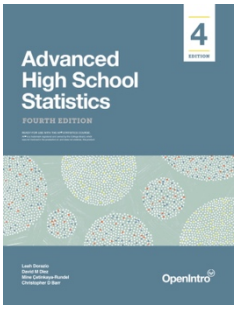
NUMWORKS CALCULATOR FUNCTIONS FOR AP STATISTICS.

EXCERPTED FROM *ADVANCED HIGH SCHOOL STATISTICS, 4TH ED*, available for free at openintro.org/ahss.



numworks.com/simulator

also available as an online app at: board.numworks.com

- Summarizing a single Variable
- Binomial probabilities
- Normal probabilities and boundary values
- Inference for a population proportion
- Inference for a difference of population proportions
- Chi-square for one-way tables (special topic)
- Chi-square distribution probabilities
- Chi-square for two-way tables
- *t*-distribution probabilities and boundary values
- Inference for a population mean or a population mean of differences
- Inference for a difference of population means
- Scatterplots and regression

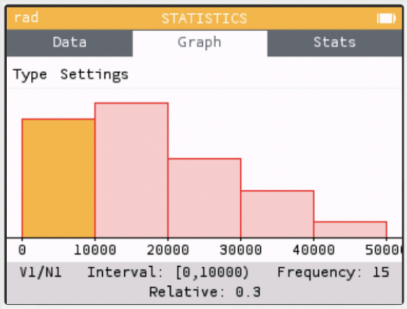
1.4.8 Technology: summarizing a single variable

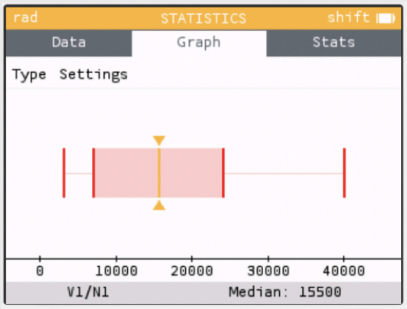
Download the `loan50` CSV file from openintro.org/data. Open it and graphically and numerically summarize the `loan_amount` variable.

NUMWORKS: SUMMARIZING DATA

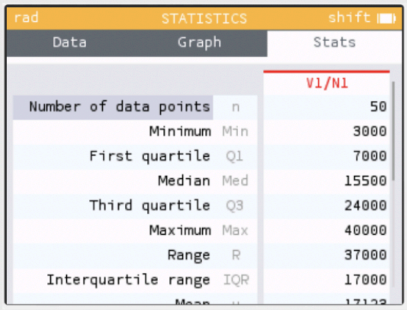
Use `OK` or `EXE` to make a selection.

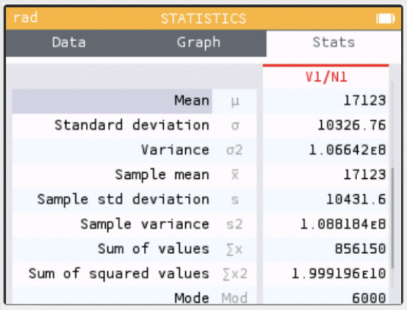
1. Click the yellow Home button (above the black Power button) to get to the home screen and select `Statistics`.
2. Make sure you have `Data` at the top highlighted, then enter your values. Use the `x` button near the upper right to delete an entry. To clear a whole list, press the up arrow until the list name is highlighted, then press the `x` button, right arrow, and choose `Confirm`.
3. Use the arrows to choose `Graph` and choose the desired graph. Note that you can use the arrows to get to `Settings` to change the Bin width and X start for a Histogram. Using arrows on Boxplot will show each value of the 5-number summary.





4. Use the arrows to choose `Stats` to see the summary statistics. Use the down arrow to see more summary statistics.





2.5.7 Technology: binomial probabilities

A spinner has four equally likely options: red, green, blue, yellow. If you spin the spinner 6 times, what is the probability you get:

a) Exactly 2 red?

b) Less than 2 red?

