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MATH 54
Section 4053
SID: 1545566

$10/10$

HW 4

9.1

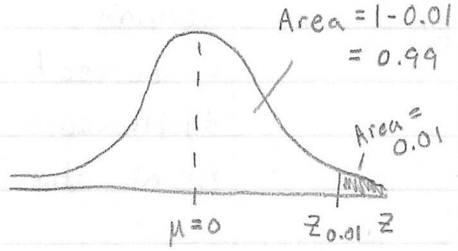
1. point estimate

5. increases

9. $98\% = 0.98$

$\alpha = 1 - 0.98 = 0.02$

$z_{\alpha/2} = z_{0.02/2} = z_{0.01} = \boxed{2.33}$



13. Lower bound: 0.462, upper bound: 0.509, n = 1680

$$\hat{p} = \frac{0.462 + 0.509}{2} = \boxed{0.4855}$$

$E = \hat{p} - \text{lower bound} = 0.4855 - 0.462 = \boxed{0.0235}$

$$\hat{p} = \frac{x}{n}$$

$$0.486 = \frac{x}{1680}$$

$x = 816.48 \approx \boxed{816}$

17. $x = 120$, $n = 500$, 99% confidence

Step 1) $\hat{p} = \frac{x}{n} = \frac{120}{500} = 0.24$

Step 2) ① $n\hat{p}(1-\hat{p}) \geq 10$ ✓ (assumed)

② $n \leq 0.05N$ ✓ (assumed)

Step 3) $\alpha = 1 - 0.99 = 0.01$

$z_{\alpha/2} = z_{0.01/2} = z_{0.005} = 2.575$

Step 4) Lower bound: $\hat{p} - z_{\alpha/2} \cdot \sqrt{\frac{\hat{p}(1-\hat{p})}{n}} = 0.24 - (2.575)\sqrt{\frac{0.24(1-0.24)}{500}}$

$= 0.191$

Upper bound: $\hat{p} + z_{\alpha/2} \cdot \sqrt{\frac{\hat{p}(1-\hat{p})}{n}} = 0.24 + (2.575)\sqrt{\frac{0.24(1-0.24)}{500}}$

$= 0.289$

Step 5) We are 99% confident that the population proportion is between 0.191 and 0.289.

21. a) flawed - no interval has been provided about the population proportion

b) flawed - this interpretation indicates that the level of confidence is varying

c) correct

d) flawed - this interpretation suggests that this interval sets the standard for all other intervals, which is not true

25. $n = 2306$, $x = 417$

a) $\hat{p} = \frac{417}{2306} = 0.181$

b) ① $n\hat{p}(1-\hat{p}) \geq 10$

$(2306)(0.181)(1-0.181) \geq 10$

$341.84 \geq 10$ ✓

② $n \leq 0.05N$

✓ b/c there are over 250 million Americans 18 +

c) 90% confidence

Step 3) $\alpha = 1 - 0.90 = 0.1$

$z_{\alpha/2} = z_{0.1/2} = z_{0.05} = 1.645$

Step 4) Lower bound: $0.181 - (1.645)\sqrt{\frac{0.181(1-0.181)}{2306}}$

$= 0.168$

Upper bound: $0.181 + (1.645)\sqrt{\frac{0.181(1-0.181)}{2306}}$

$= 0.194$

d) We are 90% confident that the proportion of adult Americans aged 18 and older who have donated blood in the past two years is between 0.168 and 0.194.

29. $n = 234$, $x = 26$

a) 95% confidence

Step 1) $\hat{p} = \frac{26}{234} = 0.1111$

Step 2) ① $n\hat{p}(1-\hat{p}) \geq 10$

$(234)(0.1111)(1-0.1111) \geq 10$

$23.11 \geq 10$ ✓

② $n \leq 0.05N$

✓ (assumed)

Step 3) $\alpha = 1 - 0.95 = 0.05$

$z_{\alpha/2} = z_{0.05/2} = z_{0.025} = 1.96$

Step 4) Lower bound: $0.1111 - (1.96)\sqrt{\frac{0.1111(1-0.1111)}{234}}$

$= 0.071$

Upper bound: $0.1111 + (1.96)\sqrt{\frac{0.1111(1-0.1111)}{234}}$

$= 0.151$

Step 5) We are 95% confident the proportion of adult males treated w/ Androgel who will experience elevated levels of PSA is between 0.071 and 0.151.

b) 99% confidence

Step 3) $\alpha = 1 - 0.99 = 0.01$

$z_{\alpha/2} = z_{0.01/2} = z_{0.005} = 2.575$

Step 4) Lower bound: $0.1111 - (2.575)\sqrt{\frac{0.1111(1-0.1111)}{234}}$

$= 0.058$

Upper bound: $0.1111 + (2.575)\sqrt{\frac{0.1111(1-0.1111)}{234}}$

$= 0.164$

Step 5) We are 99% confident the proportion of adult males treated w/ Androgel who will experience elevated levels of PSA is between 0.058 and 0.164.

c) Increasing the level of confidence increases the margin of error.

33. Lower bound: 0.451

Upper bound: 0.589

We are 95% confident that the proportion of days JNJ stock will increase is between 0.451 and 0.589.

37. $E = 0.02$, 98% confidence

a) $\hat{p} = 0.15$ $\alpha = 1 - 0.98 = 0.02$ $z_{\alpha/2} = z_{0.02/2} = z_{0.01} = 2.33$

$$n = \hat{p}(1-\hat{p})\left(\frac{z_{\alpha/2}}{E}\right)^2 = (0.15)(1-0.15)\left(\frac{2.33}{0.02}\right)^2 = 1730.46 \approx \boxed{1731}$$

b) $$n = 0.25\left(\frac{z_{\alpha/2}}{E}\right)^2 = 0.25\left(\frac{2.33}{0.02}\right)^2 = 3393.06 \approx \boxed{3394}$$

41. $\hat{p} = 0.64$, $E = 0.03$, 95% confidence

$\alpha = 1 - 0.95 = 0.05$ $z_{\alpha/2} = z_{0.05/2} = z_{0.025} = 1.96$

$$n = 0.64(1-0.64)\left(\frac{1.96}{0.03}\right)^2 = 983.45 \approx \boxed{984}$$

45. $n = 20$, $x = 2$, 95% confidence

$\alpha = 1 - 0.95 = 0.05$ $z_{\alpha/2} = z_{0.05/2} = z_{0.025} = 1.96$

$$\tilde{n} = n + z_{\alpha/2}^2 = 20 + (1.96)^2 = 23.8416$$

$$\tilde{p} = \frac{1}{\tilde{n}}\left(x + \frac{1}{2}z_{\alpha/2}^2\right) = \frac{1}{23.8416}\left(2 + \frac{1}{2}(1.96)^2\right) = 0.1645$$

Lower bound: $$\tilde{p} - z_{\alpha/2}\sqrt{\frac{1}{\tilde{n}}\cdot\tilde{p}(1-\tilde{p})} = 0.1645 - (1.96)\sqrt{\frac{1}{23.8416}(0.1645)(1-0.1645)}$$

$$= 0.016$$

Upper bound: $$\tilde{p} + z_{\alpha/2}\sqrt{\frac{1}{\tilde{n}}\cdot\tilde{p}(1-\tilde{p})} = 0.1645 + (1.96)\sqrt{\frac{1}{23.8416}(0.1645)(1-0.1645)}$$

$$= 0.313$$

49. Data must be qualitative with two possible outcomes to construct confidence intervals for a proportion.

53. Jaime: $\hat{p} = \frac{0.097 + 0.163}{2}$ Mariya: $\hat{p} = \frac{0.117 + 0.173}{2}$

$\hat{p} = 0.13$ ✓ $\hat{p} = 0.145 \neq 0.13$

$\therefore$ Mariya's interval is wrong. The upper and lower bounds are not the same distance from the point estimate.

