Chapter **1**

A Review of Basic Concepts (Optional)

1.1 a. High school GPA is a number usually between 0.0 and 4.0. Therefore, it is quantitative.

b. Country of citizenship: USA, Japan, etc is qualitative

c. The scores on the SAT's are numbers between 200 and 800. Therefore, it is quantitative.

d. Gender is either male or female. Therefore, it is qualitative.

e. Parent's income is a number: $25,000, $45,000, etc. Therefore, it is quantitative.

f. Age is a number: 17, 18, etc. Therefore, it is quantitative.

1.2 a. The experimental units are the new automobiles. The model name, manufacturer, type of transmission, engine size, number of cylinders, estimated city miles/gallon, and estimated highway miles are measured on each automobile.

b. Model name, manufacturer, and type of transmission are qualitative. None of these is measured on a numerical scale. Engine size, number of cylinders, estimated city miles/gallon, and estimated highway miles/gallon are all quantitative. Each of these variables is measured on a numerical scale.

1.3 a. The variable of interest is earthquakes.

b. Type of ground motion is qualitative since the three motions are not on a numerical scale. Earthquake magnitude and peak ground acceleration are quantitative. Each of these variables are measured on a numerical scale.

1.4 a. The experimental unit is the object that is measured in the study. In this study, we are measuring surgical patients.

b. The variable that was measured was whether the surgical patient used herbal or alternative medicines against their doctor's advice before surgery.

c. Since the responses to the variable were either Yes or No, this variable is qualitative.

1.5 a. Town where sample collected is qualitative since this variable is not measured on a numerical scale.

b. Type of water supply is qualitative since this variable is not measured on a numerical scale.

c. Acidic level is quantitative since this variable is measured on a numerical scale (pH level 1 to 14).

d. Turbidity level is quantitative since this variable is measured on a numerical scale

e. Temperature quantitative since this variable is measured on a numerical scale.

f. Number of fecal coliforms per 100 millimeters is quantitative since this variable is measured on a numerical scale.

g. Free chlorine-residual(milligrams per liter) is quantitative since this variable is measured on a numerical scale.

h. Presence of hydrogen sulphide (yes or no) is qualitative since this variable is not measured on a numerical scale.

1.6 Gender and level of education are both qualitative since neither is measured on a numerical scale. Age, income, job satisfaction score, and Machiavellian rating score are all quantitative since they can be measured on a numerical scale.

1.7 a. The population of interest is all decision makers. The sample set is 155 volunteer students. Variables measured were the emotional state and whether to repair a very old car (yes or no).

b. Subjects in the guilty-state group are less likely to repair an old car.

1.8 a. The 500 surgical patients represent a sample. There are many more than 500 surgical patients.

b. Yes, the sample is representative. It says that the surgical patients were randomly selected.

1.9 a. The experimental units are the amateur boxers.

b. Massage or rest group are both qualitative; heart rate and blood lactate level are both quantitative.

c. There is no difference in the mean heart rates between the two groups of boxers (those receiving massage and those not receiving massage). Thus, massage did not affect the recovery rate of the boxers.

d. No. Only amateur boxers were used in the experiment. Thus, all inferences relate only to boxers.

1.10 a. The sample is the set of 505 teenagers selected at random from all U.S. teenagers

b. The population from which the sample was selected is the set of all teenagers in the U.S.

c. Since the sample was a random sample, it should be representative of the population.

d. The variable of interest is the topics that teenagers most want to discuss with their parents.

e. The inference is expressed as a percent of the population that want to discuss particular topics with their parents.

f. The "margin of error" is the measure of reliability. This margin of error measures the uncertainty of the inference.

1.11 a. The population is all adults in Tennessee. The sample is 575 study participants.

b. The number of years of education is quantitative since it can be measured on a numerical scale. The insomnia status (normal sleeper or chronic insomnia) is qualitative since it can not be measured on a numerical scale.

c. Less educated adults are more likely to have chronic insomnia.

1.12 a. The population of interest is the Machiavellian traits in accountants.

b. The sample is 198 accounting alumni of a large southwestern university.

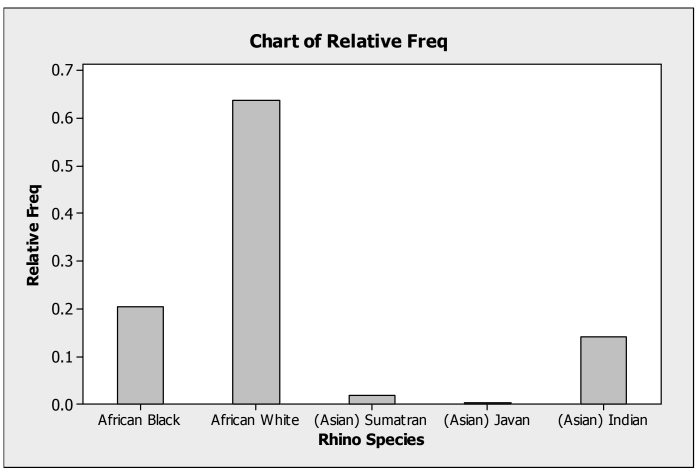
c. The Machiavellian behavior is not necessary to achieve success in the accounting profession.

d. Non-response could bias the results by not including potential other important information that could direct the researcher to a conclusion.

1.13 a.

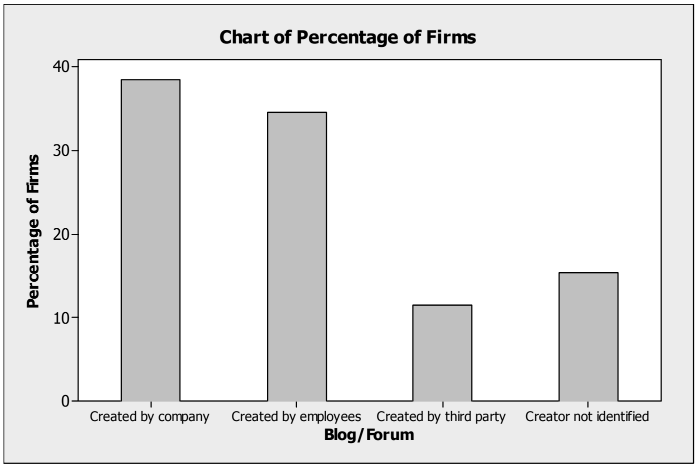
Rhino Species	**Population**	**Relative Freq**
African Black	3610	0.203
African White	11330	0.637
(Asian) Sumatran	300	0.017
(Asian) Javan	60	0.003
(Asian) Indian	2500	0.140

b.



c. African rhinos make up approximately 84% of all rhinos whereas Asian rhinos make up the remaining 16% of all rhinos.

