one-tailed test was used.)

a) Echinacea increases or has no effect on the length of colds.
b) There is no relationship between brain size and intelligence.
c) The psychic cannot predict the outcome of a coin flip.
d) Pain relief in the placebo group is greater or equal to pain relief in the drug group.

5. Assume the null hypothesis is that $\mu = 50$ and that the graph shown below is the sampling distribution of the mean (M). Would a sample value of $M = 60$ be significant in a two-tailed test at the .05 level? Roughly what value of M would be needed to be significant?

![Sampling Distribution of the Mean](image)

This mean would not be significant. $M = 69.6$ or 70 would probably be significant.

6. A researcher develops a new theory that predicts that vegetarians will have more of a particular vitamin in their blood than non-vegetarians. An experiment is conducted and vegetarians do have more of the vitamin, but the difference is not significant. The probability value is 0.13. Should the experimenter’s confidence in the theory increase, decrease, or stay the same?

Confidence should increase

7. A researcher hypothesizes that the lowering in cholesterol associated with weight loss is really due to exercise. To test this, the researcher carefully controls for exercise while comparing the cholesterol levels of a group of subjects who lose weight by dieting with a control group that does not diet. The difference between groups in cholesterol is not significant. Can the researcher claim that weight loss has no effect?

No.
8. A significance test is performed and p = .20. Why can’t the experimenter claim that the probability that the null hypothesis is true is .20?

The null hypothesis cannot be proven to be true, p = .2 only provides insufficient evidence that it is false.

9. For a drug to be approved by the FDA, the drug must be shown to be safe and effective. If the drug is significantly more effective than a placebo, then the drug is deemed effective. What do you know about the effectiveness of a drug once it has been approved by the FDA (assuming that there has not been a Type I error)?

The difference between the effectiveness of the drug and placebo is above chance.

10. When is it valid to use a one-tailed test? What is the advantage of a one-tailed test? Give an example of a null hypothesis that would be tested by a one-tailed test.

A one-tailed test is valid when you are looking for a result in a particular direction. When the researcher is only interested in a result in a particular direction and a these tests increase the likelihood of finding that result.

11. Distinguish between probability value and significance level.

The probability value is the probability of obtaining a statistic assuming that null hypothesis is true. The significance level is the probability below which the null hypothesis can be rejected.

12. Suppose a study was conducted on the effectiveness of a class on “How to take tests.” The SAT scores of an experimental group and a control group were compared. (There were 100 subjects in each group.) The mean score of the experimental group was 503 and the mean score of the control group was 499. The difference between means was found to be significant, p = .037. What do you conclude about the effectiveness of the class?

While the effect may not be large, the study provides evidence that the class is effective to some degree.

13. Is it more conservative to use an alpha level of .01 or an alpha level of .05? Would beta be higher for an alpha of .05 or for an alpha of .01?
An alpha of .01 is more conservative. Beta is larger with the smaller alpha.

14. Why is “Ho: “M1 = M2” not a proper null hypothesis?
   It should be stated in terms of the population parameters not the statistics.

15. An experimenter expects an effect to come out in a certain direction. Is this sufficient basis for using a one-tailed test? Why or why not?
   This is not sufficient. The experimenter also needs to provide a compelling reason for why an effect in the unexpected direction would not be important.

16. How do the Type I and Type II error rates of one-tailed and two-tailed tests differ?
   Type I error rates are the same. The type II error rate is higher with a two-tailed test if the hypothesized direction for the one-tailed test is correct.

17. A two-tailed probability is .03. What is the one-tailed probability if the effect were in the specified direction? What would it be if the effect were in the other direction?
   The one-tailed probability would be .015 in the specified direction and .985 in the other direction.

18. You choose an alpha level of .01 and then analyze your data.
   a. What is the probability that you will make a Type I error given that the null hypothesis is true?
   b. What is the probability that you will make a Type I error given that the null hypothesis is false?
      a) .01
      b) 0

19. Why doesn’t it make sense to test the hypothesis that the sample mean is 42?
   This does not make sense because in hypothesis testing, the test is always about the population mean.

20. True/false: It is easier to reject the null hypothesis if the researcher uses a smaller alpha (α) level.
21. True/false: You are more likely to make a Type I error when using a small sample than when using a large sample.  
   False

22. True/false: You accept the alternative hypothesis when you reject the null hypothesis.  
   True

23. True/false: You do not accept the null hypothesis when you fail to reject it.  
   True

24. True/false: A researcher risks making a Type I error any time the null hypothesis is rejected.  
   True
Chapter 12: Testing Means

1. The scores of a random sample of 8 students on a physics test are as follows: 60, 62, 67, 69, 70, 72, 75, and 78.
   a. Test to see if the sample mean is significantly different from 65 at the .05 level. Report the t and p values.
   b. The researcher realizes that she accidentally recorded the score that should have been 76 as 67. Are these corrected scores significantly different from 65 at the .05 level?
      a) t(7)=1.91, p=0.0976; not significant.
      b) t(7)=2.29, p=0.0555; not significant.

2. A (hypothetical) experiment is conducted on the effect of alcohol on perceptual motor ability. Ten subjects are each tested twice, once after having two drinks and once after having two glasses of water. The two tests were on two different days to give the alcohol a chance to wear off. Half of the subjects were given alcohol first and half were given water first. The scores of the 10 subjects are shown below. The first number for each subject is their performance in the “water” condition. Higher scores reflect better performance. Test to see if alcohol had a significant effect. Report the t and p values.

<table>
<thead>
<tr>
<th>water</th>
<th>alcohol</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>13</td>
</tr>
<tr>
<td>15</td>
<td>13</td>
</tr>
<tr>
<td>11</td>
<td>10</td>
</tr>
<tr>
<td>20</td>
<td>18</td>
</tr>
<tr>
<td>19</td>
<td>17</td>
</tr>
<tr>
<td>14</td>
<td>11</td>
</tr>
<tr>
<td>13</td>
<td>10</td>
</tr>
<tr>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>14</td>
<td>11</td>
</tr>
<tr>
<td>16</td>
<td>16</td>
</tr>
</tbody>
</table>
For a correlated t test, we need to add a column that is the difference between the two variables.

\[ t = 5.02 \text{ and } p = 0.0007; \text{ therefore there is evidence that the alcohol had an effect.} \]

3. The scores on a (hypothetical) vocabulary test of a group of 20 year olds and a group of 60 year olds are shown below.