9.2

1. decreases

5. false

9. $n = 12$, correlation $= 0.987$

$0.987 > 0.928$ ✓

boxplot $\rightarrow$ no outliers ✓

$\therefore$ yes, sample comes from a population that is normally distributed

13. $\bar{x} = \frac{18 + 24}{2} = \boxed{21}$

$E = \bar{x} -$ lower bound $= 21 - 18 = \boxed{3}$

17. (1) simple random sample ✓

(2) $n \leq 0.05N$ ✓ (assumed)

(3) population normally distributed ✓

$\bar{x} = 108$, $s = 10$

a) 96% confidence, $n = 25$

Step 3) $\alpha = 1 - 0.96 = 0.04$

$t_{\alpha/2} = t_{0.04/2} = t_{0.02}$ $df = n - 1 = 25 - 1 = 24$

$t_{0.02} = 2.172$

Step 4) Lower bound: $\bar{x} - t_{\alpha/2} \cdot \frac{s}{\sqrt{n}} = 108 - (2.172)\left(\frac{10}{\sqrt{25}}\right)$

$= 103.656$

Upper bound: $\bar{x} + t_{\alpha/2} \cdot \frac{s}{\sqrt{n}} = 108 + (2.172)\left(\frac{10}{\sqrt{25}}\right)$

$= 112.344$

Step 5) We are 96% confident that the population mean is between 103.656 and 112.344.

b) 96% confidence, $n = 10$

Step 3) $\alpha = 1 - 0.96 = 0.04$

$t_{0.04/2} = t_{0.02} = 2.172$

Step 4) Lower bound: $108 - (2.172)\left(\frac{10}{\sqrt{10}}\right) = 101.132$

Upper bound: $108 + (2.172)\left(\frac{10}{\sqrt{10}}\right) = 114.868$

Step 5) We are 96% confident that the population mean is between 101.132 and 114.868.

Decreasing the sample size increases the margin of error.

c) 90% confidence, $n = 25$

Step 3) $\alpha = 1 - 0.90 = 0.1$

$t_{0.1/2} = t_{0.05} = 1.711$ $\quad df = 25 - 1 = 24$

Step 4) LB: $108 - (1.711)\left(\frac{10}{\sqrt{25}}\right) = 104.578$

UB: $108 + (1.711)\left(\frac{10}{\sqrt{25}}\right) = 111.422$

Step 5) We are 90% confident the population mean is between 104.578 and 111.422.

Decreasing the level of confidence decreases the margin of error.

d) No b/c $n < 30$ in (a) - (c), so the sample sizes were too small.

21. a) flawed - confidence interval does not represent a probability; also this interpretation implies that the population mean varies rather than the interval

b) correct

c) flawed - this interpretation makes an implication about individuals rather than the mean

d) flawed - sample is not from Idaho only; the interpretation should be about the mean number of hours worked by adult Americans, not about adults in Idaho

25. (1) increase the sample size and (2) decrease the level of confidence to narrow the confidence interval

29. $n = 92$, $\bar{x} = 356.1$, $s = 185.7$, 95% confidence

Step 1) ① simple random sample ✓ (independence)

② $n \leq 0.05N$

✓ b/c # of people who eat Tootsie Pops is at least 1 million

③ $n \geq 30$ ✓ (normality)

Step 2) $\bar{x} = 356.1$, $s = 185.7$

Step 3) $\alpha = 1 - 0.95 = 0.05$ $\quad$ $df = 92 - 1 = 91$

$t_{\alpha/2} = t_{0.05/2} = t_{0.025} = 1.987$

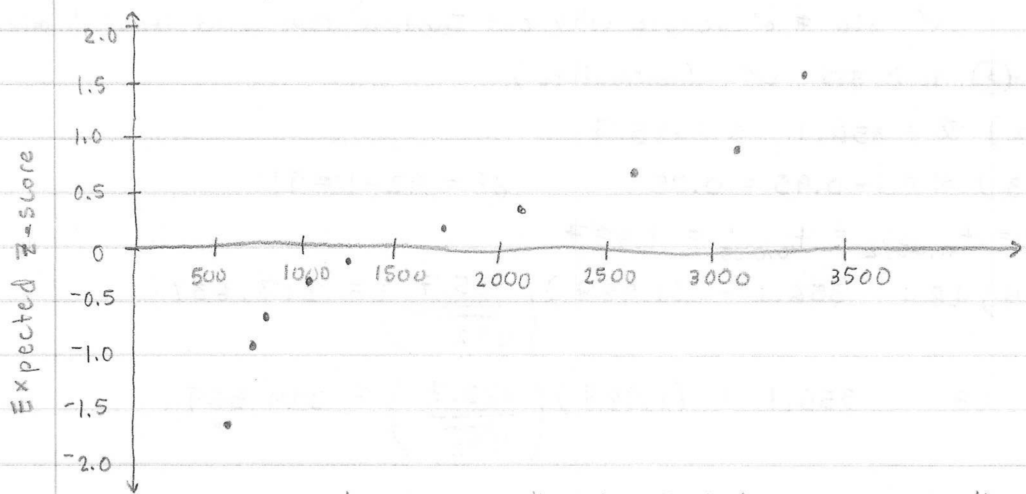
Step 4) LB: $356.1 - (1.987)\left(\frac{185.7}{\sqrt{92}}\right) = 317.631$

UB: $356.1 + (1.987)\left(\frac{185.7}{\sqrt{92}}\right) = 394.569$

Step 5) We are 95% confident the mean number of licks to the center of a Tootsie Pop is between 317.631 and 394.569.

33. a)

index, i	observed value	fi	expected z-score
1	663	$\frac{1-0.375}{10+0.25} = 0.06$	$^-1.555$
2	743	0.16	$^-0.99$
3	773	0.26	$^-0.64$
4	1071	0.35	$^-0.39$
5	1370	0.45	$^-0.13$
6	1758	0.55	0.13
7	2057	0.65	0.39
8	2637	0.74	0.64
9	3148	0.84	0.99
10	3345	0.94	1.55



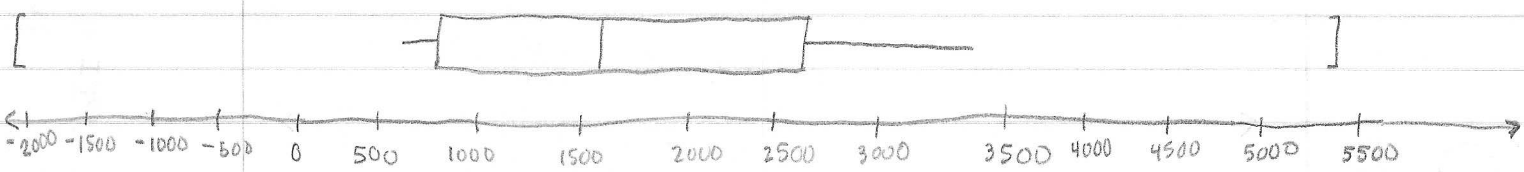
∴ population normally distributed b/c approx. linear

Repair Cost (dollars)

b) $Q_1 = 773$, $M = 1564$, $Q_3 = 2637$ $\quad IQR = 2637 - 773 = 1864$

$LF = Q_1 - 1.5(IQR) = 773 - 1.5(1864) = {}^-2023$

$UF = Q_3 + 1.5(IQR) = 2637 + 1.5(1864) = 5433$



∴ no outliers

c) Step 1) ① simple random sample ✓

② $n \leq 0.05N$

✓ b/c # of low impact collisions in mini and micro vehicles > 50,000

③ population normally distributed ✓

Step 2) $\bar{x} = 1756.5$, $s = 1007.454$

Step 3) $\alpha = 1 - 0.95 = 0.05$ $df = 10 - 1 = 9$

$t_{\alpha/2} = t_{0.05/2} = t_{0.025} = 2.262$

Step 4) LB: $1756.5 - (2.262)\left(\frac{1007.454}{\sqrt{10}}\right) = \$1035.86$