1.14 The following bar chart shows a breakdown on the entity responsible for creating a blog/forum for a company who communicates through blogs and forums. It appears that most companies created their own blog/forum.

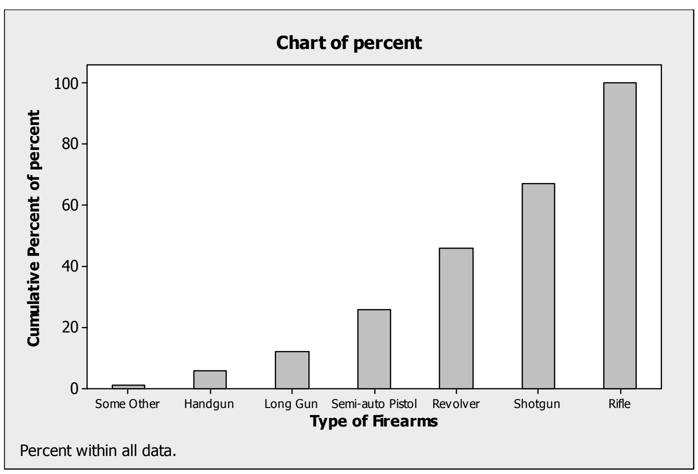


1.15 a. Pie chart

b. The type of firearms owned is the qualitative variable.

c. Rifle (33%), shotgun (21%), and revolver (20%) are the most common types of firearm.

d.

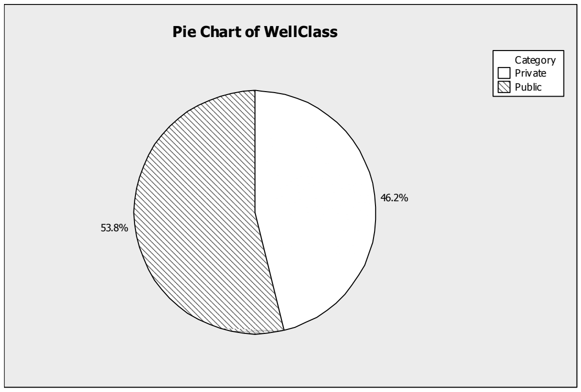


1.16 a. $\frac{196}{504} = 0.3889$ is the proportion of ice melt ponds that had landfast ice.

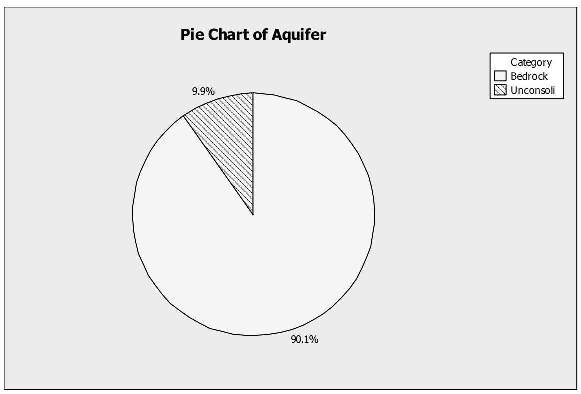
b. Yes, since $\frac{88}{504} = 0.1746$ is approximately 17%.

c. The multiyear ice type appears to be significantly different from the first-year ice melt.

1.17 a.


Pie Chart of WellClass
Category
Private
Public
46.2%
53.8%

b.


Pie Chart of Aquifer
Category
Bedrock
Unconsoli
9.9%
90.1%

c.

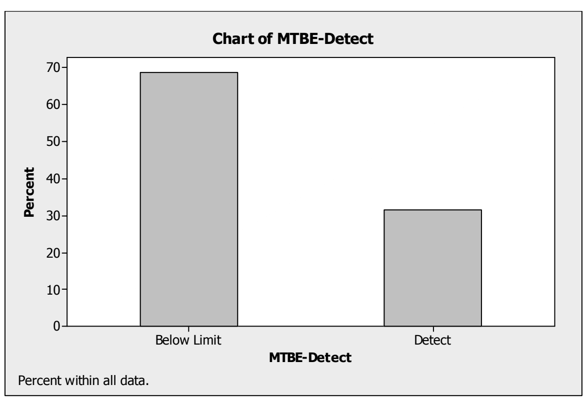
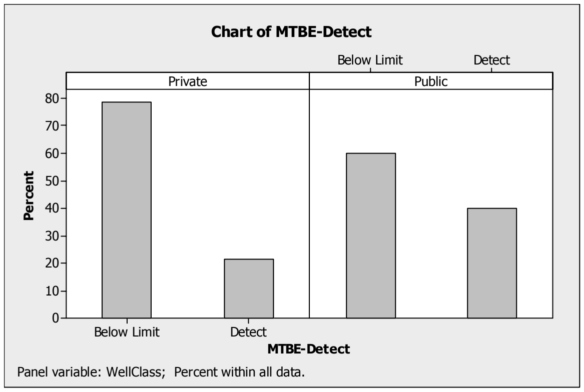


Chart of MTBE-Detect
Percent
70
60
50
40
30
20
10
0
Below Limit
Detect
MTBE-Detect
Percent within all data.

d.



Public wells (40%); Private wells (21%).

1.18 a. The estimated percentage of aftershocks measuring between 1.5 and 2.5 on the Richter scale is approximately 68%.

b. The estimated percentage of aftershocks measuring greater than 3.0 on the Richter scale is approximately 12%.

c. Data is skewed right.