<table>
<thead>
<tr>
<th>20 yr olds</th>
<th>60 yr olds</th>
</tr>
</thead>
<tbody>
<tr>
<td>27</td>
<td>26</td>
</tr>
<tr>
<td>26</td>
<td>29</td>
</tr>
<tr>
<td>21</td>
<td>29</td>
</tr>
<tr>
<td>24</td>
<td>29</td>
</tr>
<tr>
<td>15</td>
<td>27</td>
</tr>
<tr>
<td>18</td>
<td>16</td>
</tr>
<tr>
<td>17</td>
<td>20</td>
</tr>
<tr>
<td>12</td>
<td>27</td>
</tr>
<tr>
<td>13</td>
<td></td>
</tr>
</tbody>
</table>

a. Test the mean difference for significance using the .05 level.

b. List the assumptions made in computing your answer.
   a) \( t = 2.42, p = .0285, \text{ significant} \)
   b) homogeneity of variance
   - values are independent of each other
   - populations are normally distributed

4. The sampling distribution of a statistic is normally distributed with an estimated standard error of 12 (df = 20). (a) What is the probability that you would have gotten a mean of 107 (or more extreme) if the population parameter were 100? Is this probability significant at the .05 level (two-tailed)? (b) What is the probability that you would have gotten a mean of 95 or less (one-tailed)? Is this probability significant at the .05 level? You may want to use the t Distribution calculator for this problem.

a) \( t = \frac{(107-100)}{12} = 0.5833, p = .283 \)
b) \( t = -0.042, p = 0.341 \) if the hypothesized effect were negative and 0.659 if the hypothesized effect were positive.

5. How do you decide whether to use an independent groups t test or a correlated t test (test of dependent means)?

If each subject provides more than one data point then you use a correlated t. You also use a correlated t if there is matching so that each matched unit provides two scores. If there are two separate groups you use an independent groups t test.

6. An experiment compared the ability of three groups of subjects to remember briefly-presented chess positions. The data are shown below.

<table>
<thead>
<tr>
<th>Non-players</th>
<th>Beginners</th>
<th>Tournament players</th>
</tr>
</thead>
<tbody>
<tr>
<td>22.1</td>
<td>32.5</td>
<td>40.1</td>
</tr>
<tr>
<td>22.3</td>
<td>37.1</td>
<td>45.6</td>
</tr>
<tr>
<td>26.2</td>
<td>39.1</td>
<td>51.2</td>
</tr>
<tr>
<td>29.6</td>
<td>40.5</td>
<td>56.4</td>
</tr>
<tr>
<td>31.7</td>
<td>45.5</td>
<td>58.1</td>
</tr>
<tr>
<td>33.5</td>
<td>51.3</td>
<td>71.1</td>
</tr>
<tr>
<td>38.9</td>
<td>52.6</td>
<td>74.9</td>
</tr>
<tr>
<td>39.7</td>
<td>55.7</td>
<td>75.9</td>
</tr>
<tr>
<td>43.2</td>
<td>55.9</td>
<td>80.3</td>
</tr>
<tr>
<td>43.2</td>
<td>57.7</td>
<td>85.3</td>
</tr>
</tbody>
</table>

a. Using the Tukey HSD procedure, determine which groups are significantly different from each other at the .05 level.

b. Now compare each pair of groups using t-tests. Make sure to control for the familywise error rate (at 0.05) by using the Bonferroni correction. Specify the alpha level you used.

a)
b) alpha level with Bonferroni correction = .05/3 = .0167

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Q</th>
<th>P</th>
<th>Sig-test (0.05)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non player-beginner (1-2)</td>
<td>-3.81</td>
<td>0.031</td>
<td>Significant</td>
</tr>
<tr>
<td>Non player-tournament (1-3)</td>
<td>-8.55</td>
<td>&lt;0.001</td>
<td>Significant</td>
</tr>
<tr>
<td>Beginner-tournament (2-3)</td>
<td>-4.74</td>
<td>0.007</td>
<td>Significant</td>
</tr>
</tbody>
</table>

7. Below are data showing the results of six subjects on a memory test. The three scores per subject are their scores on three trials (a, b, and c) of a memory task. Are the subjects getting better each trial? Test the linear effect of trial for the data.

```
<table>
<thead>
<tr>
<th>a</th>
<th>b</th>
<th>c</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>2</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>
```

a. Compute L for each subject using the contrast weights -1, 0, and 1. That is, compute (-1)(a) + (0)(b) + (1)(c) for each subject.
b. Compute a one-sample t-test on this column (with the L values for each subject) you created.

a) The L values for each subject are 3, 5, 3, 6, 5, and 0.
b) t=4.1576 p=0.009
8. Participants threw darts at a target. In one condition, they used their preferred hand; in the other condition, they used their other hand. All subjects performed in both conditions (the order of conditions was counterbalanced). Their scores are shown below.

<table>
<thead>
<tr>
<th>Preferred</th>
<th>Non-preferred</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>11</td>
<td>8</td>
</tr>
<tr>
<td>13</td>
<td>10</td>
</tr>
<tr>
<td>10</td>
<td>9</td>
</tr>
</tbody>
</table>

a. Which kind of t-test should be used?
b. Calculate the two-tailed t and p values using this t test.
c. Calculate the one-tailed t and p values using this t test.

a) t-test for correlated pairs. (Synonyms: dependent means, matched pairs)
b) $t = -1.69$, $p = 0.166$
c) $t = -1.69$, $p = 0.083$

9. Assume the data in the previous problem were collected using two different groups of subjects: One group used their preferred hand and the other group used their non-preferred hand. Analyze the data and compare the results to those for the previous problem.

Two-tailed test: $t = 1.74$, $p = .12$
One-tailed: $t = 1.74$, $p = .06$

The independent t-tests do not reach conventional significance, but are closer than the t-tests for correlated pairs.

10. You have 4 means, and you want to compare each mean to every other mean.
(a) How many tests total are you going to compute? (b) What would be the chance of making at least one Type I error if the Type I error for each test was .05 and the tests were independent? (c) Are the tests independent and how does independence/non-independence affect the probability in (b).

a) 6
b) Approximately 0.3.
c) The tests are not independent. The probability is lower than it would be for the same number of independent comparisons.

11. In an experiment, participants were divided into 4 groups. There were 20 participants in each group, so the degrees of freedom (error) for this study was 80 - 4 = 76. Tukey’s HSD test was performed on the data. (a) Calculate the p value for each pair based on the Q value given below. You will want to use the Studentized Range Calculator. (b) Which differences are significant at the .05 level?

<table>
<thead>
<tr>
<th>Comparison of Groups</th>
<th>Q</th>
</tr>
</thead>
<tbody>
<tr>
<td>A - B</td>
<td>3.4</td>
</tr>
<tr>
<td>A - C</td>
<td>3.8</td>
</tr>
<tr>
<td>A - D</td>
<td>4.3</td>
</tr>
<tr>
<td>B - C</td>
<td>1.7</td>
</tr>
<tr>
<td>B - D</td>
<td>3.9</td>
</tr>
<tr>
<td>C - D</td>
<td>3.7</td>
</tr>
</tbody>
</table>

A-B .085 Not Significant  
A-C .043 Significant  
A-D .017 Significant  
B-C .627 Not Significant  
B-D .036 Significant  
C-D .051 Not Significant

12. If you have 5 groups in your study, why shouldn’t you just compute a t test of each group mean with each other group mean?

Each additional test increases the probability of the familywise error rate.

