12. Using the z table, find the critical value for each.

a) $\alpha=0.05$, two-tailed test, answer: -1.96,1.96

b) $\alpha=0.01$, left-tailed test, answer: -2.33, 2.33

c) $\alpha=0.005$, right-tailed test, answer: 2.58

d) $\alpha=0.01$, right-tailed test, answer: 2.33

e) $\alpha=0.05$, left- tailed test, answer: -1.65

f) $\alpha=0.02$, left- tailed test, answer: -2.05

g) $\alpha=0.05$, right- tailed test, answer: 1.65

h) $\alpha=0.01$, two- tailed test, answer: -2.58. 2.58

i) $\alpha=0.04$, left- tailed test, answer: -1.75

j) $\alpha=0.02$, right tailed test, answer: 2.05

13. For each conjecture, state the null and alternative hypothesis.

a) The average age of community college student is 24.6 years.

Answer: H_0: $\mu=24.6$ and H_1: $\mu\neq24.6$

b) The average income of accountant is $51,497.

Answer: H_0: $\mu=\$51,497$ and H_1: $\mu\neq\$51,497$

c) The average age of attorney is greater than 25.4 years.

Answer: H_0: $\mu=25.4$ and H_1: $\mu>25.4$

d) The average score of 50 high school basketball games is less than 88.

Answer: H_0: $\mu=88$ and H_1: $\mu<88$

e) The average pulse rate of male marathon runners is less than 70 beats per minute.

Answer: H_0: $\mu=70$ and H_1: $\mu<70$

f) The average cost of DVD player is $79.95

Answer: H_0: $\mu=\$79.95$ and H_1: $\mu\neq\$79.95$

g) The average weight loss for sample of people who exercise 30 minutes per day for 6 weeks is 8.2 pounds.

Answer: H_0: μ=8.2 and $_{H1}$: μ≠8.2

Section 8-2 Pg. 420 Exercises 5, 6, 7, 15, 19, 20, 21, 25

5. Health Care Expenses The mean annual expenditure per 25- to 34-year-old consumer for health care is $1468. This includes health insurance, medical services, and drugs and medical supplies. Students at a large university took a survey, and it was found that for a sample of 60 students, the mean health care expense was $1520, and the population standard deviation is $198. Is there sufficient evidence at $\alpha = 0.01$ to conclude that their health care expenditure differs from the national average of $1468? Is the conclusion different at $\alpha = 0.05$?

$H_0 : \mu = 1468$

$H_1 : \mu \neq 1468$ (claim) (a two-tailed test)

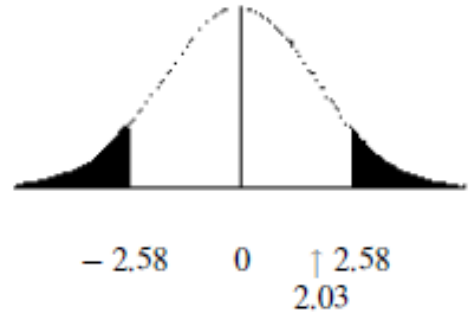$n = 60$ $\overline{X} = 5120$ $s = 198$ $\alpha = 0.01$

$C.V.$ $0.01/2 = 0.005$, $1 - 0.005 = 0.995$,
    then look up in the body of Table $E \rightarrow z_{CV} = 2.58$

$test\ value: \quad z = \dfrac{\overline{X} - \mu}{s/\sqrt{n}} = \dfrac{5120 - 1468}{198/\sqrt{60}} = 2.03$

$-2.58 \qquad 0 \qquad \uparrow 2.58$
$\qquad\qquad\qquad\qquad 2.03$

Do not reject at $\alpha = 0.01$. There is not enough evidence to support the claim that average expenditure differs from $1468. If $\alpha = 0.05$, C.V=1.96. Therefore reject at $\alpha = 0.05$.