1.19 a. A stem-and-leaf display of the data using MINITAB is:

Stem-and-leaf of FNE N = 25
Leaf Unit = 1.0

2	0	67
3	0	8
6	1	**0**01
10	1	**33**33
12	1	**4**5
(2)	1	**6**6
11	1	8**9**99
7	2	**0**0**11**
3	2	3
2	2	**45**

b. The numbers in bold in the stem-and-leaf display represent the bulimic students. Those numbers tend to be the larger numbers. The larger numbers indicate a greater fear of negative evaluation. Yes, the bulimic students tend to have a greater fear of negative evaluation.

c. A measure of reliability indicates how certain one is that the conclusion drawn is correct. Without a measure of reliability, anyone could just guess at a conclusion.

1.20 The data is slightly skewed to the right. The bulk of the PMI scores are below 8 with a few outliers.

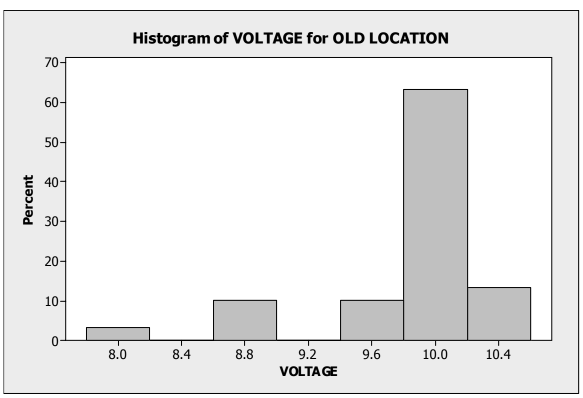
```
Stem-and-leaf of PMI  N  = 22
Leaf Unit = 0.10

1    3   3
5    4   1369
9    5   3558
(4)  6   0125
9    7   002
6    8
6    9
6    10  445
3    11  0
2    12
2    13
2    14  55
```

1.21 Yes.

1.22 a. To construct a relative frequency histogram, first calculate the range by subtracting the smallest data point (8.05) from the largest data point (10.55). Next, determine the

class width $= \frac{range}{\#ofclasses} = \frac{10.55 - 8.05}{7} = \frac{2.5}{7} = .4$. The classes are shown below:

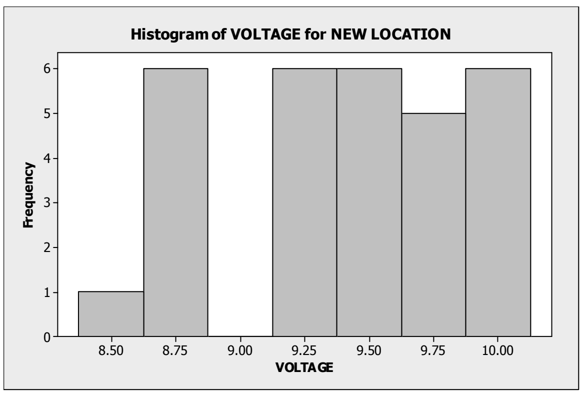
Class	Class Interval	Frequency	Relative Frequency
1	7.8 - < 8.2	1	1 / 30 = .03
2	8.2 - < 8.6	0	0 / 30 = .00
3	8.6 - < 9.0	3	3 / 30 = .10
4	9.0 - < 9.4	0	0 / 30 = .00
5	9.4 - < 9.8	3	3 / 30 = .10
6	9.8 - < 10.2	19	19 / 30 = .63
7	10.2 - < 10.6	4	4 / 30 = .13



b. The stem-and-leaf that is presented below is more informative since the actual values of the old location can be found. The histogram is useful if shape and spread of the data is what is needed, but the actual data points are absorbed in the graph.

```
Stem-and-leaf of VOLTAGE  LOCATION_OLD = 1    N  = 30
Leaf Unit = 0.10

 1    8   0
 1    8
 1    8
 3    8   77
 4    8   8
 4    9
 4    9
 5    9   5
 7    9   77
(10)  9   8888889999
 13   10  000000111
 4    10  222
 1    10  5
```

c.



d. The new process appears to be better than the old process since most of the voltage is greater than 9.2 volts.

1.23 a.

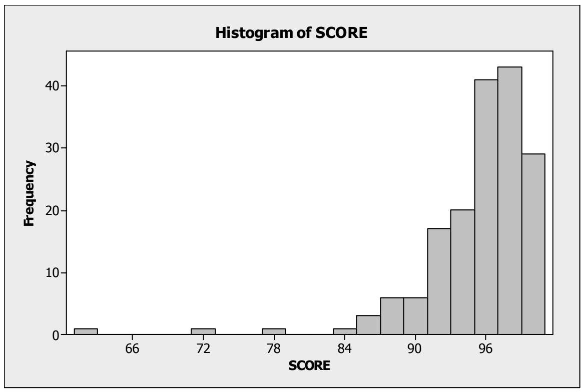
```
Stem-and-leaf of SCORE  N  = 169
Leaf Unit = 1.0

 1     6   2
 1     6
 2     7   2
 3     7   8
 4     8   4
 15    8   66677888899
 56    9   00001111111222222222233333333344444444444
(100)  9   5555555555555555555555666666666666666666667777777777777777778888888+
 13    10  0000000000000
```

b. .98 or 98 out of every 100 ships have a sanitation score that is at least 86.

c.

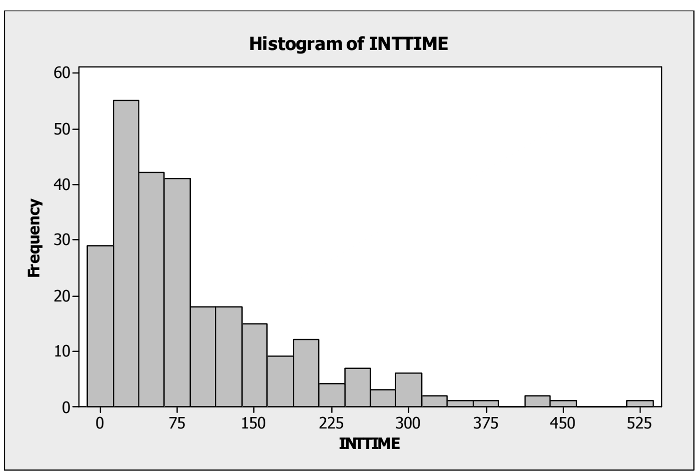
```
Stem-and-leaf of SCORE  N  = 169
Leaf Unit = 1.0

 1     6   2
 1     6
 2     7   2
 3     7   8
 4     8   4
 15    8   66677888899
 56    9   0000111111122222222222333333333344444444444
(100)  9   55555555555555555555555666666666666666666666777777777777777777888888+
 13    10  0000000000000
```

d.



e. Approximately 95% of the ships have an acceptable sanitation standard.