13. You are conducting a study to see if students do better when they study all at once or in intervals. One group of 12 participants took a test after studying for one hour continuously. The other group of 12 participants took a test after studying for three twenty minute sessions. The first group had a mean score of 75 and a variance of 120. The second group had a mean score of 86 and a variance of 100.
a. What is the calculated t value? Are the mean test scores of these two groups significantly different at the .05 level?
b. What would the t value be if there were only 6 participants in each group? Would the scores be significant at the .05 level?
   a) t(22) = 2.57, p = 0.0175, significant
   b) t(10) = 1.82, p = 0.099, not significant

14. A new test was designed to have a mean of 80 and a standard deviation of 10. A random sample of 20 students at your school take the test, and the mean score turns out to be 85. Does this score differ significantly from 80?
   p = 0.025, significant

15. You perform a one-sample t test and calculate a t statistic of 3.0. The mean of your sample was 1.3 and the standard deviation was 2.6. How many participants were used in this study?
   36

16. True/false: The contrasts (-3, 1 1 1) and (0, 0, -1, 1) are orthogonal.
   True

17. True/false: If you are making 4 comparisons between means, then based on the Bonferroni correction, you should use an alpha level of .01 for each test.
   False

18. True/false: Correlated t tests almost always have greater power than independent t tests.
   True

19. True/false: The graph below represents a violation of the homogeneity of variance assumption.
20. True/false: When you are conducting a one-sample t test and you know the population standard deviation, you look up the critical t value in the table based on the degrees of freedom.

False

Questions from Case Studies

Angry Moods (AM) case study

21. (AM) Do athletes or non-athletes calm down more when angry? Conduct a t test to see if the difference between groups in Control-In scores is statistically significant.

\[ t(76) = 3.04, \ p = .003, \] the difference is statistically significant.
22. (AM) Do people in general have a higher Anger-Out or Anger-In score? Conduct a t test on the difference between means of these two scores. Are these two means independent or dependent?

t(77) = 3.53, p = .001, people generally have a higher Anger-In score. The means are dependent.

**Smiles and Leniency (SL) case study**

23. (SL) Compare each mean to the neutral mean. Be sure to control for the familywise error rate.

<table>
<thead>
<tr>
<th></th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-4</td>
<td>3.06</td>
<td>.003</td>
</tr>
<tr>
<td>2-4</td>
<td>2.04</td>
<td>.045</td>
</tr>
<tr>
<td>3-4</td>
<td>2.2</td>
<td>.031</td>
</tr>
</tbody>
</table>

Control for familywise error rate alpha = .05/3 = .017
Only the first comparison is significant.

24. (SL) Does a “felt smile” lead to more leniency than other types of smiles? (a) Calculate L (the linear combination) using the following contrast weights false: -1, felt: 2, miserable: -1, neutral: 0. (b) Perform a significance test on this value of L.

t(135) = 0.21, p = .837

**Animal Research (AR) case study**

25. (AR) Conduct an independent samples t test comparing males to females on the belief that animal research is necessary.

a) t(32) = 1.84, p = .0745

26. (AR) Based on the t test you conducted in the previous problem, are you able to reject the null hypothesis if alpha = 0.05? What about if alpha = 0.1?

You can only reject if alpha = .1

27. (AR) Is there any evidence that the t test assumption of homogeneity of variance is violated in the t test you computed in #27?
There is no evidence of unequal variance between the groups.

**ADHD Treatment (AT) case study**

28. (AT) Compare each dosage with the dosage below it (compare d0 and d15, d15 and d30, and d30 and d60). Remember that the patients completed the task after every dosage. (a) If the familywise error rate is .05, what is the alpha level you will use for each comparison when doing the Bonferroni correction? (b) Which differences are significant at this level?

<table>
<thead>
<tr>
<th>Comparisons</th>
<th>Alpha Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>d0 - d15</td>
<td>.0001</td>
</tr>
<tr>
<td>d15 - d30</td>
<td>.00001</td>
</tr>
<tr>
<td>d30 - d60</td>
<td>.848</td>
</tr>
</tbody>
</table>

a) alpha = .0167

b) Only d30 - d60 is not significant.

29. (AT) Does performance increase linearly with dosage?

a. Plot a line graph of this data.

b. Compute L for each patient. To do this, create a new variable where you multiply the following coefficients by their corresponding dosages and then sum up the total: (-3)d0 + (-1)d15 + (1)d30 + (3)d60 (see #8). What is the mean of L?

c. Perform a significance test on L. Compute the 95% confidence interval for L.

a)
b) mean = 19.54

c) t(23) = 3.96, p = .001
Chapter 13: Power

1. Define power in your own words.

   Power is the probability of finding a significant difference given that the null hypothesis is false.

2. List 3 measures one can take to increase the power of an experiment. Explain why your measures result in greater power.

   Increase sample size: this reduces the standard error
   Use within-subject design: this reduces error
   Use a homogeneous population: this reduces sampling error.
   Use one-tailed tests: this raises the significance level if the effect is in the hypothesized direction.

3. Population 1 mean = 36
   Population 2 mean = 45
   Both population standard deviations are 10.
   Sample size per group is 16.
   What is the probability that a t test will find a significant difference between means at the 0.05 level? Give results for both one- and two-tailed tests. Hint: the power of a one-tailed test at 0.05 level is the power of a two-tailed test at 0.10.

   two-tailed: p = .693
   one-tailed: p = .800

4. Rank order the following in terms of power.

<table>
<thead>
<tr>
<th></th>
<th>Population 1 Mean</th>
<th>n</th>
<th>Population 2 Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>29</td>
<td>20</td>
<td>43</td>
<td>12</td>
</tr>
<tr>
<td>b</td>
<td>34</td>
<td>15</td>
<td>40</td>
<td>6</td>
</tr>
<tr>
<td>c</td>
<td>105</td>
<td>24</td>
<td>50</td>
<td>27</td>
</tr>
</tbody>
</table>
c, a, b, d

5. Alan, while snooping around his grandmother's basement stumbled upon a shiny object protruding from under a stack of boxes. When he reached for the object a genie miraculously materialized and stated: "You have found my magic coin. If you flip this coin an infinite number of times you will notice that heads will show 60% of the time." Soon after the genie's declaration he vanished, never to be seen again. Alan, excited about his new magical discovery, approached his friend Ken and told him about what he had found. Ken was skeptical of his friend's story, however, he told Alan to flip the coin 100 times and to record how many flips resulted with heads.

(a) What is the probability that Alan will be able convince Ken that his coin has special powers by finding a p value below 0.05 (one tailed).

Use the Binomial Calculator (and some trial and error)

(b) If Ken told Alan to flip the coin only 20 times, what is the probability that Alan will not be able to convince Ken (by failing to reject the null hypothesis at the 0.05 level)?

a) .623
b) .874
Chapter 14: Regression

1. What is the equation for a regression line? What does each term in the line refer to?

   \[ Y' = bX + A \]

   \( b \) is the slope, \( A \) is the Y intercept

2. The formula for a regression equation is \( Y' = 2X + 9 \).
   a. What would be the predicted score for a person scoring 6 on \( X \)?
   b. If someone’s predicted score was 14, what was this person’s score on \( X \)?

   a) \( Y' = (2)(6) + 9 = 21 \)
   b) \( 14 = 2X + 9 \) \( X = 2.5 \)

3. What criterion is used for deciding which regression line fits best?

   Most common criterion: the line that minimizes the sum of the squared errors of prediction.

