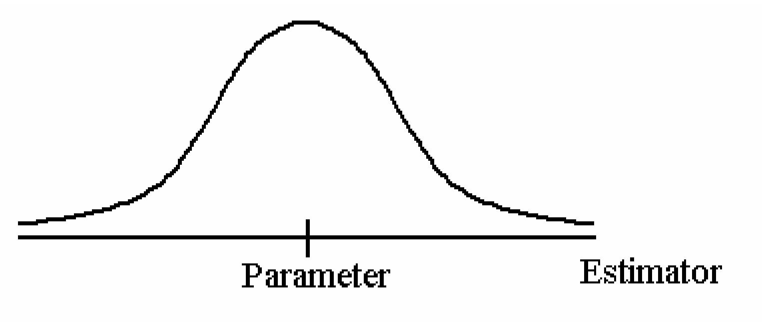
Chapter 10

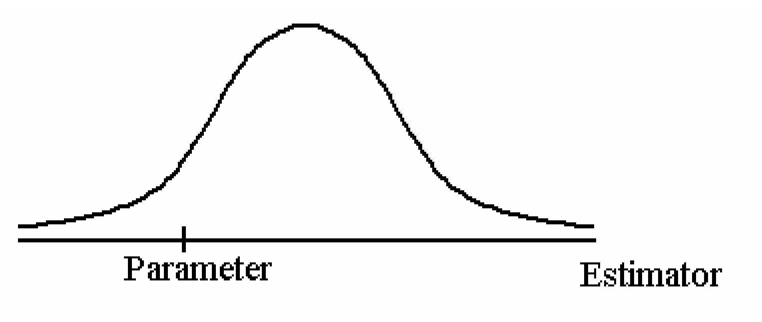
10.1 A point estimator is a single value; an interval estimator is a range of values.

10.2 An unbiased estimator of a parameter is an estimator whose expected value equals the parameter.

10.3

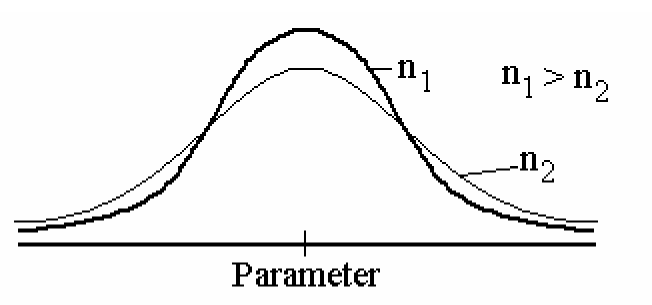


10.4



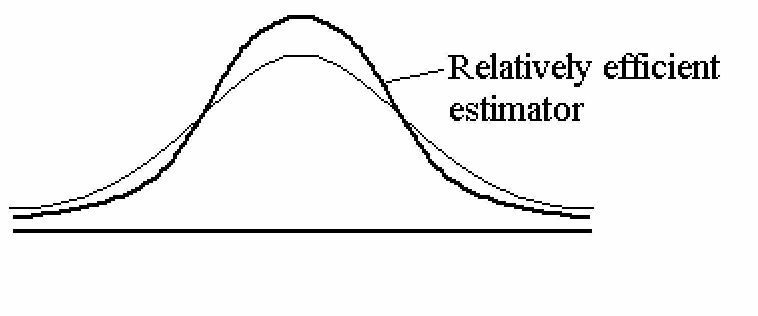
10.5 An unbiased estimator is consistent if the difference between the estimator and the parameter grows smaller as the sample size grows.

10.6



10.7 If there are two unbiased estimators of a parameter, the one whose variance is smaller is relatively efficient.

10.8



10.9 a. $\bar{x} \pm z_{\alpha/2}\sigma/\sqrt{n}$ = 100 $\pm$ 1.645(25/$\sqrt{50}$) = 100 $\pm$ 5.82; LCL = 94.18, UCL = 105.82

b. $\bar{x} \pm z_{\alpha/2}\sigma/\sqrt{n}$ = 100 $\pm$ 1.96(25/$\sqrt{50}$) = 100 $\pm$ 6.93; LCL = 93.07, UCL = 106.93

c. $\bar{x} \pm z_{\alpha/2}\sigma/\sqrt{n}$ = 100 $\pm$ 2.575(25/$\sqrt{50}$) = 100 $\pm$ 9.11; LCL = 90.89, UCL = 109.11

d. The interval widens.