1.24 According to the histogram presented below, the data is skewed right. Answers may vary on whether the phishing attack against the organization was an "inside job."



1.25 a. 2.12; average magnitude for the aftershocks is 2.12.

b. 6.7; difference between the largest and smallest magnitude is 6.7.

c. .66; about 95% of the magnitudes fall in the interval mean $\pm$ 2(std. dev.) $= (.8, 3.4)$

d. $\mu =$ mean; $\sigma =$ Standard deviation

1.26 a. Tchebysheff's theorem best describes the nicotine content data set.

b. $\bar{y} \pm 2s \Rightarrow 0.8425 \pm 2(0.345525) \Rightarrow 0.8425 \pm 0.691050 \Rightarrow (0.15145,\ 1.53355)$

c. Tchebysheff's theorem states that at least 75% of the cigarettes will have nicotine contents within the interval.

d.. Using the histogram, it appears that approximately 7-8% of the nicotine contents fall outside the computed interval. This indicates that 92-93% of the nicotine contents fall inside the computed interval. Since this interval is just an approximation, the observed findings will be said to agree with the expected 95%.

1.27 a. $\bar{y} = 94.91$, s = 4.83

b. $\bar{y} \pm 2s = 94.91 \pm 2 * 4.83 \Rightarrow (85.25, 104.57)$.

c. .976; yes

1.28 a. $\bar{y} = 50.020$, $s = 6.444$.

b. 95% of the ages should be within $\bar{y} \pm 2 * s \Rightarrow 50.02 \pm 2 * 6.444 \Rightarrow (37.132, 62.908)$

1.29 a. The average daily ammonia concentration $\bar{y}$ =

$$\frac{\sum y_i}{n} = \frac{1.53+1.50+1.37+1.51+1.55+1.42+1.41+1.48}{8}$$

$$= \frac{11.77}{8} = 1.47 \text{ ppm}$$

b. $$s^2 = \frac{\sum y_i^2 - n\bar{y}^2}{n-1} = \frac{\sum y_i^2 - \frac{\left(\sum y_i\right)^2}{n}}{n-1}$$

$$= \frac{\left(1.53^2 + 1.50^2 + 1.37^2 + 1.51^2 + 1.55^2 + 1.42^2 + 1.41^2 + 1.48^2\right) - \frac{(11.77)^2}{8}}{8-1}$$

$$s^2 = \frac{17.3453 - \frac{(11.77)^2}{8}}{8-1} = \frac{.0287}{7} = .0041$$

$$s = \sqrt{s^2} = \sqrt{.0041} = .0640$$

We would expect about most of the daily ammonia levels to fall with
$\hat{y} \pm 2s \Rightarrow 1.47 \pm 2(.0640) \Rightarrow (1.34, 1.60)$ ppm.

c. The morning drive-time has more variable ammonia levels as it has the larger standard deviation.

1.30 Group T: $10.5 \pm 2*7.6 \Rightarrow (-4.7, 25.7)$

Group V: $3.9 \pm 2*7.5 \Rightarrow (-11.1, 18.9)$

Group C: $1.4 \pm 2*7.5 \Rightarrow (-13.6, 16.4)$

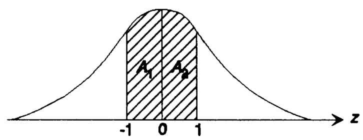
The patient is more likely to have come from Group T.

1.31 a. $(-111, 149)$

b. $(-91, 105)$

c. A student is more likely to get a 140-point increase on the SAT-Math test.

1.32 a. The probability that a normal random variable will lie between 1 standard deviation below the mean and 1 standard deviation above the mean is indicated by the shaded area in the figure:



The desired probability is:

$P(-1 \le z \le 1) = P(-1 \le z \le 0) + P(0 \le z \le 1) = A_1 + A_2.$

Now, $A_1 = P(-1 \le z \le 0)$

$= P(0 \le z \le 1)$ (by symmetry of the normal distribution)

$= .3413$ (from Table 1)

and $A_2 = P(0 \le z \le 1)$

$= .3413$ (from Table 1)

Thus, $P(-1 \le z \le 1) = .3413 + .3413 = .6826$

b. $P(-1.96 \le z \le 1.96) = P(-1.96 \le z \le 0) + P(0 \le z \le 1.96)$

$= P(0 \le z \le 1.96) + P(0 \le z \le 1.96) = .4750 + .4750 = .9500$

c. $P(-1.645 \le z \le 1.645) = P(-1.645 \le z \le 0) + P(0 \le z \le 1.645)$

$= P(0 \le z \le 1.645) + P(0 \le z \le 1.645)$

Now, $P(0 \le z \le 1.645) = \dfrac{P(0 \le z \le 1.64) + P(0 \le z \le 1.65)}{2}$

$= \dfrac{.4495 + .4505}{2} = .4500$

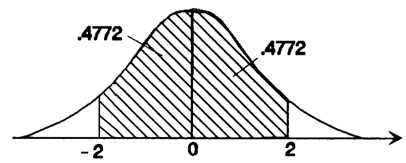
Thus, $P(-1.645 \le z \le 1.645) = .4500 + .4500 = .9000$

d. $P(-3 \le z \le 3) = P(-3 \le z \le 0) + P(0 \le z \le 3)$

$= P(0 \le z \le 3) + P(0 \le z \le 3) = .4987 + .4987 = .9974$

1.33 a. The z-score for $\mu-2\sigma$ is $z=\dfrac{(\mu-2\sigma)-\mu}{\sigma}=-2$

The z-score for $\mu+2\sigma$ is $z=\dfrac{(\mu+2\sigma)-\mu}{\sigma}=2$

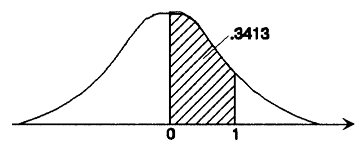


$P(\mu-2\sigma\le y\le\mu+2\sigma)\ =P(-2\le z\le 2)$
$=P(-2\le z\le 0)+P(0\le z\le 2)$