4. What does the standard error of the estimate measure? What is the formula for the standard error of the estimate?

   The standard error of the estimate is a measure of the accuracy of predictions. The formula is as follows:

   \[ \sigma_{est} = \sqrt{\frac{\sum (Y - Y')}{N}} \]

   Its OK if the student gives the estimate which has N-2 in the denominator.

5.

   a. In a regression analysis, the sum of squares for the predicted scores is 100 and the sum of squares error is 200, what is \( R^2 \)?

   b. In a different regression analysis, 40% of the variance was explained. The sum of squares total is 1000. What is the sum of squares of the predicted values?
a) \( R^2 = (100/300) = 0.333 \)
b) \( SSY' = 0.40 \times 1000 = 400. \)

6. For the X,Y data below, compute:
   a. \( r \) and determine if it is significantly different from zero.
   b. the slope of the regression line and test if it differs significantly from zero.
   c. the 95\% confidence interval for the slope.

<table>
<thead>
<tr>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>11</td>
<td>17</td>
</tr>
<tr>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>14</td>
<td>21</td>
</tr>
</tbody>
</table>

a) \( r = 0.8492; \ p = 0.0324. \) Therefore, \( r \) is significantly different from 0 and we can reject the null hypothesis in this case.
b) Slope = 1.133, intercept = 3.123
c) 

\[ t \text{ for confidence interval with } 6-2 = 4 \text{ df} = 2.776 \]
\[ \text{Standard error} = .352 \]
\[ \text{Lower limit} = 1.133 - (2.776)(.352) = 0.155 \]
\[ \text{Upper limit} = 1.133 + (2.776)(.352) = 2.111 \]

7. What assumptions are needed to calculate the various inferential statistics of linear regression?

Three assumptions are made in order to calculate the various inferential statistics of linear regression:

1) linearity
2) Homoscedasticity
3) normally distributed residuals
8. The correlation between years of education and salary in a sample of 20 people from a certain company is .4. Is this correlation statistically significant at the .05 level?
   
   \[ t = 1.85, \text{ df } = 18, p = 0.081, \text{ not significant at 0.05} \]

9. A sample of X and Y scores is taken, and a regression line is used to predict Y from X. If SSY’ = 300, SSE = 500, and N = 50, what is:
   
   (a) SSY?
   
   (b) the standard error of the estimate?
   
   (c) R²?
   
   a) \[ SSY = SSY' + SSE = 800 \]
   
   b) 3.23
   
   c) 0.375

10. Using linear regression, find the predicted post-test score for someone with a score of 45 on the pre-test.
<table>
<thead>
<tr>
<th>Pre</th>
<th>Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>59</td>
<td>56</td>
</tr>
<tr>
<td>52</td>
<td>63</td>
</tr>
<tr>
<td>44</td>
<td>55</td>
</tr>
<tr>
<td>51</td>
<td>50</td>
</tr>
<tr>
<td>42</td>
<td>66</td>
</tr>
<tr>
<td>42</td>
<td>48</td>
</tr>
<tr>
<td>41</td>
<td>58</td>
</tr>
<tr>
<td>45</td>
<td>36</td>
</tr>
<tr>
<td>27</td>
<td>13</td>
</tr>
<tr>
<td>63</td>
<td>50</td>
</tr>
<tr>
<td>54</td>
<td>81</td>
</tr>
<tr>
<td>44</td>
<td>56</td>
</tr>
<tr>
<td>50</td>
<td>64</td>
</tr>
<tr>
<td>47</td>
<td>50</td>
</tr>
<tr>
<td>55</td>
<td>63</td>
</tr>
<tr>
<td>49</td>
<td>57</td>
</tr>
<tr>
<td>45</td>
<td>73</td>
</tr>
<tr>
<td>57</td>
<td>63</td>
</tr>
<tr>
<td>46</td>
<td>46</td>
</tr>
<tr>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>65</td>
<td>47</td>
</tr>
<tr>
<td>64</td>
<td>73</td>
</tr>
<tr>
<td>50</td>
<td>58</td>
</tr>
<tr>
<td>74</td>
<td>85</td>
</tr>
<tr>
<td>59</td>
<td>44</td>
</tr>
</tbody>
</table>

Post = 16.155 + 0.787 x Pre

Y’ = (.787) (45) + 15.6458 = 51.56
11. The equation for a regression line predicting the number of hours of TV watched by children (Y) from the number of hours of TV watched by their parents (X) is \( Y' = 4 + 1.2X \). The sample size is 12.

   a. If the standard error of b is .4, is the slope statistically significant at the .05 level?
   b. If the mean of X is 8, what is the mean of Y?
      a) \( t = 3, p = 0.0133 \), significant
      b) 13.6

12. Based on the table below, compute the regression line that predicts Y from X.

<table>
<thead>
<tr>
<th>M_X</th>
<th>M_Y</th>
<th>s_X</th>
<th>s_Y</th>
<th>r</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>12</td>
<td>2.5</td>
<td>3.0</td>
<td>-0.6</td>
</tr>
</tbody>
</table>

\[ Y' = 19.2 - 0.72X \]

13. Does A or B have a larger standard error of the estimate?

sem: B is larger

14. True/false: If the slope of a simple linear regression line is statistically significant, then the correlation will also always be significant.

True
15. True/false: If the slope of the relationship between X and Y is larger for Population 1 than for Population 2, the correlation will necessarily be larger in Population 1 than in Population 2. Why or why not?
   False, other factors such as variance affect r.

16. True/false: If the correlation is .8, then 40% of the variance is explained.
   False

17. True/false: If the actual Y score was 31, but the predicted score was 28, then the error of prediction is 3.
   True

Questions from Case Studies

Angry Moods (AM) case study

18. (AM) Find the regression line for predicting Anger-Out from Control-Out.
   a. What is the slope?
   b. What is the intercept?
   c. Is the relationship at least approximately linear?
   d. Test to see if the slope is significantly different from 0.
   e. What is the standard error of the estimate?
      a) -0.524
      b) 28.495
      c) Yes
      d) t = 6.25, p < .001, significant
      e) 3.449

SAT and GPA (SG) case study

19. (SG) Find the regression line for predicting the overall university GPA from the high school GPA.
   a. What is the slope?
b. What is the y-intercept?
c. If someone had a 2.2 GPA in high school, what is the best estimate of his or her college GPA?
d. If someone had a 4.0 GPA in high school, what is the best estimate of his or her college GPA?
   a) 0.675  
   b) 1.097  
   c) 2.58  
   d) 3.797

Driving (D) case study

20. (D) What is the correlation between age and how often the person chooses to drive in inclement weather? Is this correlation statistically significant at the .01 level? Are older people more or less likely to report that they drive in inclement weather?
   \[ r = .439, p = .0004, \text{significant}. \] Older people are less likely to drive in bad weather.