6. Peanut Production in Virginia. The average production of peanuts in the state of Virginia is 3000 pounds per acre. A new plan food has been developed and is tested on 60 individual plots of land. The mean yield with the new plant food is 3120 pounds of peanuts per acre with a standard deviation of 578 pounds. At   α= 0.05, can one conclude that the average production has increased?
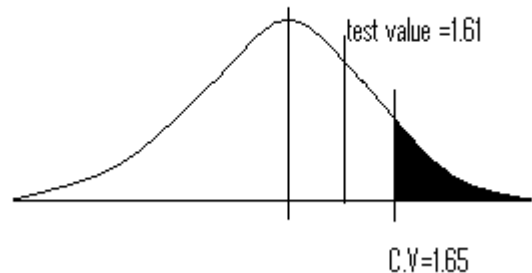
$H_0 : \mu = 3000$

$H_1 : \mu > 3000$ (claim) (a right-tailed test)

$n = 60$ $\overline{X} = 3120$ $s = 578$ $\alpha = 0.05$

$C.V.$ $1 - 0.05 = 0.95$
    then look up in the body of Table $E \rightarrow z_{CV} = 1.65$

$test\ value: \quad z = \dfrac{\overline{X} - \mu}{s/\sqrt{n}} = \dfrac{3120 - 3000}{578/\sqrt{60}} = 1.61$

test value =1.61

C.V=1.65

Since the test value does not fall within the critical region, we don't reject the null hypothesis. Therefore, there is not enough evidence to support the claim that the average production of peanuts in the state of Virginia has increased.

7. **Heights of 1-Year-Olds** The average 1-year-old (both genders) is 29 inches tall. A random sample of 30 one-year-olds in a large day-care franchise resulted in the following heights. At $\alpha = 0.05$, can it be concluded that the average height differs from 29 inches?

25 32   35 25 30 26.5 26 25.5 29.5 32

30 28.5 30 32 28 31.5 29 29.5 30   34
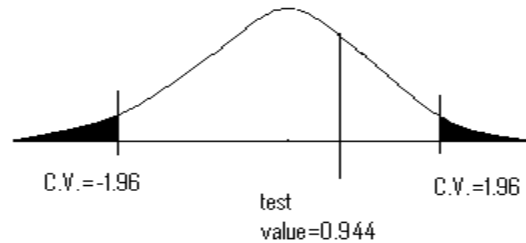
29 32   27 28 33 28   27 32   29   29.5

$H_0 : \mu = 29$

$H_1 : \mu \neq 29$ (claim) (a two- tailed test)

$n = 30$ $\overline{X} = 29.45$ $s = 2.61$ $\alpha = 0.05$

C.V. $z_{CV} = \pm 1.96$

test value : $z = \dfrac{\overline{X} - \mu}{s/\sqrt{n}} = \dfrac{29.45 - 29}{2.61/\sqrt{30}} = 0.944$

C.V.=-1.96   C.V.=1.96
            test
            value=0.944

Do not reject the null hypothesis. There is enough evidence to reject the claim that the average height differs from 29 inches.

15) State whether the null hypothesis should be rejected on the basis of the given P-value.

    a) P-value= 0.258, α=0.05, one tailed test

        If P-value $\leq \alpha$, reject the null hypothesis.

        Since $0.258 > 0.05$, do not reject H_0.

    b) P-value= 0.0684, α=0.10, two tailed test

        Since $(0.0684) \leq 0.10$, reject H_0.

    c) P-value= 0.0153, α=0.01, one tailed test

        Since $0.0153 > 0.01$, do not reject H_0.

    d) P-value= 0.0232, α=0.05, two tailed test

        Since $0.0232 \leq 0.05$, reject H_0.

    e) P-value= 0.002, α=0.01, one tailed test

        Since $0.002 \leq 0.01$, reject H_0.