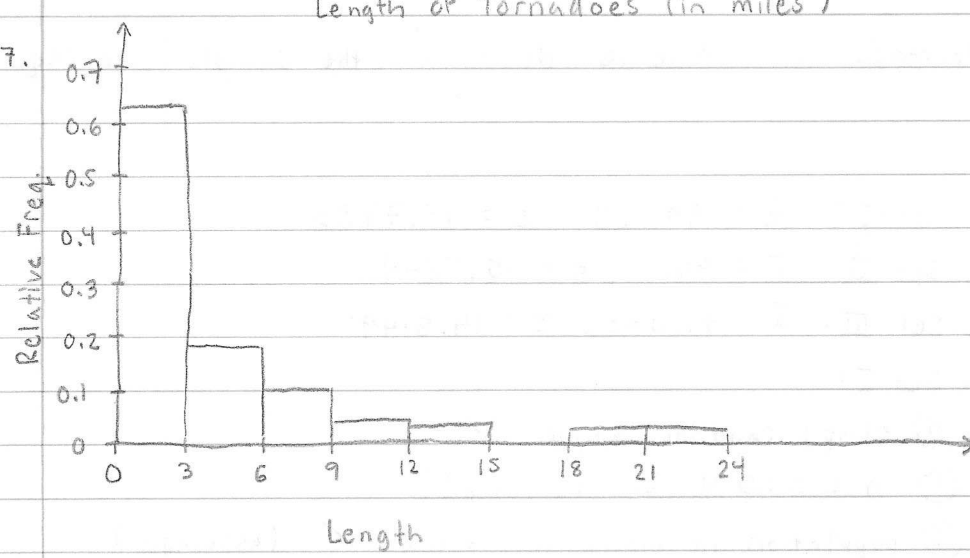
UB: $1756.5 + (2.262)\left(\frac{1007.454}{\sqrt{10}}\right) = \$2477.14$

Step 5) We are 95% confident the mean repair cost of low impact collisions in mini and micro vehicles is between \$1035.86 and \$2477.14.

d) The 95% confidence interval would likely be narrower b/c there is less variability in the data b/c variability associated with the make of the vehicle has been removed.

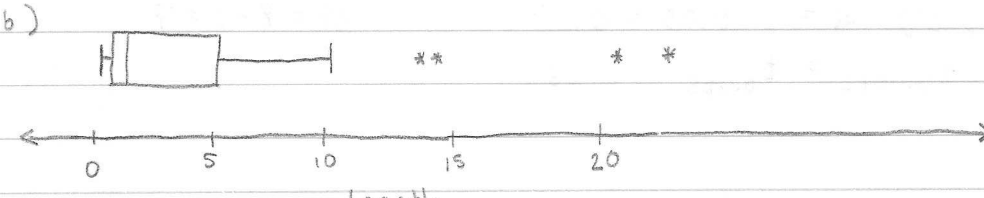
Length of Tornadoes (in miles)

37.



- skewed right

b)



∴ Yes, there are outliers

b) b/c of the outliers and skewed distribution of the sample data, it is necessary to have a large sample size to invoke the Central Limit Theorem so that the sampling distribution of the sample mean is approximately normal.

c) LB : 2.400 miles ; UB : 4.280 miles

We are 95% confident that the mean length of a tornado in Oklahoma is between 2.400 and 4.280 miles.

41. $E = 2$, $s = 13.4$

99% confidence : $\alpha = 1 - 0.99 = 0.01$

$$z_{\alpha/2} = z_{0.01/2} = z_{0.005} = 2.575$$

$$n = \left(\frac{z_{\alpha/2} \cdot s}{E}\right)^2 = \left(\frac{2.575 \cdot 13.4}{2}\right)^2 = 297.65 \approx \boxed{298}$$

95% confidence : $\alpha = 1 - 0.95 = 0.05$

$$z_{\alpha/2} = z_{0.05/2} = z_{0.025} = 1.96 = 172.45 \approx \boxed{173}$$

$$n = \left(\frac{1.96 \cdot 13.4}{2}\right)^2$$

The decrease in confidence decreases the sample size required.

45. $\mu = 100$

a) Data Set I : $\bar{x} = 99.125$, $s = 19.7733$

Data Set II : $\bar{x} = 99.1$, $s = 15.7844$

Data Set III : $\bar{x} = 99.0333$, $s = 14.8149$

b) Data Set I :

Step 1) ① simple random sample ✓

② $n \le 0.05N$ ✓ (assumed)

③ population normally distributed ✓ (assumed)

Step 2) $\bar{x} = 99.125$, $s = 19.7733$

Step 3) $\alpha = 1 - 0.95 = 0.05$ $\quad df = 8 - 1 = 7$

$t_{0.05/2} = t_{0.025} = 2.365$

Step 4) LB: $99.125 - (2.365)\left(\frac{19.7733}{\sqrt{8}}\right) = 82.5914$

UB: $99.125 + (2.365)\left(\frac{19.7733}{\sqrt{8}}\right) = 115.6585$

Step 5) We are 95% confident the population mean is between 82.5914 and 115.6585.

Data Set II:

Step 1) ① simple random sample ✓

② $n \leq 0.05N$ ✓ (assumed)

③ population normally distributed ✓ (assumed)

Step 2) $\bar{x} = 99.1$, $s = 15.7844$

Step 3) $\alpha = 1 - 0.95 = 0.05$ $df = 20 - 1 = 19$

$t_{0.05/2} = t_{0.025} = 2.093$

Step 4) LB: $99.1 - (2.093)\left(\frac{15.7844}{\sqrt{20}}\right) = 91.7128$

UB: $99.1 + (2.093)\left(\frac{15.7844}{\sqrt{20}}\right) = 106.4872$

Step 5) We are 95% confident the population mean is between 91.7128 and 106.4872.

Data Set III:

Step 1) ① simple random sample ✓

② $n \leq 0.05N$ ✓ (assumed)

③ population normally distributed ✓ (assumed)

Step 2) $\bar{x} = 99.0333$, $s = 14.8149$

Step 3) $\alpha = 1 - 0.95 = 0.05$ $df = 30 - 1 = 29$

$t_{0.05/2} = t_{0.025} = 2.045$

Step 4) LB: $99.0333 - (2.045)\left(\frac{14.8149}{\sqrt{30}}\right) = 93.5019$

UB: $99.0333 + (2.045)\left(\frac{14.8149}{\sqrt{30}}\right) = 104.5647$

Step 5) We are 95% confident the population mean is between 93.5019 and 104.5647.

c) Increasing the sample size n decreases the width of the interval.

d) Data Set I: LB: 58.6, UB: 117.2

Data Set II: LB: 83.2, UB: 106.0

Data Set III: LB: 88.1, UB: 103.9

e) Each interval contains the population mean. The procedure for constructing the confidence interval is robust. This also illustrates the Law of Large Numbers, and the Central Limit Theorem.

49. a) completely randomized design

b) The treatment is the smoking cessation program. There are 2 levels.

c) The response variable is whether or not the smoker had "even a puff" from a cigarette in the past 7 days.

d) The statistics reported are 22.3 % of participants in the experimental group reported abstinence and 13.1% of participants in the control group reported abstinence.

e) $\dfrac{p(1-q)}{q(1-p)} = \dfrac{0.223(1-0.131)}{0.131(1-0.223)} \approx 1.90$

This means that reported abstinence is almost twice as likely in the experimental group than in the control group.

f) The authors are 95% confident that the population odds ratio is between 1.12 and 3.26.

g) Smoking cessation is more likely when the Happy Ending Intervention program is used rather than the control method.