21. (D) What is the correlation between how often a person chooses to drive in inclement weather and the percentage of accidents the person believes occur in inclement weather? Is this correlation significantly different from 0?
   \[ r = -.143, p = .271. \] Correlation is not significant.

22. (D) Use linear regression to predict how often someone rides public transportation in inclement weather from what percentage of accidents that person thinks occur in inclement weather. (Pubtran by Accident)
   (a) Create a scatter plot of this data and add a regression line.
   (b) What is the slope?
   (c) What is the intercept?
   (d) Is the relationship at least approximately linear?
   (e) Test if the slope is significantly different from 0.
   (f) Comment on possible assumption violations for the test of the slope.
   (g) What is the standard error of the estimate?
b) 0.347

c) 0.594

d) The relationship seems to have a linear component, but may not be entirely linear.

e) p = .026, significant

f) There are possible linearity and homoscedasticity violations.

g) 30.286
Chapter 15 ANOVA

1. What is the null hypothesis tested by analysis of variance?
   The null hypothesis tested by ANOVA is that all the population means are equal.

2. What are the assumptions of between-subjects analysis of variance?
   (1) homogeneity of variance
   (2) normal distribution of populations
   (3) independent values (each subject give only one score)

3. What is a between-subjects variable?
   A between subjects variable is one for which different subjects are used to obtain different scores for multiple levels of the same variable (factor).

4. Why not just compute t-tests among all pairs of means instead computing an analysis of variance?
   Computing individual t-tests for all pairs of means increases the familywise error rate and the probability of committing a type I error.

5. What is the difference between “N” and “n”?
   “n” is the number of observations in each group while “N” is the total number observations.

6. How is it that estimates of variance can be used to test a hypothesis about means?
   The test of a hypothesis about means is based on two estimates of population variance: the first is the mean square error that is based on the difference among scores within groups and estimates the variance; the second is the mean square between that is based on differences among the sample means.

7. Explain why the variance of the sample means has to be multiplied by “n” in the computation of MS\text{between}.
Since MSB is an estimate of population variance based on the sample means multiplying by “n” counters the property of the sampling distribution of the mean where its variances decreases as “n” increases.

8. What kind of skew does the F distribution have?
   
   positive

9. When do MS\text{between} and MS\text{error} estimate the same quantity?
   
   When population means are equal.

10. If an experiment is conducted with 5 conditions and 6 subjects in each condition, what are df\text{n} and df\text{e}?

   \[ df_n = 5-1 = 4. \]

   \[ df_e = 6 \times 5 - 5 = 25, \text{ or } 5(6-1) = 25. \]

11. How is the shape of the F distribution affected by the degrees of freedom?

   Greater degrees of freedom reduce the skew of the F distribution.

12. What are the two components of the total sum of squares in a one-factor between-subjects design?

   The sum of squares for condition and the sum of squares error.

13. How is the mean square computed from the sum of squares?

   The mean square is computed by dividing the sum of squares by the degrees of freedom.

14. An experimenter is interested in the effects of two independent variables on self esteem. What is better about conducting a factorial experiment than conducting two separate experiments, one for each independent variable?

   A factorial experiment can be used to detect interactions between the independent variables as they relate to self esteem.

15. An experiment is conducted on the effect of age (5 yr, 10 yr and 15 yr) and treatment condition (experimental versus control) on reading speed. Which statistical term (main effect, simple effect, interaction, specific comparison) applies to each of the descriptions of effects.
a. The effect of the treatment was larger for 15-year olds than it was for 5- or 10-year olds.

b. Overall, subjects in the treatment condition performed faster than subjects in the control condition.

c. The age effect was significant under the treatment condition.

d. The difference between the 15-year olds and the average of the 5- and 10-year olds was significant.

e. As they grow older, children read faster.

a) interaction
b) main effect
c) simple effect
d) specific comparison
e) main effect

16. An A(3) x B(4) factorial design with 6 subjects in each group is analyzed. Give the source and degrees of freedom columns of the analysis of variance summary table.

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2</td>
</tr>
<tr>
<td>B</td>
<td>3</td>
</tr>
<tr>
<td>A X B</td>
<td>6</td>
</tr>
<tr>
<td>Error</td>
<td>60</td>
</tr>
</tbody>
</table>

17. The following data are from a hypothetical study on the effects of age and time on scores on a test of reading comprehension. Compute the analysis of variance summary table.
<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SSQ</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>age</td>
<td>1</td>
<td>2000</td>
<td>2000</td>
<td>47.28</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>time</td>
<td>1</td>
<td>793.8</td>
<td>793.8</td>
<td>18.77</td>
<td>.001</td>
</tr>
<tr>
<td>age x time</td>
<td>1</td>
<td>336.2</td>
<td>336.2</td>
<td>7.95</td>
<td>.012</td>
</tr>
<tr>
<td>Error</td>
<td>16</td>
<td>676.8</td>
<td>42.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>19</td>
<td>3806.8</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

18. Define “Three-way interaction”
   This occurs when a two-way interaction is a function of a third factor.

19. Define interaction in terms of simple effects.
   An interaction occurs when there is a difference between simple effects.

20. Plot an interaction for an A(2) x B(2) design in which the effect of B is greater at A1 than it is at A2. The dependent variable is “Number correct.” Make sure to label both axes.
21. Following are two graphs of population means for 2 x 3 designs. For each graph, indicate which effect(s) (A, B, or A x B) are nonzero.

**Graph a:** A x B is nonzero

**Graph b:** A and B are nonzero

22. The following data are from an A(2) x B(4) factorial design.
a. Compute an analysis of variance.
b. Test differences among the four levels of B using the Bonferroni correction.
c. Test the linear component of trend for the effect of B.
d. Plot the interaction.
e. Describe the interaction in words.

\[
\begin{array}{|c|c|c|c|c|}
\hline
& A1 & & & \\
& 1 & 2 & 3 & 4 \\
& 3 & 2 & 4 & 5 \\
& 4 & 4 & 2 & 6 \\
& 5 & 5 & 6 & 8 \\
\hline
& A2 & & & \\
& 1 & 2 & 4 & 8 \\
& 1 & 3 & 6 & 9 \\
& 2 & 2 & 7 & 9 \\
& 2 & 4 & 8 & 8 \\
\hline
\end{array}
\]

a) Source | df | SSQ | MS | F     | p  \\
a | 1   | 4.5 | 4.5 | 2.32  | .141  \\
b | 3   | 110.75 | 36.92 | 19.05 | < .001  \\
a x b | 3   | 29.75 | 9.92 | 5.12  | .007  \\
Error | 24  | 46.5 | 1.94 | | \\
Total | 31  | 191.5 | | | \\

b) p (6 times uncorrected t)

1-2 | 1 | not significant \\
1-3 | .006 | significant \\
1-4 | <.001 | significant \\
2-3 | .054 | not significant \\
2-4 | <.001 | significant \\
3-4 | .033 | significant
c) \( t = 7.38, p < .001, \) significant.

d)

e) The dependent variable increases at a more rapid rate across categories of “b” in level 2 of “a.”