19) **Burning Calories by playing tennis**. A health researcher read that a 200-pound male can burn an average of 546 calories per hour playing tennis. Thirty-six males were randomly selected and tested. The
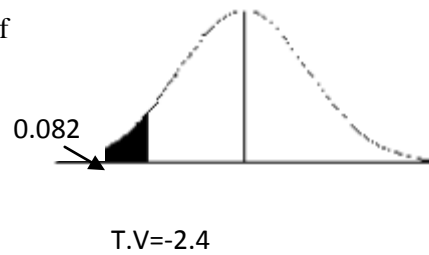
mean of the number of calories burned per hour was 544.8. Test the claim that the average number of calories burned is actually less than 546, and find the P-value. On the basis of the P-value, should the null hypothesis be rejected at α=0.01? The standard deviation of the sample is 3. Can it be concluded that the average number of calories burned is less than originally thought?

$H_0 : \mu = 546$

$H_1 : \mu < 546$ (claim) (a left- tailed test)

$n = 36 \quad \overline{X} = 544.8 \quad s = 3 \quad \alpha = 0.01$

$z = \dfrac{\overline{X} - \mu}{s/\sqrt{n}} = \dfrac{544.8 - 546}{3/\sqrt{36}} = -2.4$

0.082

T.V=-2.4

Look up table E and find the area that corresponds to z=-2.4

The area corresponding to z= -2.4 is 0.082. Thus P-value is 0.082.

Since $0.0082 < 0.01$, we reject H_0. Therefore, there is enough evidence to support the claim that the average number of calories burned per hours is less than 546.

20) **Breaking Strength of Cable.** A special cable has a breaking strength of 800 pounds. The standard deviation of the population is 12 pounds. A researcher selects a sample of 20 cables and finds the average breaking strength is 793 pounds. Can one reject the claim that the breaking strength is 800 pounds? Find the P-value. Should the null hypothesis be rejected at α=0.01? Assume that the variable is normally distributed.

$H_0 : \mu = 800$ (claim)

$H_1 : \mu \neq 800$ (a two- tailed test)

$n = 20 \quad \overline{X} = 793 \quad \sigma = 12 \quad \alpha = 0.01$

$z = \dfrac{\overline{X} - \mu}{\sigma/\sqrt{n}} = \dfrac{793 - 800}{12/\sqrt{20}} \approx -2.61$

0.0045

T.V=-2.61
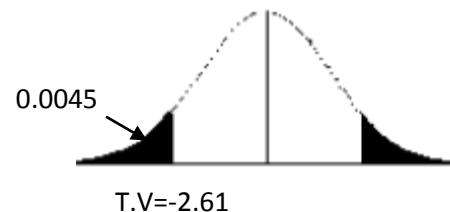
Look up in table E for the area corresponding to the z = - 2.61. The corresponding area is 0.0045. Since this is a two tail test, P-value is 2(0.0045) = 0.0090.

Since $0.0090 < 0.01$, we reject the null hypothesis. Thus, there is enough evidence to reject the claim that the breaking strength is 800 pounds.

21) **Farm Size**. The average farm size in the United States is 444 acres. A random sample of 40 farms in Oregon indicated a mean size of 430 acres, and the population standard deviation is 52 acres. At $\alpha = 0.05$, can it be concluded that the average farm in Oregon differs from the national mean? Use the P-value method.

$H_0 : \mu = 444$

$H_1 : \mu \neq 444$ (claim) (a two tailed test)

$n = 40 \quad \overline{X} = 430 \quad s = 52 \quad \alpha = 0.05$

$z = \dfrac{\overline{X} - \mu}{s/\sqrt{n}} = \dfrac{430 - 444}{52/\sqrt{40}} \approx -1.70$

0.0446

T.V=-1.70
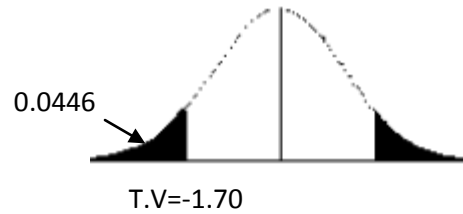
Look up in table E for the area corresponding to the z = - 1.70. The corresponding area is 0.0446. Since this is a two tail test, P-value is 2(0. 0446) = 0.0892.

