

```

2-PropZInt
x1:45
n1:50
x2:38
n2:51
C-Level:.95
Calculate

```

```

2-PropZInt
(.00923, .30057)
p1=.9
p2=.7450980392
n1=50
n2=51

```

Notice that the calculator gives the same interval as the interval that is calculated by hand but with more decimal places.

The confidence interval can be written mathematically using either inequality symbols or interval notation, as shown below.

$$0.009 < p_1 - p_2 < 0.301$$

or

$$(0.009, 0.301)$$

Therefore, we are 95% confident that the percentage of students who passed the class is between 0.9% and 30.1% higher for the population of students who used the new instructional technology (Population 1) than for the population of students who did not use the technology (Population 2). Thus, with 95% confidence, the professor can conclude that the new instructional technology does improve students' scores.

## 9.4 Section Exercises

### Necessary Conditions for Using the Normal Distribution to Compare Two Population Proportions

*Verify that the normal distribution can be used to compare the population proportions using the given information, or show how the conditions have not been met.*

- $n_1 = 130$ ,  $n_2 = 200$ ,  $\hat{p}_1 \approx 0.869$ ,  $\hat{p}_2 = 0.72$
- $n_1 = 1100$ ,  $n_2 = 1200$ ,  $\hat{p}_1 = 0.05$ ,  $\hat{p}_2 = 0.01$
- $n_1 = 23$ ,  $n_2 = 14$ ,  $\hat{p}_1 \approx 0.435$ ,  $\hat{p}_2 \approx 0.714$
- $n_1 = 19$ ,  $n_2 = 12$ ,  $\hat{p}_1 \approx 0.158$ ,  $\hat{p}_2 \approx 0.333$

### Point Estimates for Differences between Two Population Proportions

*Find each specified point estimate.*

- Sample 1 has 17 “yes” responses out of 97 responses in the sample, and Sample 2 has 46 “yes” responses out of 131 responses in the sample. Calculate the point estimate for the difference between the population proportions of “yes” responses.
- A random sample of records from Public School A shows that 61 out of 156 students started first grade having already lost their first tooth, while at Public School B, 46 out of a random sample of 121 students had lost their first tooth before entering first grade. Find the point estimate for the difference between the population proportions of students who have lost their first tooth before entering first grade at the two schools.
- Given that the first sample had 15 broken eggs out of 360 eggs in the sample and that the second sample had 12 broken eggs out of 540 eggs, find the point estimate for the difference between the population proportions of broken eggs.

8. Find the point estimate for the difference between the population proportions of “no” votes given the following information. Sample A: 16 no, 32 yes. Sample B: 43 no, 55 yes.

### Margins of Error of Confidence Intervals for Differences between Two Population Proportions

*Calculate the margin of error of a confidence interval for the difference between the two population proportions using the given information.*

9.  $n_1 = 130$ ,  $n_2 = 200$ ,  $\hat{p}_1 \approx 0.869231$ ,  $\hat{p}_2 = 0.72$ , 95% level of confidence
10.  $n_1 = 1100$ ,  $n_2 = 1200$ ,  $\hat{p}_1 = 0.05$ ,  $\hat{p}_2 = 0.01$ ,  $\alpha = 0.05$
11.  $n_1 = 88$ ,  $n_2 = 74$ ,  $\hat{p}_1 \approx 0.431818$ ,  $\hat{p}_2 \approx 0.608108$ ,  $c = 0.99$
12.  $n_1 = 24$ ,  $n_2 = 39$ ,  $\hat{p}_1 \approx 0.542$ ,  $\hat{p}_2 \approx 0.641$ ,  $c = 0.90$
13. The following table shows a random sample of data collected by a state highway patrolman on whether the driver in the vehicle in a traffic stop was wearing a seat belt. Group A consists of vehicles that were stopped for what the officer considered serious offenses, and Group B consists of vehicles that were stopped for minor offenses. Using a 99% level of confidence, calculate the margin of error for the true difference between the proportions of drivers who do not wear their seat belts for the populations of drivers stopped for major offenses and those stopped for minor offenses.

Seat Belt Use		
	No	Yes
Group A	73	486
Group B	159	453

14. The data below represent a random sample of students from a community college (which would only have freshmen and sophomores), showing how many students in the sample are attending school without financial aid and with financial aid. Calculate the margin of error of the 90% confidence interval for the true difference between the proportions of freshmen and sophomores who are attending school without financial aid.

Financial Aid		
	Freshmen	Sophomores
Without Aid	36	68
With Aid	72	36

15. The data below are the proportions of respondents from surveys conducted in January and May who said they feel strongly that the mayor is doing a good job.

January: 365 out of 500

May: 402 out of 600

Using a 90% level of confidence, calculate the margin of error for the true difference between the population proportions of people who feel strongly that the mayor is doing a good job.

## Confidence Intervals for Differences between Two Population Proportions

**Construct and interpret each specified confidence interval.**

**Note:** You may assume the requirements mentioned in this section are met; namely, all samples are independent, simple random samples, the conditions for a binomial distribution are met, and the sample sizes are large enough to ensure that  $n_1 \hat{p}_1 \geq 10$ ,  $n_1 (1 - \hat{p}_1) \geq 10$ ,  $n_2 \hat{p}_2 \geq 10$ , and  $n_2 (1 - \hat{p}_2) \geq 10$ .

16. Doctors at a fertility clinic wish to determine if taking fertility drugs increases the chances of a multiple birth (having two or more babies at once). Doctors record the number of multiple births and the number of single births for a sample of patients taking fertility drugs and a sample of patients not taking fertility drugs. The data are shown below. Construct and interpret a 99% confidence interval for the true difference between the proportions of multiple births for women taking fertility drugs and those who are not.