Using Table 1 in Appendix D, $P(-2\le z\le 0)=.4772$ and $P(0\le z\le 2)=.4772$.
So $P(\mu-2\sigma\le y\le\mu+2\sigma)=.4772+.4772=.9544$

b. The z-score for $y=108$ is $z=\dfrac{y-\mu}{\sigma}=\dfrac{108-100}{8}=1$

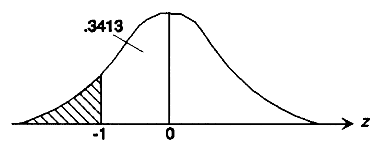
$P(y\ge 108)=P(z\ge 1)$



Using Table 1 of Appendix D, we find $P(0\le z\le 1)=.3413$, so
$P(z\ge 1)=.5-.3413=.1587$

c. The z-score for $y=92$ is $z=\dfrac{y-\mu}{\sigma}=\dfrac{92-100}{8}=-1$

$P(y\le 92)=P(z\le -1)$

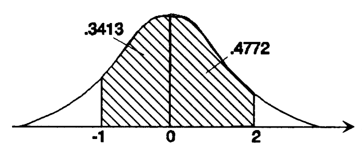


Using Table 1 of Appendix D, we find $P(-1\le z\le 0)=.3413$, so
$P(z\le -1)=.5-.3413=.1587$

d. The z-score for $y=92$ is $z=\dfrac{y-\mu}{\sigma}=\dfrac{92-100}{8}=-1$

The z-score for $y=116$ is $z=\dfrac{y-\mu}{\sigma}=\dfrac{116-100}{8}=2$

$P(92\le y\le 116)=P(-1\le z\le 2)$

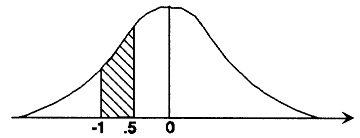


Using Table 1 of Appendix D, $P(-1\le z\le 0)=.3413$ and
$P(0\le z\le 2)=.4772$. So $P(92\le y\le 116)=P(-1\le z\le 2)$
$=.3413+.4772=.8185$.

e. The z-score for $y = 92$ is $z = \frac{y-\mu}{\sigma} = \frac{92-100}{8} = -1$

The z-score for $y = 96$ is $z = \frac{y-\mu}{\sigma} = \frac{96-100}{8} = -.5$

$P(92 \le y \le 96) = P(-1 \le z \le -.5)$

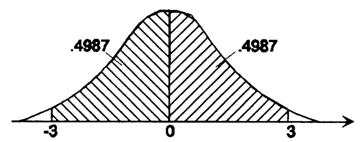


Using Table 1 of Appendix D, $P(-1 \le z \le 0) = .3413$ and $P(-.5 \le z \le 0) = .1915$. So $P(92 \le y \le 96)$ $= P(-1 \le z \le -.5) = .3413 - .1915 = .1498$.

f. The z-score for $y = 76$ is $z = \frac{y-\mu}{\sigma} = \frac{76-100}{8} = -3$

The z-score for $y = 124$ is $z = \frac{y-\mu}{\sigma} = \frac{124-100}{8} = 3$

$P(76 \le y \le 124) = P(-3 \le z \le 3)$



Using Table 1 of Appendix D, $P(-3 \le z \le 0) = .4987$ and $P(0 \le z \le 3) = .4987$. So $P(76 \le y \le 124) =$ $P(-3 \le z \le 3) = .4987 + .4987 = .9974$.

1.34 a. Let y = transmission delay of an RSVP liked to a wireless device. Using Table 1, Appendix D,

$$P(y < 57) = P\left(Z < \frac{57-48.5}{8.5}\right) = P(Z < 1.00) = 0.5 + 0.3413 = 0.8413$$

b. Using Table 1, Appendix D,

$$P(40 < y < 60) = P\left(\frac{40-48.5}{8.5} < Z < \frac{60-48.5}{8.5}\right) = P(-1.00 < Z < 1.35)$$
$$= 0.3413 + 0.4115 = 0.7528$$

1.35 a. Let x = alkalinity level of water specimens collected from the Han River.

Using Table 1, Appendix D,

$$P(y > 45) = P\left(z > \frac{45-50}{3.2}\right) = P(z > -1.56) = .5 + .4406 = .9406.$$

b. Using Table 1, Appendix D,

$$P(y < 55) = P\left(z < \frac{55-50}{3.2}\right) = P(z < 1.56) = .5 + .4406 = .9406.$$

c. Using Table 1, Appendix D,

$$P(51 < y < 52) = P\left(\frac{51-50}{3.2} < z < \frac{52-50}{3.2}\right) = P(.31 < z < .63) = .2357 - .1217 = .1140.$$

1.36 Half of 90% is 45%, so the Z score should be found to be 1.645 as in problem #33, when calculating a confidence interval instead of a Z score value of 2 for a 95% confidence interval. Therefore the range should be in either $64 \pm 1.645 * 2.6 \Rightarrow (59.72, 68.28)$.

1.37 a. Using Table 1, Appendix D,

$$P(40 < y < 50) = P\left(\frac{40-37.9}{12.4} < z < \frac{50-37.9}{12.4}\right) = P(.17 < z < .98)$$
$$= .3365 - .0675 = .2690.$$

b. Using Table 1, Appendix D,

$$P(y < 30) = P\left(z < \frac{30-37.9}{12.4}\right) = P(z < -.64) = .5 - .2389 = .2611.$$

c. We know that if $P(z_L < z < z_U) = .95$, then $P(z_L < z < 0) + P(0 < z < z_U) = .95$ and

$$P(z_L < z < 0) = P(0 < z < z_U) = .95/2 = .4750.$$

Using Table 1, Appendix D, $z_U = 1.96$ and $z_L = -1.96$.

$$P(y_L < y < y_U) = .95 \Rightarrow P\left(\frac{y_L - 37.9}{12.4} < z < \frac{y_U - 37.9}{12.4}\right) = .95$$

$$\Rightarrow \frac{y_L - 37.9}{12.4} = -1.96 \quad \text{and} \quad \frac{y_U - 37.9}{12.4} = 1.96$$

$$\Rightarrow y_L - 37.9 = -24.3 \quad \text{and} \quad y_U - 37.9 = 24.3 \Rightarrow y_L = 13.6 \text{ and } y_U = 62.2$$