Is 0.0892 < 0.05? No. Since P-value is not less than or equal to α , we do not reject the null hypothesis. Therefore, there is not enough evidence to support the claim that the mean differs from 444.

25) **Sick Days** A manager states that in his factory, the average number of days per year missed by the employees due to illness is less than the national average of 10. The following data show the number of days missed by 40 employees last year. Is there sufficient evidence to believe the manager statement at α= 0.05? Use the P-value method.

0 6 12 3 3 5 4 1

3 9 6 0 7 6 3 4

7 4 7 1 0 8 12 3

2 5 10 5 15 3 2 5

3 11 8 2 2 4 1 9

$H_0 : \mu = 10$

$H_1 : \mu < 10$ (claim) (a-left tailed test)

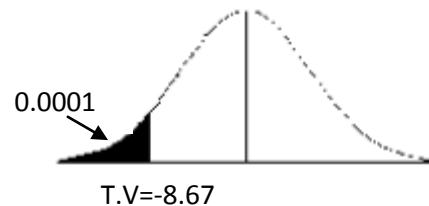$n = 40 \quad \overline{X} = 5.025 \quad s \approx 3.63 \quad \alpha = 0.05$

$z = \dfrac{\overline{X} - \mu}{s/\sqrt{n}} = \dfrac{5.025 - 10}{3.63/\sqrt{40}} \approx -8.67$

Use table E to look up the area that corresponds to the z value of -8.67which is 0.0001. Thus P-value is 0.0001.

0.0001

T.V=-8.67

Since 0.0001 < 0.05, reject the null hypothesis. Hence, there is enough evidence to support the claim that the average number of days per year missed by the employees due to illness is less than the national average of 10 days.

4. Using Table F, find the P-value interval for each test value.

a) $t = 2.321$, n=15, right-tailed

d.f. $= n-1=15-1=14$

      0.01<p-value<0.025

b) $t = 1.945$, n=28, two-tailed

d.f. =n-1=28-1=27

      0.05<p-value<0.10

c) $t = -1.267$, n=8, left-tailed

d.f. =n-1=8-1=7

      0.10<p-value<0.25

d) $t = 1.562$, n=17, two-tailed

d.f. =n-1=17-1=16

      0.10<p-value<0.20

e) $t = 3.025$, n=24, right-tailed

d.f. =n-1=24-1=23

      P-value<0.005

f) $t = -1.145$, n=5, left –tai7led

d.f. =n-1=5-1=4

      0.10<p-value<0.25

Use the traditional method of hypothesis testing unless otherwise specified.

Assume that the population is approximately normally distributed.

5. Veterinary Expenses of Cat Owners According to the American Pet Products Manufacturers Association, cat owners spend an average of $179 annually in routine veterinary visits. A random sample of local cat owners revealed that 10 randomly selected owners spent an average of $205 with s _ $26. Is there a significant statistical difference at a $\alpha = 0.01$?

Traditional Method
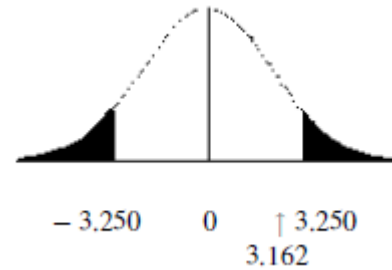
$n = 10,\ \overline{X} = 205,\ s = 26$

$\alpha = 0.01,\ d.f. = 9$

$H_0 : \mu = 179$

$H_1 : \mu \neq 179$ (claim) (a two-tailed test)

$C.V.\ \pm 3.252$

$t = \dfrac{\overline{X} - \mu}{s/\sqrt{n}} = \dfrac{205 - 179}{26/\sqrt{10}} = 3.162$

$-3.250 \qquad 0 \qquad \uparrow 3.250$

3.162

Do not reject the null hypothesis since the test value does not fall within the critical region. There is not enough evidence to support the claim that the average expense is $179.