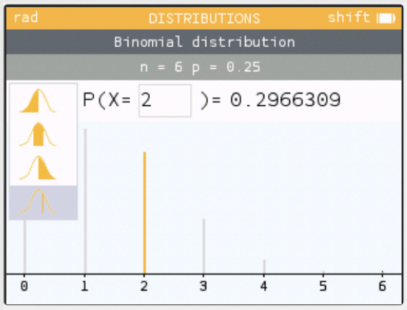
c) At least 3 red?

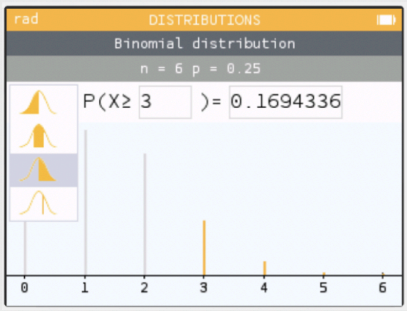
This scenario describes a **binomial distribution** with $n = 6$ and $p = 0.25$.

NUMWORKS: BINOMIAL CALCULATIONS

Use OK or EXE to make a selection.

1. From the home screen, select Distributions then select Binomial. If a list of distributions does not appear, hit the ↩ button (next to OK) as many times as needed.
2. Enter the values of n and p then choose Next. If the screen shows a graph rather than asking for n and p, hit the ↩ button.
3. Hit the left arrow to highlight the graph. Hit the down arrow to choose whether you want left, inner, right, or exactly, then hit OK. Hit the right arrow and enter the boundary value(s) followed by EXE.





2.6.4 Technology: normal probabilities and boundary values

Given a standard normal distribution ($\mu = 0$, $\sigma = 1$),

(i) find the following probabilities:

(a) Probability of a value between -2 and 2.

(b) Probability of a value less than -1.5.

(ii) find the following boundary values:

(a) The value that corresponds to the 40th percentile.

(b) The value $z^\star$ such that 95% of the distribution lies between $-z^\star$ and $z^\star$.

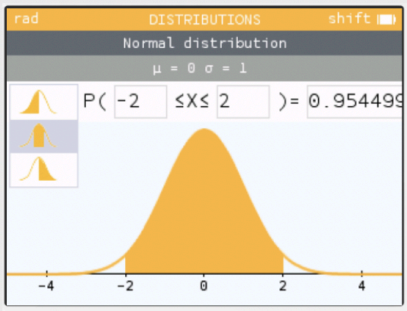
*With the standard normal distribution ($\mu = 0$, $\sigma = 1$), the values of the distribution correspond to Z-scores. If a problem involves a normal distribution with a different mean and standard deviation (e.g. battery life), we can use the mean and standard deviation of that distribution in place of 0 and 1.

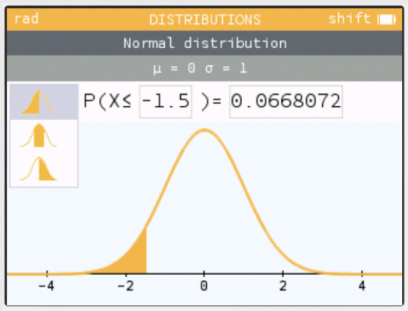
NUMWORKS: NORMAL PROBABILITIES AND BOUNDARY VALUES

Use OK or EXE to make a selection.

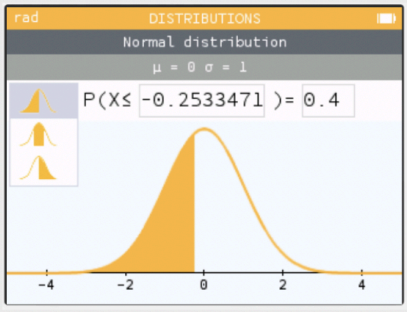
1. From the home screen, select Distributions then select Normal. If a list of distributions does not show up, hit the ↩ button (next to OK) as many times as needed.
2. Enter μ and σ then choose Next. Note: if the screen shows a graph, hit the ↩ button.
3. Hit the left arrow to highlight the graph. Hit the down arrow to choose whether you want left, inner, or right, then hit OK. Hit the right arrow to enter the desired value(s).