10.10 a. $\bar{x} \pm z_{\alpha/2}\sigma/\sqrt{n}$ = 200 $\pm$ 1.96(50/$\sqrt{25}$) = 200 $\pm$ 19.60; LCL = 180.40, UCL = 219.60

b. $\bar{x} \pm z_{\alpha/2}\sigma/\sqrt{n}$ = 200 $\pm$ 1.96(25/$\sqrt{25}$) = 200 $\pm$ 9.80; LCL = 190.20, UCL = 209.80

c. $\bar{x} \pm z_{\alpha/2}\sigma/\sqrt{n}$ = 200 $\pm$ 1.96(10/$\sqrt{25}$) = 200 $\pm$ 3.92; LCL = 196.08, UCL = 203.92

d. The interval narrows.

10.11 a. $\bar{x} \pm z_{\alpha/2}\sigma/\sqrt{n}$ = 80 $\pm$ 1.96(5/$\sqrt{25}$) = 80 $\pm$ 1.96; LCL = 78.04, UCL = 81.96

b. $\bar{x} \pm z_{\alpha/2}\sigma/\sqrt{n}$ = 80 $\pm$ 1.96(5/$\sqrt{100}$) = 80 $\pm$ .98; LCL = 79.02, UCL = 80.98

c. $\bar{x} \pm z_{\alpha/2}\sigma/\sqrt{n}$ = 80 $\pm$ 1.96(5/$\sqrt{400}$) = 80 $\pm$ .49; LCL = 79.51, UCL = 80.49

d. The interval narrows.

10.12 a. $\bar{x} \pm z_{\alpha/2}\sigma/\sqrt{n}$ = 500 $\pm$ 2.33(12/$\sqrt{50}$) = 500 $\pm$ 3.95; LCL = 496.05, UCL = 503.95

b. $\bar{x} \pm z_{\alpha/2}\sigma/\sqrt{n}$ = 500 $\pm$ 1.96(12/$\sqrt{50}$) = 500 $\pm$ 3.33; LCL = 496.67, UCL = 503.33

c. $\bar{x} \pm z_{\alpha/2}\sigma/\sqrt{n}$ = 500 $\pm$ 1.645(12/$\sqrt{50}$) = 500 $\pm$ 2.79; LCL = 497.21, UCL = 502.79

d. The interval narrows.

10.13 a. $\bar{x} \pm z_{\alpha/2}\sigma/\sqrt{n}$ = 500 ± 2.575(15/$\sqrt{25}$) = 500 ± 7.73; LCL = 492.27, UCL = 507.73

b. $\bar{x} \pm z_{\alpha/2}\sigma/\sqrt{n}$ = 500 ± 2.575(30/$\sqrt{25}$) = 500 ± 15.45; LCL = 484.55, UCL = 515.45

c. $\bar{x} \pm z_{\alpha/2}\sigma/\sqrt{n}$ = 500 ± 2.575(60/$\sqrt{25}$) = 500 ± 30.91; LCL = 469.09, UCL = 530.91

d. The interval widens.

10.14 a. $\bar{x} \pm z_{\alpha/2}\sigma/\sqrt{n}$ = 10 ± 1.645(5/$\sqrt{100}$) = 10 ± .82; LCL = 9.18, UCL = 10.82

b. $\bar{x} \pm z_{\alpha/2}\sigma/\sqrt{n}$ = 10 ± 1.645(5/$\sqrt{25}$) = 10 ± 1.64; LCL = 8.36, UCL = 11.64

c. $\bar{x} \pm z_{\alpha/2}\sigma/\sqrt{n}$ = 10 ± 1.645(5/$\sqrt{10}$) = 10 ± 2.60; LCL = 7.40, UCL = 12.60

d. The interval widens.