Is $P-value \leq \alpha$? NO, do not reject the null hypothesis since the P-value is not less than or equal to $\alpha = 0.01$.

There is not enough evidence to support the claim that the average expense is $179.

6. Park Acreage A state executive claims that the average number of acres in western Pennsylvania state park is less than 2000 acres. A random sample of five parks is selected, and the number of acres is shown. At $\alpha = 0.01$, is there enough evidence to support the claim?

959   1187   493   6249   541

Traditional method

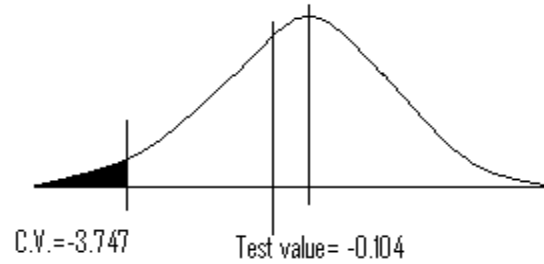$n = 5, \quad \overline{X} = 1885.8, \quad s = 2456.3$

$\alpha = 0.01, \quad d.f. = 4$

$H_0 : \mu = 2000$

$H_1 : \mu < 2000$ (claim) (a left- tailed test)

$C.V. = -3.747$

C.V.=-3.747   Test value= -0.104

$$t = \frac{\overline{X} - \mu}{s / \sqrt{n}} = \frac{1885.8 - 2000}{2456.3 / \sqrt{5}} = -0.104$$

Do not reject the null hypothesis since the test value does not fall within the critical region. There is not enough evidence to support the claim that the average acreage is less than 2000.

P-value method

$n = 5, \quad \overline{X} = 1885.8, \quad s = 2456.3$

$\alpha = 0.01, \quad d.f. = 4$

$H_0 : \mu = 2000$

$H_1 : \mu < 2000$ (claim) (a left- tailed test)

$$t = \frac{\overline{X} - \mu}{s / \sqrt{n}} = \frac{1885.8 - 2000}{2456.3 / \sqrt{5}} = -0.104$$

$P - value > 0.10$

Is $P - value \le \alpha$? No, do not reject the null hypothesis since the P-value is not less than or equal to $\alpha = 0.01$. There is not enough evidence to support the claim that the average acreage is less than 2000.

9. **Heights of Tall Buildings** A researcher estimates that the average height of the buildings of 30 or more stories in a large city is at least 700 feet. A random sample of 10 buildings is selected, and the heights in feet are shown. At α=0.025, is there enough evidence to reject the claim?

485 511 841 725 615

520 535 635 616 582

Test value = -2.71
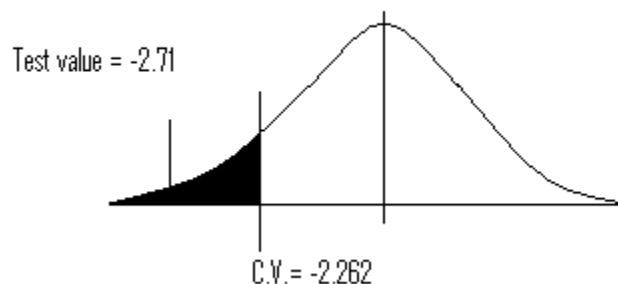
C.V.= -2.262

Traditional method

$n = 10, \ \bar{X} = 606.5, \ s = 109.1$

$\alpha = 0.025, \ d.f. = 9$

$H_0 : \mu = 700 \ (claim)$

$H_1 : \mu < 700 \ (\text{a left-tail test})$

$C.V. = -2.262$

$$t = \frac{\bar{X} - \mu}{s / \sqrt{n}} = \frac{606.5 - 700}{109.1 / \sqrt{10}} = -2.71$$

Reject the null hypothesis since the test value falls within the critical region. There is enough evidence to reject the claim that the average height of the buildings is at least 700 feet.