53. The degrees of freedom are the number of data values that are free to vary.

9.3

1. false; the chi-square distribution is skewed to the right

5. 90% confidence, n = 20

$\alpha = 1 - 0.90 = 0.1$ $\qquad$ $df = 20 - 1 = 19$

$\chi^2_{1-\alpha/2} = \chi^2_{1-0.1/2} = \chi^2_{1-0.05} = \chi^2_{0.95} = \boxed{10.117}$

$\chi^2_{\alpha/2} = \chi^2_{0.1/2} = \chi^2_{0.05} = \boxed{30.144}$

9. $s^2 = 12.6$

Step 1) ① simple random sample ✓

② $n \le 0.05N$ ✓ (assumed)

③ population normally distributed ✓ (given)

Step 2) $s^2 = 12.6$

a) 90% confidence, n = 20

Step 3) $\alpha = 1 - 0.90 = 0.1$ $\qquad$ $df = 20 - 1 = 19$

$\chi^2_{1-\alpha/2} = \chi^2_{1-0.1/2} = \chi^2_{1-0.05} = \chi^2_{0.95} = 10.117$

$\chi^2_{\alpha/2} = \chi^2_{0.1/2} = \chi^2_{0.05} = 30.144$

Step 4) LB: $\dfrac{(n-1)s^2}{\chi^2_{\alpha/2}} = \dfrac{(20-1)(12.6)}{30.144} = 7.9419$

UB: $\dfrac{(n-1)s^2}{\chi^2_{1-\alpha/2}} = \dfrac{(20-1)(12.6)}{10.117} = 23.6631$

We are 90% confident the population variance is between 7.9419 and 23.6631.

b) 90% confidence, n = 30

Step 3) $\alpha = 1 - 0.90 = 0.1$ $\qquad$ $df = 30 - 1 = 29$

$\chi^2_{1-\alpha/2} = \chi^2_{1-0.1/2} = \chi^2_{1-0.05} = \chi^2_{0.95} = 17.708$

$\chi^2_{0.1/2} = \chi^2_{0.05} = 42.557$

Step 4) LB: $\dfrac{(30-1)(12.6)}{42.557} = 8.5861$

UB: $\dfrac{(30-1)(12.6)}{17.708} = 20.6347$

We are 90% confident the population variance is between 8.5861 and 20.6347.

Increasing the sample size decreased the width of the interval.

c) 98% confidence, $n = 20$

Step 3) $\alpha = 1 - 0.98 = 0.02$ $\quad df = 20 - 1 = 19$

$\chi^2_{1-0.02/2} = \chi^2_{1-0.01} = \chi^2_{0.99} = 7.633$

$\chi^2_{0.02/2} = \chi^2_{0.01} = 36.191$

Step 4) LB: $\dfrac{(20-1)(12.6)}{36.191} = 6.6149$

UB: $\dfrac{(20-1)(12.6)}{7.633} = 31.3638$

We are 98% confident the population variance is between 6.6149 and 31.3638.

Increasing the level of confidence increased the width of the confidence interval.

13. 90% confidence, $s = 1007.4542$, $n = 10$

Step 1) ① simple random sample ✓

② $n \leq 0.05N$ ✓ (assumed)

③ population normally distributed ✓ (9.2 Prob 33)

Step 2) $s^2 = 1014963.965$

Step 3) $\alpha = 1 - 0.90 = 0.1$ $\quad df = 10 - 1 = 9$

$\chi^2_{1-\alpha/2} = \chi^2_{1-0.1/2} = \chi^2_{1-0.05} = \chi^2_{0.95} = 3.325$

$\chi^2_{0.1/2} = \chi^2_{0.05} = 16.919$

Step 4) LB: $\sqrt{\dfrac{(10-1)(1014963.965)}{16.919}} = 734.7832 \approx 734.78$

UB: $\sqrt{\dfrac{(10-1)(1014963.965)}{3.325}} = 1657.4893 \approx 1657.49$

We are 90% confident the standard deviation repair cost of a low impact collision involving mini and micro vehicles is between \$734.78 and \$1657.49.

17. df = 100

$$\chi^2_{0.975} = \frac{(z_{0.975} + \sqrt{2(100)-1})^2}{2} = \frac{(-1.96 + \sqrt{199})^2}{2} = 73.772$$

73.772 < 74.222 but close to value from Table VIII

$$\chi^2_{0.025} = \frac{(z_{0.025} + \sqrt{2(100)-1})^2}{2} = \frac{(1.96 + \sqrt{199})^2}{2} = 129.070$$

129.070 < 129.561 but close to value from Table VIII

10.1

1. hypothesis

5. I

9. right-tailed, mean

13. left-tailed, mean

17. a) $H_0: \mu = 245700$
$H_1: \mu < 245700$

b) A Type I error would be sample evidence leading you to reject the null hypothesis and conclude the mean home price is less than \$245,700, when in fact the mean is equal to \$245,700.

c) A Type II error would be sample evidence leading you to not reject the null hypothesis and conclude there is not sufficient evidence that the mean home price is less than \$245,700, when in fact the mean is less than \$245,700.

21. a) $H_0: \mu = 48.79$
$H_1: \mu \neq 48.79$

b) Type I error: The sample evidence led the researcher to believe the mean monthly cell phone bill is different from \$48.79, when in fact the mean bill is \$48.79.

c) Type II error: The sample evidence did not lead the researcher to believe the mean monthly cell phone bill is different from \$48.79, when in fact the mean bill is different from \$48.79.

25. There is not sufficient evidence to conclude the mean price of a single family home in the broker's neighborhood is less than \$245,700.

29. There is sufficient evidence to conclude the mean monthly revenue per cell phone is different from \$48.79 today.

33. There is sufficient evidence to conclude the mean price of a single family home in the broker's neighborhood is less than \$245,700.

37. a) $H_0: p = 0.028$

$H_1: p > 0.028$

b) There is not sufficient evidence to conclude that more than 2.8% of students at the high school use electronic cigarettes.

c) Type II

41. a) $0.04(750000) = \$30,000$

b) ① fixed # of trials ✓ ($n = 20$)

② trials are independent ✓ (one person's answer does not affect another's)

③ two mutually exclusive outcomes ✓ (believe it would be safe to withdraw 6 to 8 percent of their retirement savings annually or do not believe it is safe)

④ probability of success is the same for each trial ✓ ($p = 0.16$)

$n = 20, \quad p = 0.16$

c) $n = 20, \quad p = 0.16, \quad x = 8$

$P(8) = {}_{20}C_8 \, (0.16)^8 \, (1 - 0.16)^{20-8}$

$= 0.0067$

d) $n = 20,\ p = 0.16$

$P(x < 8) = P(0 \text{ or } 1 \text{ or } 2 \text{ or } 3 \text{ or } 4 \text{ or } 5 \text{ or } 6 \text{ or } 7)$

$= P(0) + P(1) + P(2) + P(3) + P(4) + P(5) + P(6) + P(7)$

$= \text{binompdf}(20, 0.16, 0) + \ldots + \text{binompdf}(20, 0.16, 7)$

$= 0.9912$

e) $n = 500$

① simple random sample ✓

② $n \leq 0.05N$

✓ b/c there are over 1 million retirees

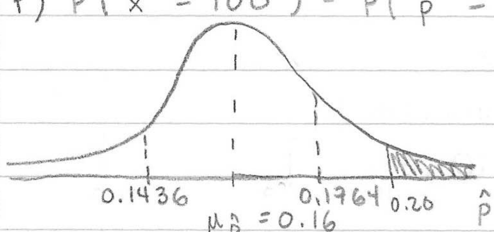
③ $np(1-p) \geq 10$

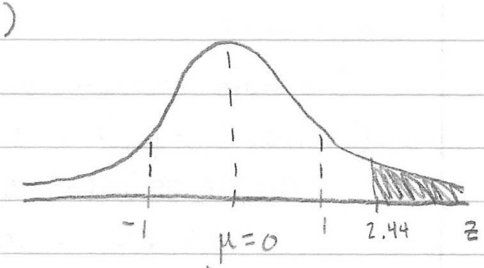
$(500)(0.16)(1-0.16) \geq 10$

$67.2 \geq 10$

∴ the shape of the sampling distribution of $\hat{p}$ is approx. normal w/ $\mu_{\hat{p}} = p = 0.16$ and $\sigma_{\hat{p}} = \sqrt{\dfrac{p(1-p)}{n}} = \sqrt{\dfrac{0.16(1-0.16)}{500}} = 0.0164$

f) $P(x \geq 100) = P(\hat{p} \geq 0.20)$





$P(\hat{p} \geq 0.20) = P\left(\dfrac{\hat{p} - \mu_{\hat{p}}}{\sigma_{\hat{p}}} \geq \dfrac{0.20 - \mu_{\hat{p}}}{\sigma_{\hat{p}}}\right) = P\left(\dfrac{\hat{p} - 0.16}{0.0164} \geq \dfrac{0.20 - 0.16}{0.0164}\right)$

$= P(z \geq 2.44)$

$= 1 - P(z \leq 2.44)$

$= 1 - 0.9927$

$= 0.0073$

Yes this result is unusual b/c $P(\hat{p} \geq 0.20) = 0.0073 < 0.05$. If the true proportion of 60-75-year-olds who believe it is safe is 0.16, we would expect about 7 of every 1000 samples of size 500 to result in at least 100 who believe this. We might conclude from this that the true proportion who believe it is safe is greater than 0.16.