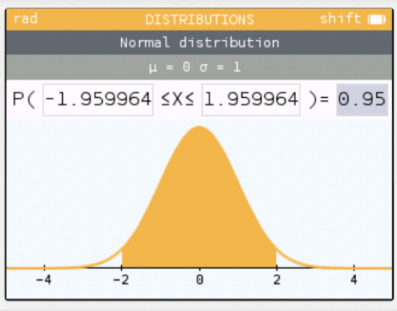
   (i) For a probability, enter the boundary value(s), then hit EXE.





   (ii) For a boundary value, enter the desired area as a decimal to the right of the = sign, then hit EXE.





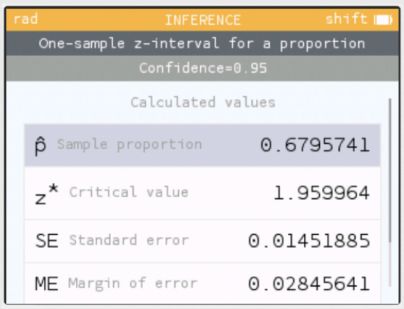
3.4.8 Technology: the one-sample Z-interval and Z-test for p

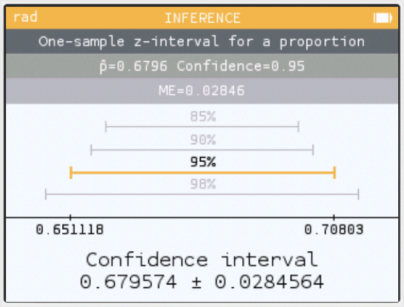
Evaluate the 95% confidence interval from Example 3.29 to estimate the proportion of US adults who think there is intelligent life on other planets. Also find the test statistic and p-value for a test to see if there is evidence that the true proportion differs from 0.70. The sample percent was 68% and the sample size was 1,033. Conditions were verified to be met.

NUMWORKS: 1-PROPORTION Z-INTERVAL

Use OK or EXE to make a selection.

1. From the home screen, select Inference, then Intervals, then One proportion. If these options do not appear, click the ↩ button in the upper right as many times as needed.
2. Enter the values of x, n, and Confidence level. Hit the down arrow and choose Next.
3. Note the quantities returned. Click the down arrow and choose Next.
4. In addition to seeing the confidence interval displayed in two ways, you can press the up and down arrows to quickly change confidence level and see the resulting interval and margin of error.

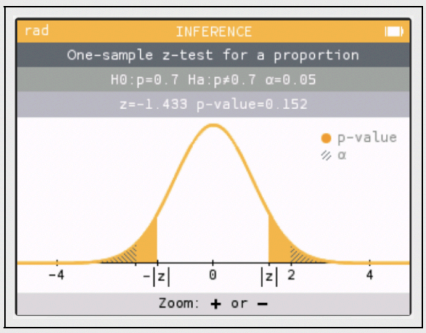


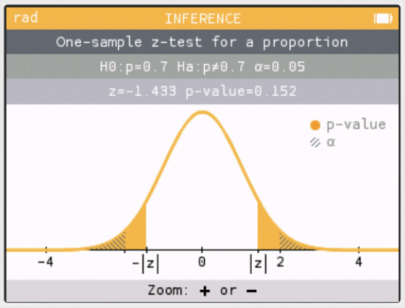


NUMWORKS: 1-PROPORTION Z-TEST

Use OK or EXE to make a selection.

1. From the home screen, select Inference, then Tests, then One proportion. If these options do not appear, click the ↩ button in the upper right as many times as needed.
2. Enter the value of the hypothesized proportion for the Null hypothesis. Press the down arrow. Press OK and choose <, ≠ , or > for the Alternative hypothesis. Press the down arrow and choose Next.
3. Enter the values of x, n, and α. Hit the down arrow and choose Next.
4. Note the quantities returned. Click the down arrow and choose Next.
5. On this screen, the p-value and alpha are shaded on the normal distribution and can be visually compared.