1.38 a. Let y = gestation length. Using Table 1, Appendix D,

$$P(275.5 < y < 276.5) = P\left(\frac{275.5-280}{20} < z < \frac{276.5-280}{20}\right) = P(-.23 < z < -.18)$$
$$= .0910 - .0714 = .0196.$$

b. Using Table 1, Appendix D,

$$P(258.5 < y < 259.5) = P\left(\frac{258.5-280}{20} < z < \frac{259.5-280}{20}\right)$$
$$= P(-1.08 < z < -1.03) = .3599 - .3485 = .0114.$$

c. Using Table 1, Appendix D,

$$P(254.5 < y < 255.5) = P\left(\frac{254.5-280}{20} < z < \frac{255.5-280}{20}\right) = P(-1.28 < z < -1.23)$$
$$= .3997 - .3907 = .0090.$$

e. If births are independent, then

P(baby 1 is 4 days early ∩ baby 2 is 21 days early ∩ baby 3 is 25 days early)

= *P*(baby 1 is 4 days early) P(baby 2 is 21 days early) P(baby 3 is 25 days early)

$= .0196*.0114*.0090 \approx$ 2 / (1 million).

1.39 Using Table 1, Appendix D, $P(-1.5 < Z < 1.5) = 2*0.4332 = 0.8664$. Approximately 87% of the time *Six Sigma* will met their goal.

1.40 a. The relative frequency distribution is:

Value	Frequency	Relative Frequency
0	26	26/300 = .087
1	30	30/300 = .100
2	24	.080
3	29	.097
4	31	.103
5	25	.083
6	42	.140
7	36	.120
8	27	.090
9	30	.100
	300	1.000

b. $\bar{y} = \frac{\sum y_i}{n} = \frac{1404}{300} = 4.68$

c. $s^2 = \frac{\sum y_i^2 - \frac{\left(\sum y_i\right)^2}{n}}{n-1} = \frac{8942 - \frac{1404^2}{300}}{300-1} = 7.9307$

d. The 50 sample means are:

4.833	4.500	4.500	5.667
4.667	5.000	4.167	5.000
5.167	4.667	5.333	4.167
4.500	5.333	3.833	2.500
5.667	3.833	4.333	2.667
5.000	4.167	4.833	5.500
7.333	4.000	3.500	2.167
5.833	3.333	3.500	7.000
4.000	4.333	6.833	5.833
6.167	4.000	6.833	2.667
3.167	3.833	5.833	5.667
4.833	5.167	3.833	5.500
5.500	3.500		

The frequency distribution for $\overline{y}$ is:

Sample Mean	Frequency	Relative Frequency
2.000 - 2.999	4	4/50 = .08
3.000 - 3.999	9	9/50 = .18
4.000 - 4.999	16	.32
5.000 - 5.999	16	.32
6.000 - 6.999	3	.06
7.000 - 7.999	2	.04
	50	1.00

The mean of the sample means is:

$$\overline{\overline{y}} = \frac{\sum y_i}{n} = \frac{234}{50} = 4.68$$

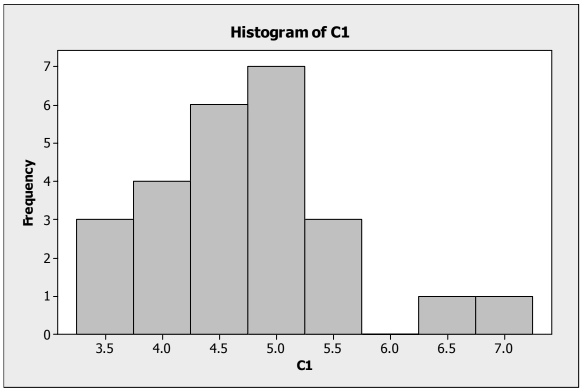
$$s_{\overline{y}}^2 = \frac{\sum \overline{y}^2 - \frac{\left(\sum \overline{y}\right)^2}{n}}{n-1} = \frac{1162.483337 - \frac{234^2}{50}}{50-1} = 1.375$$

1.41 a. The twenty-five means are:

4.75	4.58	4.00
4.83	4.58	4.92
5.33	3.50	3.92
6.58	5.33	4.33
4.75	3.33	6.83
5.00	4.08	4.83
4.00	4.58	4.25
3.67	5.08	5.58
4.33		

Class	Frequency	Relative Frequency
3.20 - 3.70	3	3/25 = .12
3.70 - 4.20	4	4/25 = .16
4.20 - 4.70	6	6/25 = .24
4.70 - 5.20	7	7/25 = .28
5.20 - 5.70	3	3/25 = .12
5.70 - 6.20	0	0/25 = .00
6.20 - 6.70	1	1/25 = .04
6.70 - 7.20	1	1/25 = .04

We can see that the histogram is less spread out than in the previous problem.



The mean of the sampling distribution is 4.680 and the standard deviation is .838. As expected, the standard deviation is smaller.

b. $\bar{\bar{y}} = \frac{\sum_{i=1}^{n} \bar{y}_i}{n} = \frac{117}{25} = 4.68$ $\quad S_{\bar{y}} = \frac{\sum \left(\bar{y}_i - \bar{\bar{y}}\right)^2}{n-1} = \frac{20.112}{25-1} = .838$

This standard deviation is smaller than the one in the previous problem. Since the sample size is larger in this problem, we expect the standard deviation of $\bar{y}_i$'s to be smaller.