P-value method

$n = 10, \ \bar{X} = 606.5, \ s = 109.1$

$\alpha = 0.025, \ d.f. = 9$

$H_0 : \mu = 700 \ (claim)$

$H_1 : \mu < 700 \ (\text{a left-tailed test})$

$$t = \frac{\bar{X} - \mu}{s / \sqrt{n}} = \frac{606.5 - 700}{109.1 / \sqrt{10}} = -2.71$$

$0.01 < P - value < 0.025$

Reject the null hypothesis since P-value is less than or equal to $\alpha = 0.025$. There is enough evidence to reject the claim that the average height of the buildings is at least 700 feet.

11. **Cost of College** The average undergraduate cost for tuition, fees, and room and board for two- year institutions last year was $13,252. The following year, a random sample of 20 two-year institutions had a mean of $15,560 and a standard deviation of $3500. Is there sufficient evidence at the $\alpha = 0.01$ level to conclude that the mean cost has increased?

Traditional method

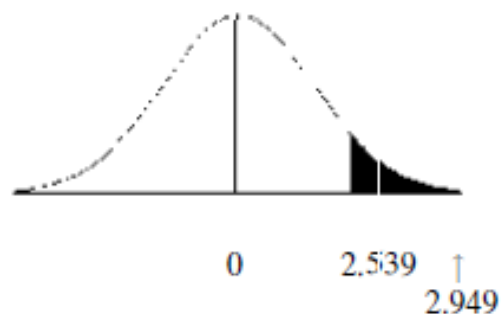$n = 20, \ \bar{X} = \$15,560, \ s = \$3,500$

$\alpha = 0.01, \ d.f. = 19$

$H_0 : \mu = 13252$

$H_1 : \mu > 13252 \ (\text{claim}) \ (\text{a right-tailed test})$

$C.V = 2.539$

$$t = \frac{\bar{X} - \mu}{s / \sqrt{n}} = \frac{15560 - 13252}{3500 / \sqrt{20}} = 2.949$$

0   2.539 ↑
                2.949

Reject the null hypothesis since the test value falls within the critical region. There is sufficient evidence to support the claim that the average tuition cost has increased.

P-value method

$n = 20, \ \bar{X} = \$15,560, \ s = \$3,500$

$\alpha = 0.01, \ d.f. = 19$

$H_0 : \mu = 13252$

$H_1 : \mu > 13252 \ \ (claim) \ right \ tail \ test$

$t = \dfrac{\bar{X} - \mu}{s/\sqrt{n}} = \dfrac{15560 - 13252}{3500/\sqrt{20}} = 2.949$

$P - value < 0.005$

Is $P - value \leq \alpha$? Is $0.005 \leq 0.01$? Yes! Therefore, we reject the null hypothesis.

There is sufficient evidence to support the claim that the average tuition cost has increased.

17. **Doctor Visits** A report by the Gallup Poll stated that on average a woman visits her physician 5.8 times a year. A researcher randomly selects 20 women and obtained these data.

3 2 1 3 7 2 9 4   6 6   8 0 5 6   4 2   1 3 4 1

At $\alpha = 0.05$, can it be concluded that the average is still 5.8 visits per year?
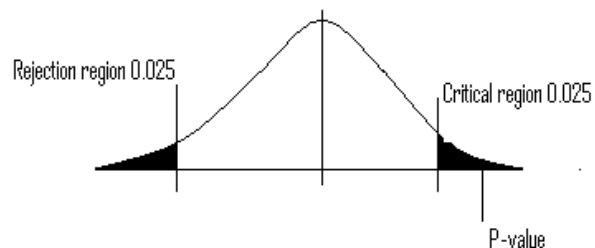
$n = 20, \ \bar{X} = 3.85, \ s = 2.519$

$\alpha = 0.05, \ d.f. = 19$

$H_0 : \mu = 5.8 \qquad H_1 : \mu \neq 5.8 \ (claim) \ (a \ tw$

$t = \dfrac{\bar{X} - \mu}{s/\sqrt{n}} = \dfrac{3.85 - 5.8}{2.519/\sqrt{20}} = -3.46$

$P - value < 0.01$

Rejection region 0.025

Critical region 0.025

P-value

Is $P - value \leq \alpha$? $0.01 \leq 0.05$? yes, then we reject the null hypothesis.