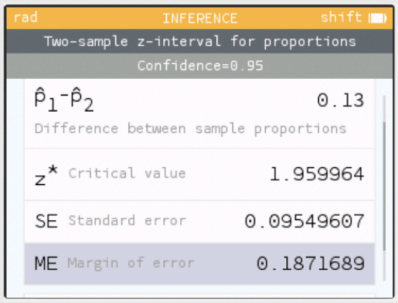
3.7.4 Technology: the two-sample Z-interval and Z-test for $p_1 - p_2$

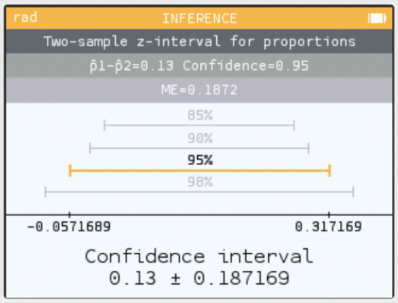
Figure 3.16, summarizes an experiment involving patients admitted to a hospital for a heart attack. 14 out of the 40 patients assigned to the treatment (blood thinner) group survived versus 11 out of 50 assigned to the control group. Calculate a 95% confidence interval for a difference in the proportion (treatment – control) that would survive. Also calculate the test statistic and p-value to test whether there is evidence that the true proportions *differ*. Conditions have been verified.

NUMWORKS: 2-PROPORTION Z-INTERVAL

Use OK or EXE to make a selection.

1. From the home screen, select Inference, then Intervals, then Two proportions. If these options do not appear, click the ↩ button in the upper right as many times as needed.
2. Enter x_1, n_1, x_2, n_2, and Confidence level, then choose Next.
3. Click the down arrow to see all quantities returned and then choose Next.
4. In addition to seeing the confidence interval displayed in two ways, you can press the up and down arrows to quickly change confidence level and see the resulting interval and margin of error.

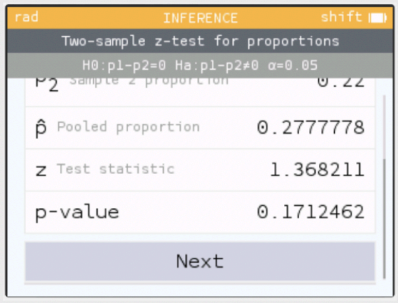


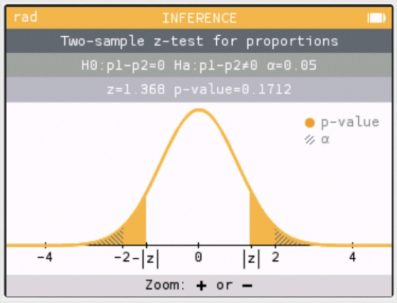


NUMWORKS: 2-PROPORTION Z-TEST

Use OK or EXE to make a selection.

1. From the home screen, select Inference, then Tests, then Two proportions. If these options do not appear, click the ↩ button in the upper right as many times as needed.
2. Enter the hypothesized difference. Usually this will be 0. Press the down arrow. Press OK and choose <, ≠ , or > for the Alternative hypothesis. Press the down arrow and choose Next.
3. Enter the values of x_1, n_1, x_2, n_2, and α. Hit the down arrow and choose Next.
4. Note the quantities returned. Click the down arrow to see all of the values, including the p-value, then choose Next.
5. On this screen, the p-value and alpha are shaded on the normal distribution and can be visually compared.