1.42 a. For df = $n - 1 = 10 - 1 = 9$, $t_0 = 2.262$ yields $P(t \geq t_0) = .025$

b. For df = $n - 1 = 5 - 1 = 4$, $t_0 = 3.747$ yields $P(t \geq t_0) = .01$

c. For df = $n - 1 = 20 - 1 = 19$, $t_0 = -2.861$ yields $P(t \leq t_0) = .005$

d. For df = $n - 1 = 12 - 1 = 11$, $t_0 = -1.796$ yields $P(t \leq t_0) = .05$

1.43 a. $E\left(\bar{y}\right) = \mu_{\bar{y}} = \mu = 0.10 \quad Var\left(\bar{y}\right) = \frac{\sigma^2}{n} = \frac{(0.10)^2}{50} \cong 0.0002 \quad \sigma_{\bar{y}} = \frac{s}{\sqrt{n}} = \frac{0.10}{\sqrt{50}} \cong 0.0141$

b. Since the sample size is greater than 30, the sample distribution of $\bar{y}$ is approximately normal by The Central Limit Theorem.

c. $P\left(\bar{y} > 0.13\right) = P\left(Z > \frac{0.13 - 0.10}{\frac{0.10}{\sqrt{50}}}\right) = P\left(Z > 2.12\right) = 0.50 - 0.4830 = 0.0170$

1.44 a. The difference between the aggressive behavior level of an individual who scored high on a personality test and an individual who scored low on the test is the parameter of interest for "y-Effect Size".

b. It appears to be approximately normal with a few high outliers. Since the sample size is large, the Central Limit Theorem ensures that the data for the average is normally distributed.

c. We can be 95% confident that the interval (0.4786, 0.8167) encloses μ, the true mean effect size.

d. Yes, the researcher can conclude that those who score high on the personality test are more aggressive since zero is not included in the interval.

1.45 a. For confidence coefficient .99, $\alpha = .01$ and $\alpha/2 = .01/2 = .005$. From Table 1, Appendix D, $z_{.005} = 2.58$. The confidence interval is:

$$\bar{y} \pm z_{\alpha/2}\frac{s}{\sqrt{n}} \Rightarrow 1.13 \pm 2.58\left(\frac{2.21}{\sqrt{72}}\right) \Rightarrow 1.13 \pm .67 \Rightarrow (.46,\ 1.80)$$

We are 99% confident that the true mean number of pecks made by chickens pecking at blue string is between .458 and 1.802.

b. Yes, there is evidence that chickens are more apt to peck at white string. The mean number of pecks at white string is 7.5. Since 7.5 is not in the 99% confidence interval for the mean number of pecks at blue string, it is not a likely value for the true mean for blue string.

1.46 Some preliminary calculations:

$$\bar{y} = \frac{\sum y}{n} = \frac{6.44}{6} = 1.073$$

$$s^2 = \frac{\sum y^2 - \frac{\left(\sum y\right)^2}{n}}{n-1} = \frac{7.1804 - \frac{6.44^2}{6}}{6-1} = .0536$$

$$s = \sqrt{.0536} = .2316$$

a. For confidence coefficient .95, $\alpha = .05$ and $\alpha/2 = .05/2 = .025$. From Table 2, Appendix D, with $\text{df} = \text{n} - 1 = 6 - 1 = 5$, $\text{t}_{.025} = 2.571$. The confidence interval is:

$$\bar{y} \pm t_{\alpha/2}\frac{s}{\sqrt{n}} \Rightarrow 1.073 \pm 2.571\left(\frac{.2316}{\sqrt{6}}\right) \Rightarrow 1.073 \pm .243 \Rightarrow (.830,\ 1.316)$$

We are 95% confident that the true average decay rate of fine particles produced from oven cooking or toasting is between .830 and 1.316

b. The phrase "95% confident" means that in repeated sampling, 95% of all confidence intervals constructed will contain the true mean.

c. In order for the inference above to be valid, the distribution of decay rates must be normally distributed.

1.47 a. $E\left(y\right) = \mu_{\bar{y}} = \mu = 99.6$

b. From Table 1 of Appendix D, $Z = 1.96$

$$\bar{y} \pm z\left(s_{\bar{y}}\right) = \bar{y} \pm z\left(\frac{s}{\sqrt{n}}\right) = 99.6 \pm 1.96\left(\frac{12.6}{\sqrt{122}}\right) = 99.6 \pm 2.2 \Rightarrow (97.4, 101.8)$$

c. We are 95% confident that the true mean Mach rating score is between 97.4 and 101.8.

d. Yes, since the value of 85 is not contained in the confidence interval it is unlikely that the true mean Mach rating score could be 85.

1.48 a. The 95% confidence interval for the mean failure time is (1.6711, 2.1989).

b. We are 95% confident that the true mean failure time of used colored display panels is between 1.6711 and 2.1989 years.

c. 95 out of 100 repeated samples will generate the true mean failure time.

1.49 Using Table 2, Appendix D,

$$\bar{y} \pm t_{\alpha/2}\left(\frac{s}{\sqrt{n}}\right) = \bar{y} \pm t_{0.005}\left(\frac{s}{\sqrt{n}}\right) = 19 \pm 3.055\left(\frac{2.2}{\sqrt{13}}\right) = 19 \pm 1.9 \Rightarrow (17.1, 20.9)$$

We are 99% confident that the true mean quality of the methodology of the Wong scale is between 17.1 and 20.9.

1.50 a. $20.9 \pm 1.701\left(\frac{3.34}{\sqrt{29}}\right) = 20.9 \pm 1.1 \Rightarrow (19.8, 22.0)$ I'm 90% confident that the true mean number of eggs that a male and female pair of infected spider mites produced is between 19.8 and 22.0.

$20.3 \pm 1.717\left(\frac{3.50}{\sqrt{23}}\right) = 20.3 \pm 1.3 \Rightarrow (19, 21.6)$ I'm 90% confident that the true mean number of eggs that a treated male infected spider mite produced is between 19 and 21.6.

$22.9 \pm 1.740\left(\frac{4.37}{\sqrt{18}}\right) = 22.9 \pm 1.8 \Rightarrow (21.1, 24.7)$ I'm 90% confident that the true mean number of eggs that a treated female infected spider mite produced is between 21.1 and 24.7.

$18.6 \pm 1.725\left(\frac{2.11}{\sqrt{21}}\right) = 18.6 \pm 0.8 \Rightarrow (17.8, 19.4)$ I'm 90% confident that the true mean number of eggs that a male and female treated pair of infected spider mites produced is between 17.8 and 19.4.

b. It appears that the female treated group produces the highest mean number of eggs.