There is enough evidence to support the claim that the mean is not 5.8.

Section 8-4 P440 #13, 16, 17, 19. (Use P-value method)

13) After school Snacks. In the Journal of the American Dietetic Association, it was reported that 54% of kids said that they had a snack after school. Test the claim that a random sample of 60 kids was selected

and 36 said that they had a snack after school Use α= 0.01 and the p-value method. On the basis of the results, should parents be concerned about their children eating a healthy snack?
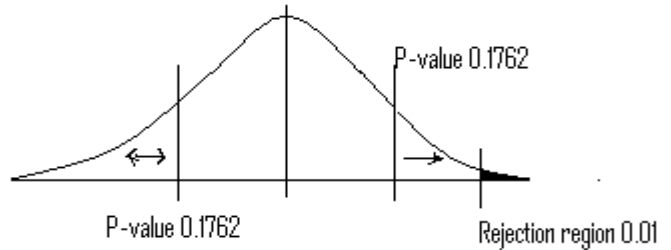
P=0.54, n=60, x=36, α= 0.01, $\hat{p} = \dfrac{x}{n} = \dfrac{36}{60} = 0.6$

q=1-p, q=1-0.54, q=0.46

Ho: p=0.54(claim)   H₁: p≠ 0.54

A two-tailed test.

$z = \dfrac{\hat{p} - p}{\sqrt{\dfrac{pq}{n}}} = \dfrac{0.6 - 0.54}{\sqrt{\dfrac{(0.54)(0.46)}{60}}} = 0.93$.

P-value 0.1762

P-value 0.1762   Rejection region 0.01

Find the area that corresponds to z=0.93 in the E-table. The area is 0.8238.

Since this is a two tail test, the P-value is 2(1-0.8238)=0.3524.

Then compare P(value) with α. 0.3524 > 0.01. Since the P(value) is not less than or equal to α, we do not reject the null hypothesis.

There is enough evidence to support the claim that 54% of children have snacks after school. Yes, healthy snacks should be monitor by their parents.

16) Credit Card Usage. For certain year a study reports that the percentage of college students using credit cards was 83%. A college dean of student services feels that this is too high for her university, so she randomly selects 50 students and finds that 40 of them use credit cards. At α=0.04, is she correct about her university?
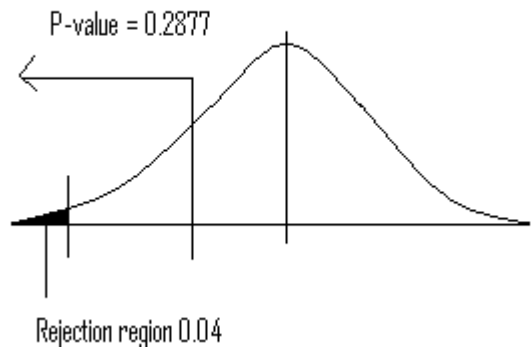
P=0.83, n=50, x=40, α= 0.04, $\hat{p} = \dfrac{x}{n} = \dfrac{40}{50} = 0.8$

q=1-p, q=1-0.83, q=0.17

P-value = 0.2877

Ho: p= 0.83   Hi: p<0.83 (claim)

A left-tested test.