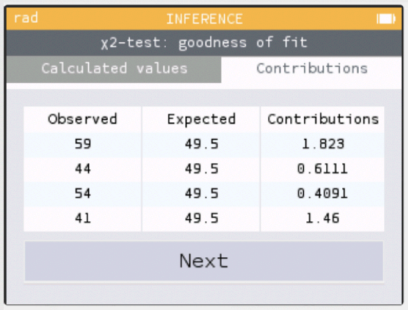
3.8.5 Technology: the chi-square goodness of fit test

A spinner has four colors that are supposed to be equally likely: red, green, blue, yellow. Someone records the number of each color after many spins in a game. After 200 spins, there are 59 red, 44 green, 54 blue and 41 yellow. Use technology to find the test statistic, df, and p-value for a chi-square goodness of fit test, testing whether there is evidence that the colors do not have the same likelihood of coming up. Also find the expected values and chi-square contributions for the test. Assume conditions for the test are met.

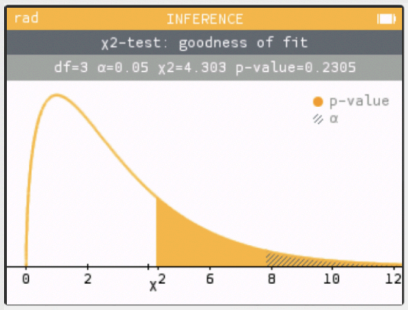
NUMWORKS: CHI-SQUARE GOODNESS OF FIT TEST

Use OK or EXE to make a selection.

1. From the home screen, select Inference, then Tests, then Chi-square, then Goodness of fit. If these options do not appear, click the ↩ button in the upper right as many times as needed.
2. Enter the Observed counts, then enter the Expected counts. Use arrows as needed. Press the down arrow and record the df. Enter α, then choose Next.
3. On this screen, you will see the chi-square statistic and p-value. Use the up and right arrow and choose Contributions to see the chi-square contributions.



4. When you have recorded the information, press the down arrow and choose Next to see the chi-square distribution with the p-value shaded.



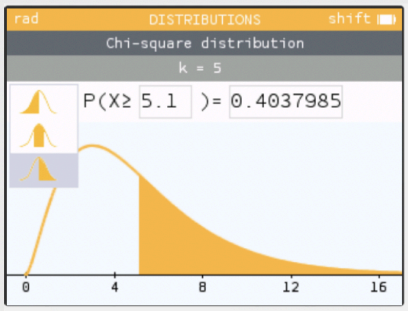
3.9.7 Technology: chi-square distribution probabilities

Use technology to find the upper tail area for a chi-square distribution with 5 degrees of freedom and a cutoff of 5.1.

NUMWORKS: FINDING AREA UNDER THE CHI-SQUARE DISTRIBUTION

Use OK or EXE to make a selection.

1. From the home screen, select Distributions, arrow down and choose Chi-square. If a list of distributions does not appear, click the ↩ button in the upper right as many times as needed.
2. Enter the Degrees of freedom. Hit the down arrow and choose Next.
3. Hit the left arrow to highlight the graph. Hit the down arrow to choose whether you want left, inner, or right, then hit OK. Hit the right arrow and enter the boundary value(s), then hit EXE.



3.9.8 Technology: the chi-square test for two-way tables

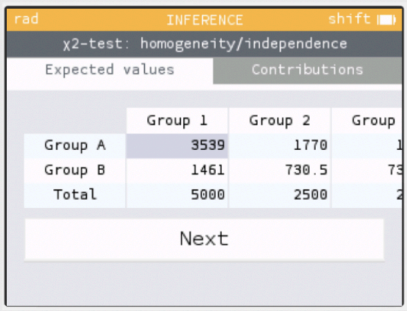
Consider the data from the search algorithm experiment introduced in Example 3.9.1. Use technology to find the test statistic, *df*, and p-value for a chi-square test for homogeneity, testing whether there is evidence that the algorithms do not perform equally well. Also find the expected values and chi-square contributions for this test. Conditions were verified to be met.