23. Why are within-subjects designs usually more powerful than between-subjects design?

Within-subjects designs control for individual differences between subjects.

24. What source of variation is found in an ANOVA summary table for a within-subjects design that is not in in an ANOVA summary table for a between-subjects design. What happens to this source of variation in a between-subjects design?

"Subjects" is not a source of variation in between-subjects designs. It goes into the error term.
25. The following data contain three scores from each of five subjects. The three scores per subject are their scores on three trials of a memory task.

<table>
<thead>
<tr>
<th></th>
<th>4</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>6</td>
<td>9</td>
</tr>
</tbody>
</table>

a. Compute an ANOVA
b. Test all pairwise differences between means using the Bonferroni test at the .01 level.
c. Test the linear and quadratic components of trend for these data.
   a) F = 13.94, p = .002
   b) alpha = .01/3 = .003
   Grp 1 - Grp 2 .01 Not significant
   Grp 1 - Grp 3 .002 significant
   Grp 2 - Grp 3 .512 Not significant
   c) Linear: F = 51.88, p = .002
      Quadratic: F = 2.07, p = .223

26. Give the source and df columns of the ANOVA summary table for the following experiments:
   a. Twenty two subjects are each tested on a simple reaction time task and on a choice reaction time task.
   b. Twelve male and 12 female subjects are each tested under three levels of drug dosage: 0 mg, 10 mg, and 20 mg.
   c. Twenty subjects are tested on a motor learning task for three trials a day for two days.
   d. An experiment is conducted in which depressed people are either assigned to a drug therapy group, a behavioral therapy group, or a control group. Ten subjects are assigned to each group. The level of measured once a month for four months.
a)  
Source | df  
--- | ---  
Subjects | 21  
Time | 1  
Error | 21  
Total | 43  

b)  
Source | df  
--- | ---  
Gender | 1  
Error | 22  
Dosage | 2  
Gender x Dosage | 2  
Error | 44  

c)  
Source | df  
--- | ---  
Subjects | 19  
Day | 1  
Error (Day) | 19  
Trial | 2  
Error (Trial) | 38  
Day x Trial | 2  
Error (Day x Trial) | 38  

d)  
Source | df  
--- | ---  
Groups | 2  
Error | 27  

Questions from Case Studies

*Stroop Interference (S) case study*

27. (S) The dataset Stroop Interference has the scores (times) for males and females on each of three tasks.

a. Do a Gender (2) x Task (3) analysis of variance.

b. Plot the interaction.

a)

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SSQ</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>ge</td>
<td>1</td>
<td>83.3247</td>
<td>83.3247</td>
<td>1.9939</td>
<td>0.1648</td>
</tr>
<tr>
<td>Error</td>
<td>45</td>
<td>1880.5618</td>
<td>41.7903</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DV</td>
<td>2</td>
<td>9525.9733</td>
<td>4762.9867</td>
<td>228.0551</td>
<td>0.0000</td>
</tr>
<tr>
<td>gexDV</td>
<td>2</td>
<td>55.8457</td>
<td>27.9228</td>
<td>1.3170</td>
<td>0.2678</td>
</tr>
<tr>
<td>Error</td>
<td>90</td>
<td>1879.6720</td>
<td>20.8852</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

b) 

*Figure 1. Response time as a function of Task*
**ADHD Treatment (AT) case study**

28. (AT) The dataset ADHD Treatment has four scores per subject. a. Is the design between-subjects or within-subjects? b. Create an ANOVA summary table.

a) within-subjects design.

b)

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SSQ</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subjects</td>
<td>23</td>
<td>9065.4896</td>
<td>394.1517</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DV</td>
<td>3</td>
<td>557.6146</td>
<td>185.8715</td>
<td>5.1785</td>
<td>0.0028</td>
</tr>
<tr>
<td>Error</td>
<td>69</td>
<td>2476.6354</td>
<td>35.8933</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>95</td>
<td>12099.7396</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

29. (AT) Using the Anger Expression Index from the Angry Moods study as the dependent variable, perform a 2x2 ANOVA with gender and sports participation as the two factors. Do athletes and non-athletes differ significantly in how much anger they express? Do the genders differ significantly in Anger Expression Index? Is the effect of sports participation significantly different for the two genders?

Athletes and non-athletes differ significantly in how much anger they express. The genders do not differ significantly in how much anger they express. The effect of sports participation is not significantly different for the two genders.

**Weapons and Aggression (WA) case study**

30. (WA) Using the Weapons and Aggression data, Compute a 2x2 ANOVA with the following two factors: prime type (was the first word a weapon or not?) and word type (was the second word aggressive or non-aggressive?). Consider carefully whether the variables are between-subject or within-subjects variables.
Smiles and Leniency (SL) case study

31. (SL) Compute the ANOVA summary table for the smiles and leniency data.

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SSQ</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>pr</td>
<td>1</td>
<td>276.1250</td>
<td>276.1250</td>
<td>1.8978</td>
<td>0.1782</td>
</tr>
<tr>
<td>Error</td>
<td>31</td>
<td>4510.3750</td>
<td>145.4960</td>
<td></td>
<td></td>
</tr>
<tr>
<td>wo</td>
<td>1</td>
<td>45.1250</td>
<td>45.1250</td>
<td>0.2165</td>
<td>0.6449</td>
</tr>
<tr>
<td>Error</td>
<td>31</td>
<td>6460.3750</td>
<td>208.3992</td>
<td></td>
<td></td>
</tr>
<tr>
<td>prxwo</td>
<td>1</td>
<td>569.5313</td>
<td>569.5313</td>
<td>4.6499</td>
<td>0.0389</td>
</tr>
<tr>
<td>Error</td>
<td>31</td>
<td>3796.9688</td>
<td>122.4829</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Smiles and Leniency (SL) case study

31. (SL) Compute the ANOVA summary table for the smiles and leniency data.

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SSQ</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>smile</td>
<td>3</td>
<td>27.5349</td>
<td>9.1783</td>
<td>3.4650</td>
<td>0.0182</td>
</tr>
<tr>
<td>Error</td>
<td>132</td>
<td>349.6544</td>
<td>2.6489</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>135</td>
<td>377.1893</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
1. When is a log transformation valuable?

When it makes the relationship between variables clearer. Also acceptable is when it reduces skew.

2. If the arithmetic mean of \( \log_{10} \) transformed data were 3, what would be the geometric mean?

1,000

3. Using Tukey's ladder of transformation, transform the following data using a \( \lambda \) of 0.5: 9, 16, 25

3, 4, 5

4. What value of \( \lambda \) in Tukey's ladder decreases skew the most?

-2

5. What value of \( \lambda \) in Tukey's ladder increases skew the most?

2
6. In the ADHD case study, transform the data in the placebo condition (D0) with λ's of .5, 0, -.5, and -1. How does the skew in each of these compare to the skew in the raw data. Which transformation leads to the least skew?