□ Clarify 45. "beyond all reasonable doubt" implies that proof in the mind of a reasonable person is needed which is less of an impossible standard than "beyond all doubt". We never "accept" the statement in the null hypothesis b/c assuming it is true minimizes the probability of a Type I error (convicting an innocent person), by putting the burden of proof on proving or not proving the alternative hypothesis (that a person is guilty).

10.2

1. statistically significant

5. $-z_{\alpha} = -z_{0.1} = -1.28$

9. $H_0: p = 0.55$ versus $H_1: p < 0.55$

$n = 150, \quad x = 78, \quad \alpha = 0.1$

Conditions:

1. simple random sample ✓
2. $np_0(1-p_0) \geq 10$ (normality)

   $(150)(0.55)(1-0.55) \geq 10$

   $37.125 \geq 10$ ✓
3. independence: $n \leq 0.05N$ ✓ (assumed)

Step 1) $H_0: p = 0.55$

$H_1: p < 0.55$ (left-tailed)

Step 2) $\alpha = 0.1$

a) Classical: Step 3) $z_0 = \dfrac{\hat{p} - p_0}{\sqrt{\dfrac{p_0(1-p_0)}{n}}} = \dfrac{0.52 - 0.55}{\sqrt{\dfrac{0.55(1-0.55)}{150}}}$ $\qquad \hat{p} = \dfrac{78}{150} = 0.52$

$z_0 = -0.74$

$-z_{\alpha} = -z_{0.1} = -1.28$

Step 4) $z_0 < -z_{\alpha}$?

$-0.74 \not< -1.28$

$\therefore$ do not reject H_0

Step 5) There is not sufficient evidence to conclude $p < 0.55$ at the $\alpha = 0.1$ level of significance.

b) P-Value:

Step 3) $z_0 = -0.74$

P-value $= P(z < z_0) = P(z < -0.74) = 0.2296$

Step 4) P-value $< \alpha$?

$0.2296 \nless 0.1$

$\therefore$ do not reject H_0

Step 5) There is not sufficient evidence at the $\alpha = 0.1$ level of significance to conclude $p < 0.55$.

13. $H_0: p = 0.5$ P-value $= 0.2743$

$H_1: p > 0.5$ (right-tailed)

About 27 in 100 samples will give a sample proportion as high or higher than the one obtained if the population proportion really is 0.5. Because this probability is not small, we do not reject the null hypothesis. There is not sufficient evidence to conclude that the dart-picking strategy resulted in a majority of winners.

17. $x = 19$, $n = 863$, $\alpha = 0.1$, $p_0 = 0.019$

Conditions: (1) simple random sample ✓

(2) $np_0(1-p_0) \geq 10$

$(863)(0.019)(1-0.019) \geq 10$

$16.085 \geq 10$ ✓

(3) $n \leq 0.05N$

✓ (assuming at least 20,000 patients take Lipitor)

Classical:

Step 1) $H_0: p = 0.019$

$H_1: p > 0.019$ (right-tailed)

Step 2) $\alpha = 0.1$

Step 3) $z_0 = \dfrac{\hat{p} - p_0}{\sqrt{\dfrac{p_0(1-p_0)}{n}}} = \dfrac{0.0220 - 0.019}{\sqrt{\dfrac{0.019(1-0.019)}{863}}}$ $\hat{p} = \dfrac{19}{863} = 0.0220$

$z_0 = 0.65$

$z_\alpha = z_{0.1} = 1.28$

Step 4) $z_0 > z_\alpha$?

$0.65 \not> 1.28$

$\therefore$ do not reject H_0

Step 5) There is not sufficient evidence to conclude that more than 1.9% of Lipitor users experience flulike symptoms as a side effect at the $\alpha = 0.1$ level of significance.

$p_0 = 0.52$, $x = 256$, $n = 800$, $\alpha = 0.05$

21. Conditions: ① simple random sample ✓

② $np_0(1-p_0) \geq 10$

$(800)(0.52)(1-0.52) \geq 10$

$199.68 \geq 10$ ✓

③ $n \leq 0.05N$

✓ b/c at least 1 million parents w/ kids in high school

Classical: Step 1) $H_0: p = 0.52$

$H_1: p \neq 0.52$ (two-tailed)

Step 2) $\alpha = 0.05$

Step 3) $z_0 = \dfrac{0.32 - 0.52}{\sqrt{\dfrac{0.52(1-0.52)}{800}}} = -11.32$

$\hat{p} = \dfrac{256}{800} = 0.32$

$z_{\alpha/2} = z_{0.05/2} = z_{0.025} = 1.96$

$-z_{\alpha/2} = -z_{0.05/2} = -z_{0.025} = -1.96$

Step 4) $z_0 < -z_{\alpha/2}$ or $z_0 > z_{\alpha/2}$?

$-11.32 < -1.96$ $\qquad$ $-11.32 \not> 1.96$

$\therefore$ reject H_0

Step 5) There is sufficient evidence to conclude parents feel differently today ($p \neq 0.52$).

25. $p_0 = 0.964$, $n = 350$, $\alpha = 0.1$, $x = ?$

Conditions: (1) simple random sample ✓

(2) $np_0(1-p_0) \geq 10$

$(350)(0.964)(1-0.964) \geq 10$

$12.15 \geq 10$ ✓

(3) $n \leq 0.05N$

✓ (assuming drive thru has at least 10000 orders)

Step 1) $H_0: p = 0.964$

$H_1: p > 0.964$ (right-tailed)

Step 2) $\alpha = 0.1$

Step 3) $z_0 = \dfrac{\hat{p} - p_0}{\sqrt{\dfrac{p_0(1-p_0)}{n}}}$

$z_\alpha = \dfrac{\frac{x}{n} - 0.964}{\sqrt{\dfrac{0.964(1-0.964)}{350}}}$ $\qquad z_0 = z_\alpha$

$z_{0.1} = \dfrac{\frac{x}{350} - 0.964}{\sqrt{\dfrac{0.964(1-0.964)}{350}}}$

$1.28 = \dfrac{\frac{x}{350} - 0.964}{\sqrt{\dfrac{0.964(1-0.964)}{350}}}$

$0.0127 = \frac{x}{350} - 0.964$

$0.9767 = \frac{x}{350}$

$x = 341.845 \approx \boxed{342}$ $\qquad z_0 > z_\alpha$

$x = 28, \; n = 31$

□ why? 29. a) $H_0: p = 0.5$

$H_1: p > 0.5$ (right-tailed)

b) Let the random variable X represent the number of years the condition holds

□ why? $P(X \geq 28) = 1 - P(X < 28)$

$= 1 - P(X \leq 27)$

$= 1 - \text{binomcdf}(31, 0.5, 27)$

$= 0.000002$

c) Always be careful about drawing conclusions of causation from apparent associations.

$n = 45, \; p_0 = 0.5, \; x = 19$

33. Conditions: ① simple random sample ✓

② $np_0(1-p_0) \geq 10$

$(45)(0.5)(1-0.5) \geq 10$

$11.25 \geq 10$ ✓

③ $n \leq 0.05N$ ✓ b/c at least 1000 NFL games

P-Value: Step 1) $H_0: p = 0.5$

Step 2) $\alpha = 0.05$ $H_1: p \neq 0.5$ (two-tailed)

Step 3) $z_0 = \dfrac{0.4222 - 0.5}{\sqrt{\dfrac{0.5(1-0.5)}{45}}} = -1.04$ $\hat{p} = \dfrac{19}{45} = 0.4222$

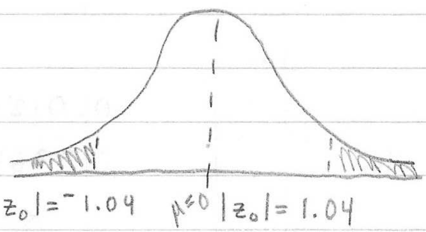
$\text{P-Value} = 2 \cdot P(z > |z_0|)$

$= 2 \cdot P(z > 1.04)$

$= 2(1 - P(z \leq 1.04))$

$= 2(1 - 0.8508)$

$= 0.2984$



Step 4) P-value $<$ α ?