Fertility Drugs		
	With Drugs	Without Drugs
Single Birth	32	43
Multiple Birth	12	13

17. Psychiatrists wish to determine if there is a higher incidence of divorce among couples in which one of the spouses has suffered a serious head injury than among the general population. Of 51 couples who were married at the time one of the spouses had a serious head injury, 20 are still married. Of 50 randomly selected couples in which no head injury occurred, 24 have remained married during this same time period. Construct and interpret a 95% confidence interval for the true difference between the divorce rates of couples in which a head injury occurred and the general population.
18. Do a larger percentage of Southerners than Northerners attend church on a weekly basis? Random samples of Northerners and Southerners are interviewed about their church attendance and the results of the survey are shown below. Construct and interpret a 90% confidence interval for the true difference between the percentages of Northerners and Southerners who attend church on a weekly basis.

Church Attendance		
	Northerners	Southerners
Attend Church Weekly	12	35
Do Not Attend Church Weekly	34	16

19. For his senior research project, Ryan is investigating factors that contribute to high school dropout rates. One factor of interest to him is whether kids who are involved in team sports as children are less likely to drop out of high school. He surveys 41 high school graduates and finds that 30 were involved in team sports as children. He surveys 38 high school dropouts and finds that 23 were involved in team sports as children. Construct and interpret a 90% confidence interval for the true difference between the proportions of high school graduates and dropouts who participated in team sports as children.
20. A hedge fund analyst wishes to know which is more open to risk in their investment portfolios, traditional banks or credit unions. He sends out a survey to 100 traditional banks and 100 credit unions, asking them whether they are open to a specified level of risk in their investment portfolios. In response to the survey, 49 of the 100 traditional banks in the sample said yes, and 52 of the 100 credit unions in the sample said yes. Construct and interpret a 95% confidence interval for the true difference between the proportions of traditional banks and credit unions who are open to risk in their investment portfolios.

21. For his senior psychology project, Robert wants to explore which generation is more honest, Baby Boomers or Millennials. To do this, he leaves a wallet filled with money and identification cards in a local store and hides a video camera to record the results. He repeats the experiment 80 times. Of the 37 Millennials who picked up the wallet, 30 returned it to Robert. Of the 43 Baby Boomers who found the wallet, 29 returned it to him. Construct and interpret a 90% confidence interval for the true difference between the proportions of Baby Boomers and Millennials who will return a lost wallet.
22. Ann, a teacher, is concerned with the obsession many of her students have with video games. She is afraid that the video games have a negative impact on her students' performance in the classroom. To test her theory, Ann sends home a letter explaining the study, and 82 parents agree to let their children participate. Ann then randomly divides the students into two equal groups. Group A is required to play video games for two hours one evening, while Group B is not allowed any time to play video games. The following day, the students are given a review test over previously learned material. From Group A, 29 students pass the test. From Group B, 34 students pass the test. Construct and interpret a 95% confidence interval for the true difference between the proportions of students who pass the test and play video games for two hours on the night before the test and those who pass the test but do not play games. Use the confidence interval to determine whether the evidence suggests that playing video games negatively impacts students' performance.
23. Frank owns a nursery, and he has had trouble in the past getting his gerbera daisies to bloom. This spring, he has decided to experiment with a new, more expensive fertilizer called FertiGro. Of the 40 plants that he treats with his regular fertilizer, 27 bloom. Of the 35 that he treats with FertiGro, 29 bloom. Construct and interpret a 99% confidence interval for the true difference between the proportions of gerbera daisy plants that bloom for the populations of plants treated with FertiGro and those treated with regular fertilizer.
24. A state politician is interested in knowing how voters in rural areas and cities differ in their opinions about gun control. For his study, 75 rural voters were surveyed, and 41 were found to support gun control. Also included in the study were 75 voters from cities, and 53 of these voters were found to support gun control. Construct and interpret a 90% confidence interval for the true difference between the proportions of rural and city voters who favor gun control.
25. Aaliyah wants to know if there is a difference between the proportions of customers who just order water to drink at two popular restaurants in town. She collected the data in the following table. Construct and interpret a 95% confidence interval for the true difference between the proportions of customers who just order water to drink at Restaurants A and B.

Drink Orders		
	Water	Other Beverage
Restaurant A	61	52
Restaurant B	68	72

26. A local city government is trying to promote road safety by encouraging drivers to buckle up. Its campaign director is trying to decide to which age group she should direct most of the promotions. She believes that fewer older adults buckle up, as they came from a generation who grew up without seat belts. She surveyed 49 senior adults and found that 30 of them buckle up on a regular basis. She then surveyed 52 middle-aged adults and found that 42 of them buckle up on a regular basis. Construct and interpret a 90% confidence interval to estimate the true difference between the proportions of senior adults and middle-aged adults who wear seat belts on a regular basis.

27. Early-childhood-development studies indicate that the more often a child is read to from birth, the earlier the child begins to read. A local parents' group wants to test this theory and samples families with young children. They find the following results. Construct and interpret a 98% confidence interval to estimate the true difference between the proportions of children who read at an early age when they are read to frequently compared to those who were read to less often, as described in the table of results.

<b>Ages When Children Begin to Read</b>		
	<b>Read to at Least Three Times per Week</b>	<b>Read to Fewer than Three Times per Week</b>
<b>Started Reading by Age 4</b>	46	31
<b>Started Reading after Age 4</b>	40	57