They all reduce skew. Skew is reduced most with λ = -1.
Chapter 17: Chi-square

1. Which of the two Chi Square distributions shown below (A or B) has the larger degrees of freedom? How do you know?

Distribution B has the larger degrees of freedom, because it is less skewed and has a higher mean.

2. Twelve subjects were each given two flavors of ice cream to taste and then were asked whether they liked them. Two of the subjects liked the first flavor and nine of them liked the second flavor. Is it valid to use the Chi Square test to determine whether this difference in proportions is significant? Why or why not?

Chi square would not be appropriate in this case. The proportions being compared are within-subject and thus are not independent of each other.
3. A die is suspected of being biased. It is rolled 25 times with the following result:

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
</tr>
</tbody>
</table>

Conduct a significance test to see if the die is biased. (a) What Chi Square value do you get and how many degrees of freedom does it have? (b) What is the p value?

\[
\text{Chi Square} = 16.04, \text{ df} = 5, \text{ p} = .007
\]

4. A recent experiment investigated the relationship between smoking and urinary incontinence. Of the 322 subjects in the study who were incontinent, 113 were smokers, 51 were former smokers, and 158 had never smoked. Of the 284 control subjects who were not incontinent, 68 were smokers, 23 were former smokers, and 193 had never smoked.

a. Create a table displaying this data.

<table>
<thead>
<tr>
<th></th>
<th>Smokers</th>
<th>Former Smokers</th>
<th>Never Smoked</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incontinent</td>
<td>113</td>
<td>51</td>
<td>158</td>
<td>322</td>
</tr>
<tr>
<td>Not incontinent</td>
<td>68</td>
<td>23</td>
<td>193</td>
<td>284</td>
</tr>
<tr>
<td>Total</td>
<td>181</td>
<td>74</td>
<td>351</td>
<td></td>
</tr>
</tbody>
</table>

b. What is the expected frequency in each cell?

c. Conduct a significance test to see if there is a relationship between smoking and incontinence. What Chi Square value do you get? What p value do you get?

d. What do you conclude?

a)
c) Chi Square = 22.97, p < .001

d) Reject the null hypothesis and conclude that there is a significant relationship between smoking and urinary incontinence.

5. At a school pep rally, a group of sophomore students organized a free raffle for prizes. They claim that they put the names of all of the students in the school in the basket and that they randomly drew 36 names out of this basket. Of the prize winners, 6 were freshmen, 14 were sophomores, 9 were juniors, and 7 were seniors. The results do not seem that random to you. You think it is a little fishy that sophomores organized the raffle and also won the most prizes. Your school is composed of 30% freshmen, 25% sophomores, 25% juniors, and 20% seniors.

a. What are the expected frequencies of winners from each class?

b. Conduct a significance test to determine whether the winners of the prizes were distributed throughout the classes as would be expected based on the percentage of students in each group. Report your Chi Square and p values.

c. What do you conclude?

a) 
Freshmen = 10.8
Sophomores = 9
Juniors = 9
Seniors = 7.2

b) Chi Square = 4.92, p = 0.18

c) Fail to reject the null hypothesis, the observed frequencies and expected frequencies are not significantly different.

6. Some parents of the West Bay little leaguers think that they are noticing a pattern. There seems to be a relationship between the number on the kids’ jerseys and their position. These parents decide to record what they see. The hypothetical

| Incontinent | 96.17 | 39.32 | 186.5 | 322 |
| Not incontinent | 84.83 | 34.68 | 164.5 | 284 |
| Total | 181 | 74 | 351 |
data appear below. Conduct a Chi Square test to determine if the parents’ suspicion that there is a relationship between jersey number and position is right. Report your Chi Square and p values.

**Chi Square = 10.23, p = .037**

<table>
<thead>
<tr>
<th></th>
<th>Infield</th>
<th>Outfield</th>
<th>Pitcher</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-9</td>
<td>12</td>
<td>5</td>
<td>5</td>
<td>22</td>
</tr>
<tr>
<td>10-19</td>
<td>5</td>
<td>10</td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>20+</td>
<td>4</td>
<td>4</td>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td>Total</td>
<td>21</td>
<td>19</td>
<td>14</td>
<td>54</td>
</tr>
</tbody>
</table>

7. True/false: A Chi Square distribution with 2 df has a larger mean than a Chi Square distribution with 12 df.

   **False**

8. True/false: A Chi Square test is often used to determine if there is a significant relationship between two continuous variables.

   **False**

9. True/false: Imagine that you want to determine if the spinner shown below is biased. You spin it 50 times and write down how many times the arrow lands in each section. You will reject the null hypothesis at the .05 level and determine that this spinner is biased if you calculate a Chi Square value of 7.82 or higher.

   **True**
Questions from Case Studies

SAT and GPA (SG) case study

10. (SG) Answer these items to determine if the math SAT scores are normally distributed. You may want to first standardize the scores.
   
a. If these data were normally distributed, how many scores would you expect there to be in each of these brackets: (i) smaller than 1 SD below the mean, (ii) in between the mean and 1 SD below the mean, (iii) in between the mean and 1 SD above the mean, (iv) greater than 1 SD above the mean?
   
b. How many scores are actually in each of these brackets?
   
c. Conduct a Chi Square test to determine if the math SAT scores are normally distributed based on these expected and observed frequencies.

<table>
<thead>
<tr>
<th>Group</th>
<th>Expected</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; -1 SD</td>
<td>16.8</td>
<td>24</td>
</tr>
<tr>
<td>-1 to 0 SD</td>
<td>35.7</td>
<td>36</td>
</tr>
<tr>
<td>0 to 1 SD</td>
<td>35.7</td>
<td>19</td>
</tr>
<tr>
<td>&gt; 1 SD</td>
<td>16.8</td>
<td>26</td>
</tr>
</tbody>
</table>

   c) Chi-square = 15.94, p = .001. Scores are not normally distributed.

Diet and Health (DH) case study

11. (DH) Conduct a Pearson Chi Square test to determine if there is any relationship between diet and outcome. Report the Chi Square and p values and state your conclusions.

   Chi-square = 16.55, p = .001. There is a significant relationship between diet and outcome.

The following questions are from ARTIST (reproduced with permission)
12. A study compared members of a medical clinic who filed complaints with a random sample of members who did not complain. The study divided the complainers into two subgroups: those who filed complaints about medical treatment and those who filed nonmedical complaints. Here are the data on the total number in each group and the number who voluntarily left the medical clinic. Set up a two-way table. Analyze these data to see if there is a relationship between complaint (no, yes - medical, yes - nonmedical) and leaving the clinic (yes or no).

<table>
<thead>
<tr>
<th></th>
<th>No Complaint</th>
<th>Medical Complaint</th>
<th>Nonmedical Complaint</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td>743</td>
<td>199</td>
<td>440</td>
</tr>
<tr>
<td><strong>Left</strong></td>
<td>22</td>
<td>26</td>
<td>28</td>
</tr>
</tbody>
</table>

Chi Square = 27.34, p < .001, There is a significant relationship between complaint and leaving the clinic.