$0.2984 \not< 0.05$

$\therefore$ do not reject H_0

Step 5) Yes, the data suggest the spreads are accurate

□ clarify this problem

37. a) $H_0: p = 0.5$

$H_1: p > 0.5$

b)

c)

d) ① fixed # of trials

② two mutually exclusive outcomes

③ trials are independent

④ probability of success fixed at 0.5

e) $n = 40, \ p = 0.5$

$$P(X \geq 24) = 1 - P(X < 24)$$
$$= 1 - P(X \leq 23)$$
$$= 1 - \text{binomcdf}(40, 0.5, 23)$$
$$= 0.1341$$

f)

g) The sample evidence suggests that savants do not have the ability to predict card color as their results could easily be obtained by chance.

41. If the P-value for a particular test statistic is 0.23, we expect results at least as extreme as the test statistic in about 23 of 100 samples if the null hypothesis is true. Since this event is not unusual, we do not reject the null hypothesis.

45. Statistical significance means that the result observed in a sample is unusual when the null hypothesis is assumed to be true.

10.3

1. a) right-tailed → t_α, $\alpha = 0.01$, df = 15

$t_\alpha = t_{0.01} = 2.602$

b) left-tailed → $-t_\alpha$, $\alpha = 0.05$, n = 20

df = 20 − 1 = 19

$-t_\alpha = -t_{0.05} = -1.729$

c) two-tailed → $-t_{\alpha/2}$, $t_{\alpha/2}$, $\alpha = 0.05$, n = 13

df = 13 − 1 = 12

$-t_{\alpha/2} = -t_{0.05/2} = -t_{0.025} = -2.179$

$t_{\alpha/2} = t_{0.05/2} = t_{0.025} = 2.179$

5. $H_0: \mu = 100$ n = 23

$H_1: \mu \neq 100$ (two-tailed) - population normally distributed

Conditions: ① simple random sample ✓

② no outliers and population normally distributed ✓

(no outliers assumed)

③ $n \leq 0.05N$ ✓ (assumed)

a) $\bar{x} = 104.8$, $s = 9.2$

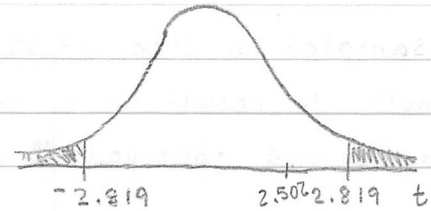
$$t_0 = \frac{\bar{x} - \mu_0}{s/\sqrt{n}} = \frac{104.8 - 100}{9.2/\sqrt{23}} = 2.502$$

b) $\alpha = 0.01$ df = 23 − 1 = 22

$-t_{\alpha/2} = -t_{0.01/2} = -t_{0.005} = -2.819$

$t_{\alpha/2} = t_{0.01/2} = t_{0.005} = 2.819$

c)



d) No, b/c $2.502 \ngtr 2.819$ (t_0 does not fall in the critical region)

e) $99\% \rightarrow \alpha = 1 - 0.99 = 0.01$

Step 2) $\bar{x} = 104.8$, $s = 9.2$

Step 3) $t_{\alpha/2} = t_{0.01/2} = t_{0.005} = 2.819$ $\quad df = 22$

Step 4) LB: $104.8 - (2.819)\left(\frac{9.2}{\sqrt{23}}\right) = 99.392$

UB: $104.8 + (2.819)\left(\frac{9.2}{\sqrt{23}}\right) = 110.208$

Step 5) We are 99% confident the population mean is between 99.392 and 110.208.

$\therefore$ Yes, this supports H_0 being true

9. $H_0: \mu = 105$ $\quad n = 35$

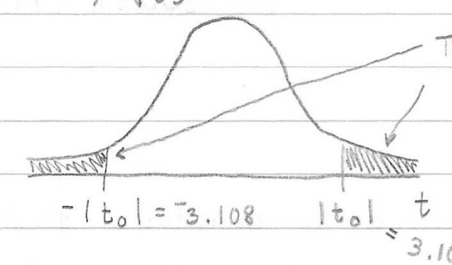
$H_1: \mu \neq 105$ (two-tailed)

a) No, b/c the sample size is large ($n \geq 30$)

b) $\bar{x} = 101.9$, $s = 5.9$

$$t_0 = \frac{101.9 - 105}{5.9/\sqrt{35}} = -3.108$$

c)



d) P-value $= P(t < -3.108) + P(t > 3.108)$ $\quad df = 35 - 1 = 34$

$= 2 \cdot P(t > 3.108)$

$3.002 < t_0 < 3.348$

$2(0.001) <$ P-value $< 2(0.0025)$

$0.002 <$ P-value < 0.005

If we obtain 1000 random samples of size $n = 35$, we would expect between 2 and 5 samples to result in a mean as extreme or more extreme than the one observed if $\mu = 105$.

e) $\alpha = 0.01$

Yes, reject H_0 b/c P-value $< \alpha$

13. $\bar{x} = 22.6$, $s = 3.9$, $n = 200$

a) $H_0 : \mu = 22$

$H_1 : \mu > 22$ (right-tailed)

b) Conditions:

① simple random sample ✓

② $n \geq 30$ ✓

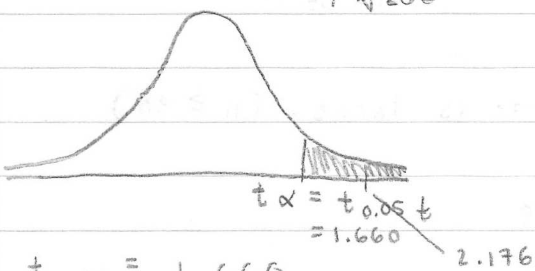
③ $n \leq 0.05N$ ✓ b/c at least 5000 students take ACT

c) $\alpha = 0.05$

Classical

Step 2) $\alpha = 0.05$

Step 3) $t_0 = \dfrac{22.6 - 22}{3.9/\sqrt{200}} = 2.176$



$t_{0.05} = 1.660$ $\qquad$ $df = 200 - 1 = 199$

Step 4) $t_0 > t_\alpha$

$2.176 > 1.660$

$\therefore$ reject H_0

d) There is sufficient evidence to conclude students are scoring above 22 on the math portion of the ACT.

P-value

17. $n = 40$, $\bar{x} = 714.2$, $s = 83.2$, $\alpha = 0.05$

Conditions: ① simple random sample ✓

② $n \geq 30$ ✓

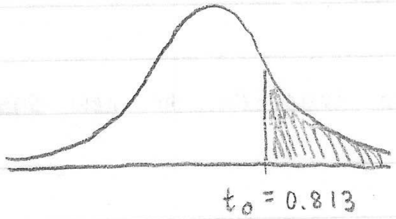
③ $n \leq 0.05N$ ✓ b/c at least 1000 people make \$100,000+/yr

Step 1) $H_0: \mu = 703.5$

$H_1: \mu > 703.5$ (right-tailed)

Step 2) $\alpha = 0.05$

Step 3) $t_0 = \dfrac{714.2 - 703.5}{83.2 / \sqrt{40}} = 0.813$



df = 40 − 1 = 39

P-value = $P(t > 0.813)$

$0.681 < t_0 < 0.851$

$0.20 < \text{P-value} < 0.25$

Step 4) P-value $< \alpha$?

$0.20 - 0.25 \not< 0.05$

∴ do not reject H_0

Step 5) There is not sufficient evidence to conclude high-income individuals have higher FICO scores at the $\alpha = 0.05$ level of significance.