10.15 a. $\bar{x} \pm z_{\alpha/2}\sigma/\sqrt{n}$ = 100 ± 1.96(20/$\sqrt{25}$) = 100 ± 7.84; LCL = 92.16, UCL = 107.84

b. $\bar{x} \pm z_{\alpha/2}\sigma/\sqrt{n}$ = 200 ± 1.96(20/$\sqrt{25}$) = 200 ± 7.84; LCL = 192.16, UCL = 207.84

c. $\bar{x} \pm z_{\alpha/2}\sigma/\sqrt{n}$ = 500 ± 1.96(20/$\sqrt{25}$) = 500 ± 7.84; LCL = 492.16, UCL = 507.84

d. The width of the interval is unchanged.

10.16 a. $\bar{x} \pm z_{\alpha/2}\sigma/\sqrt{n}$ = 400 ± 2.575(5/$\sqrt{100}$) = 400 ± 1.29; LCL = 398.71, UCL = 401.29

b. $\bar{x} \pm z_{\alpha/2}\sigma/\sqrt{n}$ = 200 ± 2.575(5/$\sqrt{100}$) = 200 ± 1.29; LCL = 198.71, UCL = 201.29

c. $\bar{x} \pm z_{\alpha/2}\sigma/\sqrt{n}$ = 100 ± 2.575(5/$\sqrt{100}$) = 100 ± 1.29; LCL = 98.71, UCL = 101.29

d. The width of the interval is unchanged.

10.17 Yes, because the expected value of the sample median is equal to the population mean.

10.18 The variance decreases as the sample size increases, which means that the difference between the estimator and the parameter grows smaller as the sample size grows larger.

10.19 Because the variance of the sample mean is less than the variance of the sample median, the sample mean is relatively more efficient than the sample median.

10.20 a sample median $\pm z_{\alpha/2}\dfrac{1.2533\,\sigma}{\sqrt{n}} = 500 \pm 1.645\dfrac{1.2533(12)}{\sqrt{50}}$ = 500 ± 3.50

b. The 90% confidence interval estimate of the population mean using the sample mean is 500 ± 2.79.

The 90% confidence interval of the population mean using the sample median is wider than that using the sample mean because the variance of the sample median is larger. The median is calculated by placing all the observations in order. Thus, the median loses the potential information contained in the actual values in the sample. This results in a wider interval estimate.

10.21 $\bar{x} \pm z_{\alpha/2}\sigma/\sqrt{n}$ = 6.89 $\pm$ 1.645(2/$\sqrt{9}$) = 6.89 $\pm$ 1.10; LCL = 5.79, UCL = 7.99

10.22 $\bar{x} \pm z_{\alpha/2}\sigma/\sqrt{n}$ = 43.75 $\pm$ 1.96(10/$\sqrt{8}$) = 43.75 $\pm$ 6.93; LCL = 36.82, UCL = 50.68

We estimate that the mean age of men who frequent bars lies between 36.82 and 50.68. This type of estimate is correct 95% of the time.

10.23 $\bar{x} \pm z_{\alpha/2}\sigma/\sqrt{n}$ = 22.83 $\pm$ 1.96(12/$\sqrt{12}$) = 22.83 $\pm$ 6.79; LCL = 16.04, UCL = 29.62

10.24 $\bar{x} \pm z_{\alpha/2}\sigma/\sqrt{n}$ = 9.85 $\pm$ 1.645(8/$\sqrt{20}$) = 9.85 $\pm$ 2.94; LCL = 6.91, UCL = 12.79

10.25 $\bar{x} \pm z_{\alpha/2}\sigma/\sqrt{n}$ = 68.6 $\pm$ 1.96(15/$\sqrt{15}$) = 68.6 $\pm$ 7.59; LCL = 61.01, UCL = 76.19

We estimate that the mean number of cars sold annually by all used car salespersons lies between 61.01 and 76.19. This type of estimate is correct 95% of the time.