13. Imagine that you believe there is a relationship between a person’s eye color and where he or she prefers to sit in a large lecture hall. You decide to collect data from a random sample of individuals and conduct a chi-square test of independence. What would your two-way table look like? Use the information to construct such a table, and be sure to label the different levels of each category.

<table>
<thead>
<tr>
<th></th>
<th>Eye Color 1</th>
<th>Eye Color 2</th>
<th>Eye Color 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Front</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Middle</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Back</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
14. A geologist collects hand-specimen sized pieces of limestone from a particular area. A qualitative assessment of both texture and color is made with the following results. Is there evidence of association between color and texture for these limestones? Explain your answer.

<table>
<thead>
<tr>
<th>Texture</th>
<th>Colour</th>
<th>Light</th>
<th>Medium</th>
<th>Dark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fine</td>
<td>4</td>
<td>20</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td>5</td>
<td>23</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Coarse</td>
<td>21</td>
<td>23</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

Chi Square = 17.73, p = .001, The test indicates that there is a significant association between the color and texture of the limestones.

15. Suppose that college students are asked to identify their preferences in political affiliation (Democrat, Republican, or Independent) and in ice cream (chocolate, vanilla, or strawberry). Suppose that their responses are represented in the following two-way table (with some of the totals left for you to calculate).

<table>
<thead>
<tr>
<th></th>
<th>Chocolate</th>
<th>Vanilla</th>
<th>Strawberry</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Democrat</td>
<td>26</td>
<td>43</td>
<td>13</td>
<td>82</td>
</tr>
<tr>
<td>Republican</td>
<td>45</td>
<td>12</td>
<td>8</td>
<td>65</td>
</tr>
<tr>
<td>Independent</td>
<td>9</td>
<td>13</td>
<td>4</td>
<td>26</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>80</strong></td>
<td><strong>68</strong></td>
<td><strong>25</strong></td>
<td><strong>173</strong></td>
</tr>
</tbody>
</table>

a. What proportion of the respondents prefer chocolate ice cream?
b. What proportion of the respondents are Independents?
c. What proportion of Independents prefer chocolate ice cream?
d. What proportion of those who prefer chocolate ice cream are Independents?
e. Analyze the data to determine if there is a relationship between political party preference and ice cream preference.

a) 46%
b) 15%
c) 35%
d) 11%
e) Chi Square = 23.81, p < .001, there is a statistically significant relationship between political affiliation and ice cream preference.
16. NCAA collected data on graduation rates of athletes in Division I in the mid-1980s. Among 2,332 men, 1,343 had not graduated from college, and among 959 women, 441 had not graduated.

a. Set up a two-way table to examine the relationship between gender and graduation.

b. Identify a test procedure that would be appropriate for analyzing the relationship between gender and graduation. Carry out the procedure and state your conclusion

a) 

<table>
<thead>
<tr>
<th></th>
<th>Graduated</th>
<th>Not Graduated</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td>989</td>
<td>1,343</td>
<td>2,332</td>
</tr>
<tr>
<td>Women</td>
<td>518</td>
<td>441</td>
<td>959</td>
</tr>
<tr>
<td>Totals</td>
<td>1507</td>
<td>1784</td>
<td>3291</td>
</tr>
</tbody>
</table>

b) Chi Square = 36.87, p < .001, there is a significant relationship between Gender and graduation.
Chapter 18: Distribution Free Tests

1. For the following data, how many ways could the data be arranged (including the original arrangement) so that the advantage of the Experimental Group mean over the Control Group mean is as large or larger than the original arrangement.

<table>
<thead>
<tr>
<th>Experimental</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>15</td>
<td>3</td>
</tr>
<tr>
<td>16</td>
<td>4</td>
</tr>
<tr>
<td>17</td>
<td>9</td>
</tr>
</tbody>
</table>

2

2. For the data in Problem 1, how many ways can the data be rearranged?

252

3. What is the one-tailed probability for a test of the difference.

0.0079

4. For the following data, how many ways can the data be rearranged?

<table>
<thead>
<tr>
<th>T1</th>
<th>T2</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>14</td>
<td>0</td>
</tr>
<tr>
<td>8</td>
<td>19</td>
<td>2</td>
</tr>
<tr>
<td>11</td>
<td>21</td>
<td>5</td>
</tr>
</tbody>
</table>

1680

5. In general, are rank randomization tests or randomization tests more powerful?

randomization tests
6. What is the advantage of rank randomization tests over randomization tests?

   There are tables for rank randomization tests

7. Test whether the differences among conditions for the data in Problem 1 is significant (one tailed) at the .01 level using a rank randomizaton test.

   rank sum = 39 which is significant at .01

Questions from Case Studies

SAT and GPA (SG) case study

8. (SG) Compute Spearman's ρ for the relationship between UGPA and SAT.

   0.716

Stereograms (S) case study

9. (S) Test the difference in central tendency between the two conditions using a rank-randomization test (with the normal approximation) with a one-tailed test. Give the Z and the p.

   Z = 2.21, p = 0.0271

Smiles and Leniency (SL) case study

10. (SL) Test the difference in central tendency between the four conditions using a rank-randomization test (with the normal approximation). Give the Chi Square and the p.

    Chi Square 9.1747, p = .0271
Chapter 19: Effect Size

1. If the probability of a disease is .34 without treatment and .22 with treatment then what is the
   (a) absolute risk reduction
   (b) relative risk reduction
   (c) Odds ratio
   (d) Number needed to treat
   a) 0.12
   b) 35.294
   c) 1.8264
   d) 8.33

2. When is it meaningful to compute the proportional difference between means?
   When the dependent variable is measured on a ratio scale

3. The mean for an experimental group is 12, the mean for the control group were 8, the MSE from the ANOVA is 16, and N, the number of observations is 20, compute g and d.
   g = 1, d = 1.054

4. Two experiments investigated the same variables but one of the experiment had subject who differed greatly from each other whereas the subjects in the other experiment were relatively homogeneous. Which experiment would likely have the larger value of g?
   The one with the more homogeneous subjects.

5. Why is $\omega^2$ preferable to $\eta^2$?
   $\eta^2$ has a positive bias.

6. What is the difference between $\eta^2$ and partial $\eta^2$?
   $\eta^2$ is the proportion of variance explained. Partial $\eta^2$ is the proportion of variance explained not counting the variance explained by other independent variables.
Questions from Case Studies

*Teacher Ratings (TR)*

7. (TR) What are the values of d and g?
   \[ g = .70; \quad d = .72 \]

8. (TR) What are the values of \( \omega^2 \) and \( \eta^2 \)?
   \[ \eta^2 = .11; \quad \omega^2 = .09 \]

*Smiles and Leniency (SL)*

9. (SL) What are the values of \( \omega^2 \) and \( \eta^2 \)?
   \[ \eta^2 = .07; \quad \omega^2 = .05 \]

*Obesity and Bias (OB)*

10. For compute \( \omega^2 \) and partial \( \omega^2 \) for the effect of "Weight" in a "Weight x Relatedness" ANOVA.
    \[ \omega^2 = .028; \quad \text{partial } \omega^2 = .029 \]