P-value

21. a) Conditions:

① simple random sample ✓

② no outliers and population normally distributed b/c $r = 0.971 > 0.918$ ✓

③ $n \leq 0.05N$ ✓ b/c at least 500 orders

∴ yes

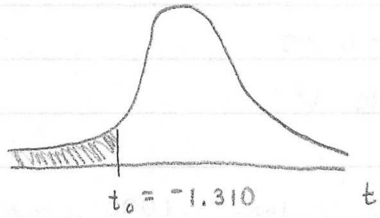
b) Step 1) $H_0: \mu = 84.3$

$H_1: \mu < 84.3$ (left-tailed)

Step 2) $\alpha = 0.1$

Step 3) $t_0 = \dfrac{\bar{x} - \mu_0}{s/\sqrt{n}} = \dfrac{78 - 84.3}{15.2050/\sqrt{10}}$ $\bar{x} = 78$ $s = 15.2050$

$= -1.310$



df = 10 - 1 = 9

$P\text{-value} = P(t < t_o) = P(t < -1.310) = P(t > 1.310)$

$1.100 < t_o < 1.383$

$0.10 < P\text{-value} < 0.15$

Step 4) $P\text{-value} < \alpha$?

$0.10 - 0.15 \not< 0.1$

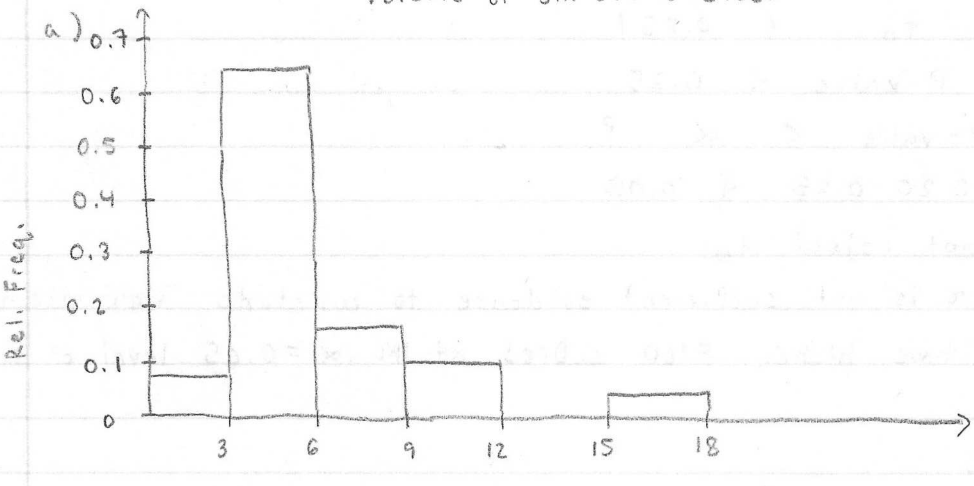
$\therefore$ do not reject H_0

Step 5) There is not sufficient evidence to conclude the new system decreases waiting time.

25. $\mu_o = 7.52$, $n = 40$

a)

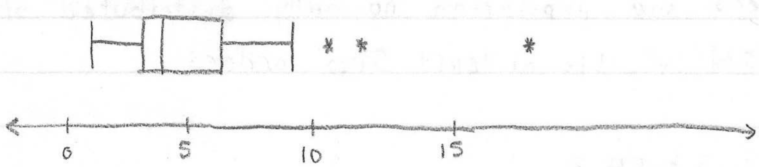
Volume of Starbucks Stock



Volume (millions of shares)

b)

Volume of Starbucks Stock



Volume (millions of shares)

yes, there are outliers

c) The histogram indicates that the data is skewed right and the boxplot shows outliers. $\therefore$ A large sample size is necessary in order to assume the distribution of the mean is normally distributed.

d) $\alpha = 0.05$

Step 0) ① simple random sample ✓

② $n \geq 30$ ✓

P-value

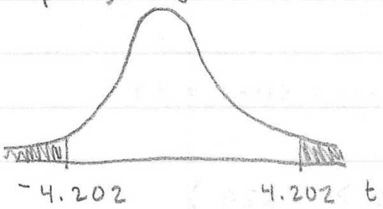
③ $n \leq 0.05N$ ✓ b/c at least 1000 trading days

Step 1) $H_0: \mu = 7.52$

$H_1: \mu \neq 7.52$ (two-tailed)

Step 2) $\alpha = 0.05$

Step 3) $t_0 = {}^{-}4.202$ $\qquad df = 40 - 1 = 39$



P-value $= P(t < {}^{-}4.202) + P(t > 4.202)$

$= 2 \cdot P(t > 4.202)$

P-value < 0.001

Step 4) P-value $< \alpha$?

$0.001 < 0.05$

∴ reject H_0

Step 5) There is sufficient evidence to conclude that the volume of Starbucks stock has changed since 2011.

29. 95% confidence

Step 1) Conditions:

① simple random sample ✓

② $n \leq 0.05N$ ✓

③ $n \geq 30$ ✓

Step 2) $\bar{x} =$ $\qquad s =$

Step 3) $\alpha = 1 - 0.95 = 0.05$ $\qquad df = 40 - 1 = 39$

$t_{\alpha/2} = t_{0.05/2} = t_{0.025} = 2.023$

Step 4) LB: 4.668

UB: 6.521

Step 5) B/c 7.52 is not in the 95% confidence interval, we reject the statement in the null hypothesis. The evidence suggests that the volume of Starbucks stock has changed since 2011.

33. $\mu_0 = 100$, $n = 40$, $\bar{x} = 103.4$, $s = 13.2$

a) The director is testing whether the mean is greater than 100.

Step 0) Conditions:

① simple random sample ✓

② $n \geq 30$ ✓

③ $n \leq 0.05N$ ✓ b/c at least 1000 students

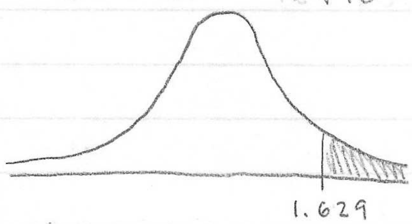
P-value

Step 1) $H_0: \mu = 100$

$H_1: \mu > 100$ (right-tailed)

Step 2) $\alpha = 0.05$

Step 3) $t_0 = \dfrac{103.4 - 100}{13.2/\sqrt{40}} = 1.629$ $df = 40 - 1 = 39$



P-value = $P(t > 1.629)$

$1.304 < t_0 < 1.685$

$0.05 < \text{P-value} < 0.10$

Step 4) P-value $< \alpha$?

$0.05 - 0.10 \not< 0.05$

∴ do not reject H_0

Step 5) There is not sufficient evidence to conclude the mean is greater than 100.

b) The director is testing whether the mean is greater than 101.

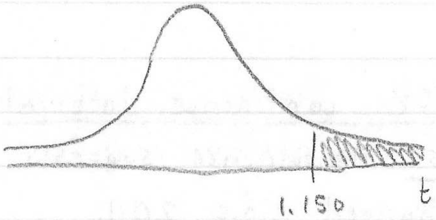
Step 0) done

Step 1) $H_0: \mu = 101$

$H_1: \mu > 101$ (right-tailed)

Step 2) $\alpha = 0.05$

Step 3) $t_0 = \dfrac{103.4 - 101}{13.2/\sqrt{40}} = 1.150$ $df = 40 - 1 = 39$



P-value = $P(t > 1.150)$

$1.050 < t_0 < 1.304$

$0.10 < \text{P-value} < 0.15$

Step 4) P-value $<$ α ?

$0.10 - 0.15 \nless 0.05$

$\therefore$ do not reject H_0

Step 5) There is not sufficient evidence to conclude the mean is greater than 101.

c) The director is testing whether the mean is greater than 102.

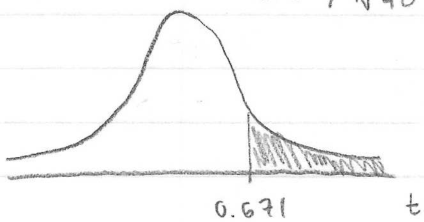
Step 0) done

Step 1) $H_0: \mu = 102$

$H_0: \mu > 102$ (right-tailed)

Step 2) $\alpha = 0.05$

Step 3) $t_0 = \dfrac{103.4 - 102}{13.2 / \sqrt{40}} = 0.671$ $\qquad$ $df = 40 - 1 = 39$



P-value $= P(t > 0.671)$

$t_0 < 0.681$

P-value > 0.25

Step 4) P-value $<$ α ?