10.26 $\bar{x} \pm z_{\alpha/2}\sigma/\sqrt{n}$ = 16.9 $\pm$ 2.575(5/$\sqrt{10}$) = 16.9 $\pm$ 4.07; LCL = 12.83, UCL = 20.97

10.27 $\bar{x} \pm z_{\alpha/2}\sigma/\sqrt{n}$ = 147.33 $\pm$ 1.96(40/$\sqrt{15}$) = 147.33 $\pm$ 20.24; LCL = 127.09, UCL = 167.57

10.28 $\bar{x} \pm z_{\alpha/2}\sigma/\sqrt{n}$ = 13.15 $\pm$ 1.645(6/$\sqrt{13}$) = 13.15 $\pm$ 2.74; LCL = 10.41, UCL = 15.89

10.29 $\bar{x} \pm z_{\alpha/2}\sigma/\sqrt{n}$ = 75.625 $\pm$ 2.575(15/$\sqrt{16}$) = 75.625 $\pm$ 9.656; LCL = 65.969, UCL = 85.281

10.30 $\bar{x} \pm z_{\alpha/2}\sigma/\sqrt{n}$ = 252.38 $\pm$ 1.96(30/$\sqrt{400}$) = 252.38 $\pm$ 2.94; LCL = 249.44, UCL = 255.32

10.31 $\bar{x} \pm z_{\alpha/2}\sigma/\sqrt{n}$ = 1,810.16 $\pm$ 1.96(400/$\sqrt{64}$) = 1,810.16 $\pm$ 98.00; LCL = 1,712.16,
UCL = 1,908.16

10.32 $\bar{x} \pm z_{\alpha/2}\sigma/\sqrt{n}$ = 12.10 ± 1.645(2.1/$\sqrt{200}$) = 12.10 ± .24; LCL = 11.86, UCL = 12.34. We estimate that the mean rate of return on all real estate investments lies between 11.86% and 12.34%. This type of estimate is correct 90% of the time.

10.33 $\bar{x} \pm z_{\alpha/2}\sigma/\sqrt{n}$ = 10.21 ± 2.575(2.2/$\sqrt{100}$) = 10.21 ± .57; LCL = 9.64, UCL = 10.78

10.34 $\bar{x} \pm z_{\alpha/2}\sigma/\sqrt{n}$ = .510 ± 2.575(.1/$\sqrt{250}$) = .510 ± .016; LCL = .494, UCL = .526. We estimate that the mean growth rate of this type of grass lies between .494 and .526 inch . This type of estimate is correct 99% of the time.

10.35 $\bar{x} \pm z_{\alpha/2}\sigma/\sqrt{n}$ = 26.81 ± 1.96(1.3/$\sqrt{50}$) = 26.81 ± .36; LCL = 26.45, UCL = 27.17. We estimate that the mean time to assemble a cell phone lies between 26.45 and 27.17 minutes. This type of estimate is correct 95% of the time.

10.36 $\bar{x} \pm z_{\alpha/2}\sigma/\sqrt{n}$ = 19.28 ± 1.645(6/$\sqrt{250}$) = 19.28 ± .62; LCL = 18.66, UCL = 19.90. We estimate that the mean leisure time per week of Japanese middle managers lies between 18.66 and 19.90 hours. This type of estimate is correct 90% of the time.

10.37 $\bar{x} \pm z_{\alpha/2}\sigma/\sqrt{n}$ = 15.00 ± 2.575(2.3/$\sqrt{100}$) = 15.00 ± .59; LCL = 14.41, UCL = 15.59. We estimate that the mean pulse-recovery time lies between 14.41 and 15.59 minutes. This type of estimate is correct 99% of the time.

10.38 $\bar{x} \pm z_{\alpha/2}\sigma/\sqrt{n}$ = 585,063 ± 1.645(30,000/$\sqrt{80}$) = 585,063 ± 5,518; LCL = 579,545,
UCL = 590,581. We estimate that the mean annual income of all company presidents lies between $579,545 and $590,581. This type of estimate is correct 90% of the time.