$z = \dfrac{\hat{p} - p}{\sqrt{\dfrac{pq}{n}}} = \dfrac{0.8 - 0.83}{\sqrt{\dfrac{(0.83)(0.17)}{50}}} = -0.56$

Rejection region 0.04

Find the area that corresponds to z= -0.56 in the E-table. The area is 0.2877.

Thus, the P(value) is 0.2877.

Then compare P(value) with α. 0.2877 > 0.04. Since the P(value) is not less than or equal to α, we do not reject the null hypothesis.

There is not enough evidence to support the claim that students who use credit cards are less than 83%.

17) Borrowing library Books. For American using library services, the American Library association (ALA)claims that 67% borrow books. A library director feels this is not true, so she randomly selects 100 borrowers and finds that 82 borrowed books. Can he show that the ALA claims is incorrect? Use α= 0.05?

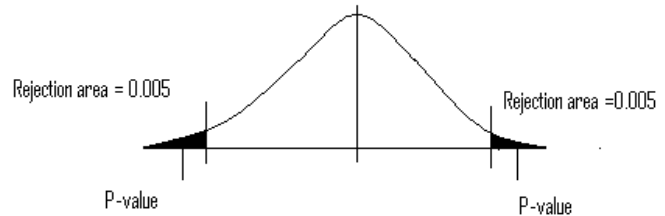P=0.67, n=100, x=82, α= 0.05, $\hat{p} = \dfrac{x}{n} = \dfrac{82}{100} = 0.82$

q=1-p, q=1-0.67, q=0.33

Ho: p=0.67   Hi: p≠ 0.67(claim)

A two- tailed test.

$$z = \dfrac{\hat{p} - p}{\sqrt{\dfrac{pq}{n}}} = \dfrac{0.82 - 0.67}{\sqrt{\dfrac{(0.67)(0.33)}{100}}} = 3.19$$

Rejection area = 0.005   Rejection area =0.005

P-value   P-value

Find the area that corresponds to z=3.19 in the E-table. The area is 0.0.9993

Now the P(value) is 2(1-0.9993)=0.0014

Then compare P(value) with α. 0.0014 < 0.05. Since the P(value) is less than α, we reject the null hypothesis.

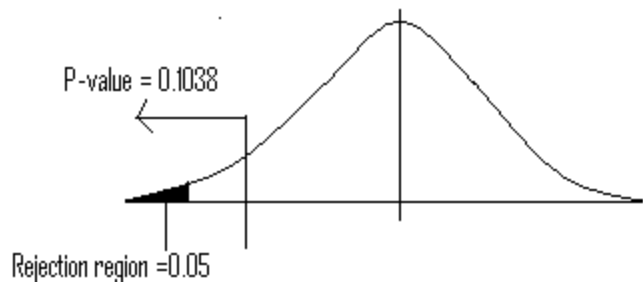There is enough evidence to support the claim that the percentage is not 67% .

19) Football Injuries. A report by the NCAA states that 57.6% of football injuries occur during practices. Ahead trainer claims that this is too high for his conference, so he randomly selects 36 injuries and finds that 17 occurred during practices. Is his claim correct, at α= 0.05?

P=0.576, n=36, x=17, α= 0.05, $\hat{p} = \dfrac{x}{n} = \dfrac{17}{36} = 0.472$

q=1-p, q=1-0.576, q=0.424

P-value = 0.1038

Ho: p= 0.576   Hi: p<0.576 (claim)

A left tailed- test.

Rejection region =0.05

$$z = \frac{\hat{p} - p}{\sqrt{\dfrac{pq}{n}}} = \frac{0.472 - 0.576}{\sqrt{\dfrac{(0.576)(0.424)}{36}}} = -1.26$$

Find the area that corresponds to z= -1.26 in the E-table. The area is 0.1038.

Thus, the P(value) is 0.1038.

Then compare P(value) with α. 0.1038 > 0.05. Since the P(value) is not less than or equal to α, we do not reject the null hypothesis.

There is not enough evidence to support the claim that the football injuries during practice is less than 57.6%.