$0.25 \nless 0.05$

$\therefore$ do not reject H_0

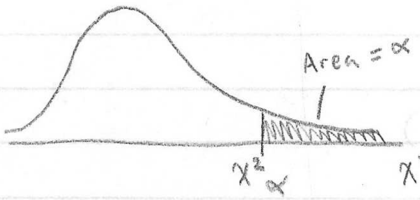
Step 5) There is not sufficient evidence to conclude the mean is greater than 102.

d) If we "accept" rather than "not reject" the null hypothesis, we are saying that the population mean is a specific value, such as 100, 101, or 102, and so we have used the same data to conclude that the population mean is three different values. However, if we do not reject the null hypothesis, we are saying that the population mean could be 100, 101, or 102 or even some other value; we are simply not ruling them out as the value of the population mean. "Accepting" the null hypothesis can lead to contradictory conclusions, whereas "not rejecting" does not.

37. Yes, b/c the head of institutional research has access to the entire population, inference is unnecessary. He can say with 100% confidence that the mean age decreased because the mean age in the current semester is less than the mean age in 1995.

10.4

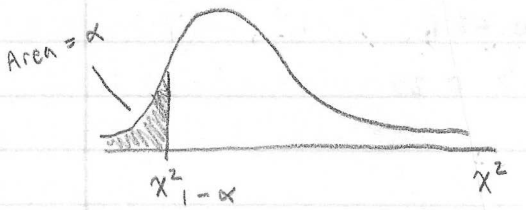
1. a) right-tailed, df = 18, $\alpha = 0.05$



$\chi^2_{\alpha} = \chi^2_{0.05} = 28.869$

b) left-tailed, n = 23, $\alpha = 0.1$

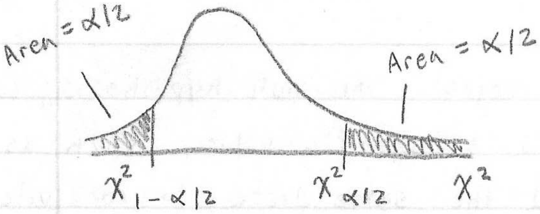
df = 23 − 1 = 22



$\chi^2_{1-\alpha} = \chi^2_{1-0.1} = \chi^2_{0.90} = 14.041$

c) two-tailed, n = 30, $\alpha = 0.05$

df = 30 − 1 = 29



$\chi^2_{1-\alpha/2} = \chi^2_{1-0.05/2} = \chi^2_{0.975} = 16.047$

$\chi^2_{\alpha/2} = \chi^2_{0.05/2} = \chi^2_{0.025} = 45.722$

5. n = 18

Step 0) Conditions:

① simple random sample ✓

② population normally distributed ✓ (given)

Step 1) $H_0: \sigma = 1.8$

$H_1: \sigma > 1.8$ (right-tailed)

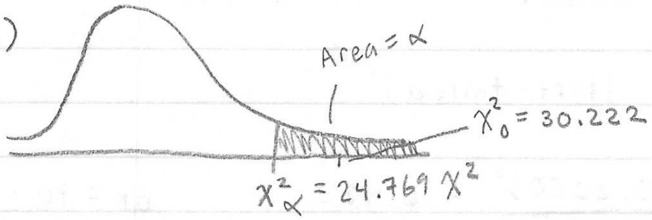
Step 2) $\alpha = 0.10$

a) $s = 2.4$

Classical

Step 3) $\chi^2_0 = \dfrac{(n-1)s^2}{\sigma_0^2} = \dfrac{(18-1)(2.4)^2}{(1.8)^2} = 30.222$

b) c)



$\chi^2_\alpha = \chi^2_{0.10} = 24.769$ $\qquad$ df = 18 − 1 = 17

d) Yes, b/c $\chi^2_0 > \chi^2_{0.10}$

$30.222 > 24.769$

$n = 25$, $s = 0.0301$

9. Step 0) Conditions:

① simple random sample ✓

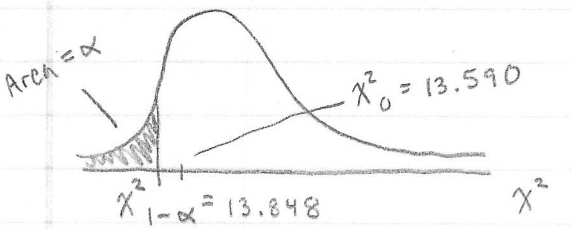
② population normally distributed ✓ (given)

Step 1) $H_0: \sigma = 0.04$

$H_1: \sigma < 0.04$ (left-tailed)

Step 2) $\alpha = 0.05$

Step 3) $\chi^2_0 = \dfrac{(25-1)(0.0301)^2}{(0.04)^2} = 13.590$ $\qquad$ df = 25 − 1 = 24



$\chi^2_{1-\alpha} = \chi^2_{1-0.05} = \chi^2_{0.95} = 13.848$

Step 4) $\chi^2_0 < \chi^2_{0.95}$

$13.590 \not< 13.848$

∴ do not reject H_0

Step 5) There is not sufficient evidence to conclude that the fund has moderate risk at the $\alpha = 0.05$ level of significance.

$n = 10$, $s = 15.2050$

13. Step 0) Conditions:

① simple random sample ✓

② population normally distributed ✓

③ $n \leq 0.05N$ ✓ b/c at least 1000 orders

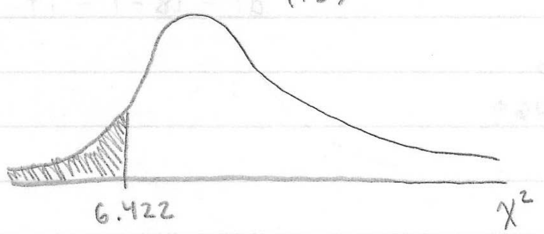
Step 1) $H_0: \sigma = 18$

$H_1: \sigma < 18$ (left-tailed)

Step 2) $\alpha = 0.05$

P-value

Step 3) $\chi^2_0 = \dfrac{(10-1)(15.2050)^2}{(18)^2} = 6.422$ $\quad$ $df = 10 - 1 = 9$



$\text{P-value} = P(\chi^2 < 6.422)$

$= 1 - P(\chi^2 > 6.422)$

$4.168 < \chi^2 < 14.684$

$0.10 < P(\chi^2 > 6.422) < 0.90$

$0.10 < \text{P-value} < 0.90$

Step 4) $\text{P-value} < \alpha$?

$0.10 - 0.90 \not< 0.05$

$\therefore$ do not reject H_0

Step 5) There is not sufficient evidence to conclude the std. dev. of the wait time is less than 18 seconds.

$n = 20$

17. b) $s = 2.059$

c) Step 0) Conditions:

① simple random sample ✓

② population normally distributed ✓ (part a)

③ $n \leq 0.05N$ ✓ b/c at least 500 players

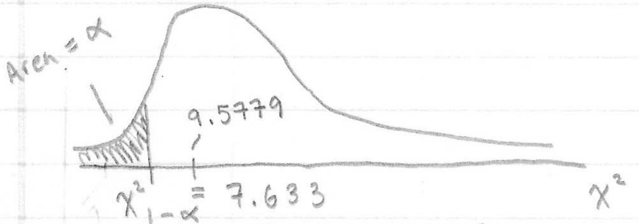
Step 1) $H_0: \sigma = 2.9$

$H_1: \sigma < 2.9$ (left-tailed)

Classical

Step 2) $\alpha = 0.01$

Step 3) $\chi^2_0 = \dfrac{(20-1)(2.059)^2}{(2.9)^2} = 9.5779$ $\quad df = 20 - 1 = 19$



$$\chi^2_{1-\alpha} = \chi^2_{1-0.01} = \chi^2_{0.99} = 7.633$$

Step 4) $\chi^2_0 < \chi^2_{1-\alpha}$?

$9.5779 \not< 7.633$

∴ do not reject H_0

Step 5) There is not sufficient evidence to conclude the standard deviation of heights of baseball players is less than 2.9 inches.