10.39 $\bar{x} \pm z_{\alpha/2}\sigma/\sqrt{n}$ = 14.98 ± 1.645(3/$\sqrt{250}$) = 14.98 ± .31; LCL = 14.67, UCL = 15.29

10.40 $\bar{x} \pm z_{\alpha/2}\sigma/\sqrt{n}$ = 27.19 ± 1.96(8/$\sqrt{100}$) = 27.19 ± 1.57; LCL = 25.62, UCL = 28.76

10.41 $n = \left(\frac{z_{\alpha/2}\sigma}{B}\right)^2 = \left(\frac{1.96 \times 15}{2}\right)^2 = 217$

10.42 $n = \left(\dfrac{z_{\alpha/2}\sigma}{B}\right)^2 = \left(\dfrac{1.96 \times 25}{5}\right)^2 = 97$

10.43 $n = \left(\dfrac{z_{\alpha/2}\sigma}{B}\right)^2 = \left(\dfrac{1.645 \times 20}{1}\right)^2 = 1{,}083$

10.44 $n = \left(\dfrac{z_{\alpha/2}\sigma}{B}\right)^2 = \left(\dfrac{1.96 \times 12}{2}\right)^2 = 139$

10.45 $n = \left(\dfrac{z_{\alpha/2}\sigma}{B}\right)^2 = \left(\dfrac{2.575 \times 360}{20}\right)^2 = 2{,}149$

10.46 a. $n = \left(\dfrac{z_{\alpha/2}\sigma}{W}\right)^2 = \left(\dfrac{1.96 \times 200}{10}\right)^2 = 1{,}537$

b. 500 ± 10

10.47 a. $\bar{x} \pm z_{\alpha/2}\dfrac{\sigma}{\sqrt{n}} = 500 \pm 1.96\dfrac{100}{\sqrt{1537}} = 500 \pm 5$

b. $\bar{x} \pm z_{\alpha/2}\dfrac{\sigma}{\sqrt{n}} = 500 \pm 1.96\dfrac{400}{\sqrt{1537}} = 500 \pm 20$

10.48 a The width of the confidence interval estimate is equal to what was specified.

b The width of the confidence interval estimate is smaller than what was specified.

c The width of the confidence interval estimate is larger than what was specified.

10.49 $n = \left(\dfrac{z_{\alpha/2}\sigma}{B}\right)^2 = \left(\dfrac{1.645 \times 10}{2}\right)^2 = 68$

10.50 a. $n = \left(\dfrac{z_{\alpha/2}\sigma}{B}\right)^2 = \left(\dfrac{1.645 \times 10}{1}\right)^2 = 271$

b. 150 ± 1

10.51 a. $\bar{x} \pm z_{\alpha/2}\frac{\sigma}{\sqrt{n}} = 150 \pm 1.645\frac{5}{\sqrt{271}} = 150 \pm .5$

b. $\bar{x} \pm z_{\alpha/2}\frac{\sigma}{\sqrt{n}} = 150 \pm 1.645\frac{20}{\sqrt{271}} = 150 \pm 2$

10.52 a. The width of the confidence interval estimate is equal to what was specified.

b. The width of the confidence interval estimate is smaller than what was specified.

c. The width of the confidence interval estimate is larger than what was specified.

10.53 a. $n = \left(\frac{z_{\alpha/2}\sigma}{B}\right)^2 = \left(\frac{2.575 \times 250}{50}\right)^2 = 166$

b. $n = \left(\frac{z_{\alpha/2}\sigma}{B}\right)^2 = \left(\frac{2.575 \times 50}{50}\right)^2 = 7$

c. $n = \left(\frac{z_{\alpha/2}\sigma}{B}\right)^2 = \left(\frac{1.96 \times 250}{50}\right)^2 = 97$

d. $n = \left(\frac{z_{\alpha/2}\sigma}{B}\right)^2 = \left(\frac{2.575 \times 250}{10}\right)^2 = 4{,}145$

10.54 a The sample size decreases.

b the sample size decreases.

c The sample size increases.

10.55 a. $n = \left(\frac{z_{\alpha/2}\sigma}{B}\right)^2 = \left(\frac{1.645 \times 50}{10}\right)^2 = 68$

b. $n = \left(\frac{z_{\alpha/2}\sigma}{B}\right)^2 = \left(\frac{1.645 \times 100}{10}\right)^2 = 271$

c. $n = \left(\frac{z_{\alpha/2}\sigma}{B}\right)^2 = \left(\frac{1.96 \times 50}{10}\right)^2 = 97$

d. $n = \left(\frac{z_{\alpha/2}\sigma}{B}\right)^2 = \left(\frac{1.645 \times 50}{20}\right)^2 = 17$

10.56 a The sample size increases.

b The sample size increases.

c The sample size decreases.