1.51 a. Null Hypothesis = H_0

b. Alternative Hypothesis = H_a

c. Type I error is when we reject the null hypothesis when the null hypothesis is in fact true.

d. Type II error is when we do not reject the null hypothesis when the null hypothesis is in fact not true.

e. Probability of Type I error is α

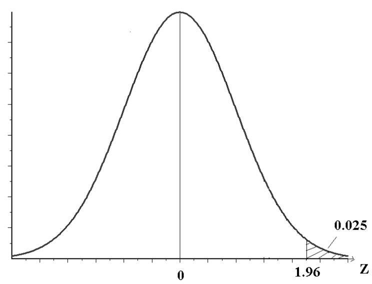
f. Probability of Type II error is β

g. p-value is the observed significance level, which is the probability of observing a value of the test statistics at least as contradictory to the null hypothesis as the observed test statistic value, assuming the null hypothesis is true.

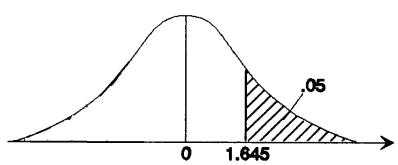
1.52 a. The rejection region is determined by the sampling distribution of the test statistic, the direction of the test (>, <, or ≠), and the tester's choice of α.

b. No, nothing is proven. When the decision based on sample information is to reject H_0, we run the risk of committing a Type I error. We might have decided in favor of the research hypothesis when, in fact, the null hypothesis was the true statement. The existence of Type I and Type II errors makes it impossible to prove anything using sample information.

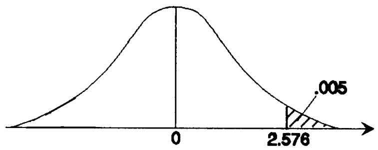
1.53 a. $\alpha = P$ (reject H_0 when H_0 is in fact true)
$= P(z > 1.96) = .025$



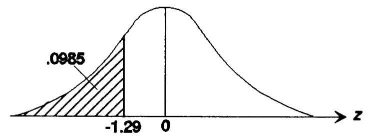
b. $\alpha = P(z > 1.645) = .05.$



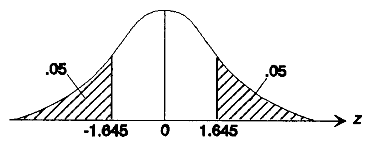
c. $\alpha = P(z > 2.576) = .005.$



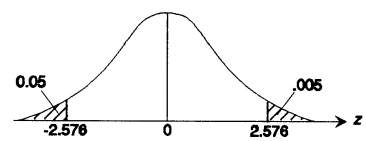
d. $\alpha = P(z < -1.29) = .0985.$



e. $\alpha = P(z < -1.645 \text{ or } z > 1.645)$
$= .05 + .05 = .10$



f. $\alpha = P(z < -2.576 \text{ or } z > 2.576)$
$= .005 + .005 = .01$



1.54 a. To determine if the average gain in green fees, lessons, or equipment expenditures for participating golf facilities exceed $2400, we test:

$H_0 : \mu = 2400$
$H_a : \mu > 2400$

b. The probability of making a Type I error will be at most 0.05. That is, 5% of the time when repeating this experiment the final conclusion would be that the true mean gain exceeded $2400 when in fact there was not enough evidence to reject the null hypothesis that the true mean was equal to $2400.

c. $\alpha = 0.05 =$ P(reject H_0 when H_0 is in fact true) $= \text{P}(z > 1.645)$.
The rejection region is $z > 1.645$.

1.55 a. To determine if the average level of mercury uptake in wading birds in the Everglades in 2000 is less than 15 parts per million, we test:

$H_0 : \mu = 15$
$H_a : \mu < 15$

b. A Type I error is rejecting H_0 when H_0 is true. In terms of this problem, we would be concluding that the average level of mercury uptake in wading birds in the Everglades in 2000 is less than 15 parts per million, when in fact, the average level of mercury uptake in wading birds in the Everglades in 2000 is equal to 15 parts per million.

c. A Type II error is accepting H_0 when H_0 is false. In terms of this problem, we would be concluding that the average level of mercury uptake in wading birds in the Everglades in 2000 is equal to 15 parts per million, when in fact, the average level of mercury uptake in wading birds in the Everglades in 2000 is less than 15 parts per million.

1.56 a. $\mu =$ true mean chromatic contrast of crab-spiders on daisies.

b. $H_0 : \mu = 70$
$H_a : \mu < 70$

c. The test statistic is $t = \dfrac{\bar{y} - \mu_0}{\sigma_{\bar{y}}} = \dfrac{57.5 - 70}{\frac{32.6}{\sqrt{10}}} = -1.21$

d. The rejection region requires $\alpha = 0.10$ in the lower tail of the t distribution from Table 2, Appendix D, with $\text{df} = n - 1 = 10 - 1 = 9, t_{0.10} = 1.383$. The rejection region is $t < -1.383$.

e. $P - \text{value} = 0.1283.$

f. Since the $p - \text{value} = 0.1283 > \alpha = 0.05$, then we can not reject the null hypothesis and conclude that there is not enough evidence to conclude that the true mean chromatic contrast of crab-spiders on daisies is less than 70.

1.57 a. To determine if the mean social interaction score of all Connecticut mental health patients differs from 3, we test:

$H_0 : \mu = 3$
$H_a : \mu \neq 3$

The test statistic is $z = \dfrac{\bar{y} - \mu_0}{\sigma_{\bar{y}}} = \dfrac{2.95 - 3}{1.10 / \sqrt{6{,}681}} = -3.72$

The rejection region requires $\alpha / 2 = .01 / 2 = .005$ in each tail of the z distribution. From Table 1, Appendix D, $z_{.005} = 2.58$. The rejection region is $z < -2.58$ or $z > 2.58$.

Since the observed value of the test statistic falls in the rejection region $(z = -3.72 < -2.58), H_0$ is rejected. There is sufficient evidence to indicate that the mean social interaction score of all Connecticut mental health patients differs from 3 at $\alpha = .01$.

b. From the test in part a, we found that the mean social interaction score was statistically different from 3. However, the sample mean score was 2.95. Practically speaking, 2.95 is very similar to 3.0. The very large sample size, $n = 6681$, makes it very easy to find statistical significance, even when no practical significance exists.