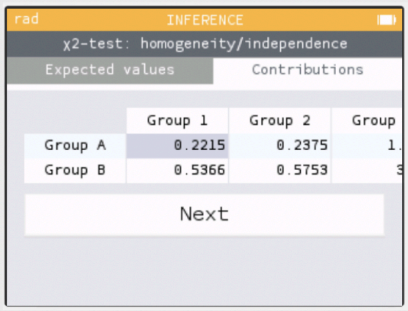
		Search algorithm			
		current	test 1	test 2	Total
outcome	success	3511	1749	1818	7078
	failure	1489	751	682	2922
	Total	5000	2500	2500	10000

NUMWORKS: CHI-SQUARE TEST FOR HOMOGENEITY AND INDEPENDENCE

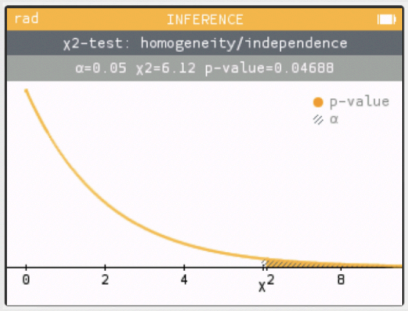
Use OK or EXE to make a selection.

1. From the home screen, select Inference, then Tests, then Chi-square, then Homogeneity/Indpendence. If these options do not appear, click the ↩ button in the upper right as many times as needed.
2. Enter the observed counts, then α, then choose Next. Use arrows as needed.
3. On this screen, you will see the table of expected counts. Use the arrows to see any rows or columns that do not fit on the screen. To see the chi-square contributions, click the up and right arrow to choose Contributions. When you are finished, choose Next.





4. On this screen, you will see the test statistic, p-value and df. Choose Next to see the chi-square distribution with the p-value shaded.



4.2.3 Technology: t-distribution probabilities and boundary values

Given a t-distribution with 3 degrees of freedom:

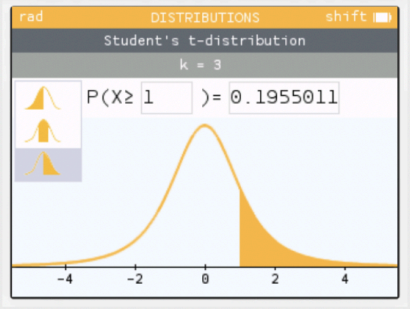
(i) Find the area to the right of $t = 1$.

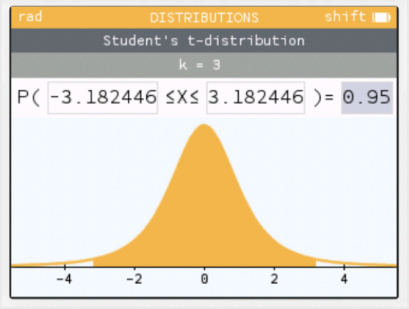
(ii) Find the boundary value $t^\star$ such that 95% of the area is between $-t^\star$ and $t^\star$.

NUMWORKS: AREA AND BOUNDARY VALUES FOR THE T-DISTRIBUTION

Use OK or EXE to make a selection.

1. From the home screen, select Distributions, arrow down and choose Student's t. If a list of distributions does not appear, click the ↩ button in the upper right as many times as needed.
2. Enter the Degrees of freedom. Hit the down arrow and choose Next.
3. Hit the left arrow to highlight the graph. Hit the down arrow to choose whether you want left, inner, or right, then hit OK. Hit the right arrow to enter desired values.
   (i) For a probability, enter the boundary value(s), then hit EXE.
   (ii) For a boundary value, enter the desired area as a decimal to the right of the = sign, then hit EXE.





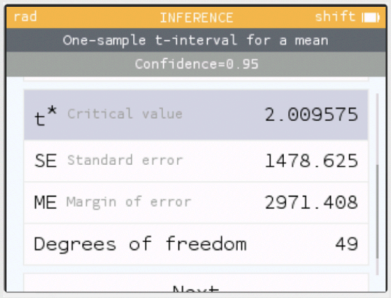
4.3.4 Technology: the one-sample t-interval and t-test for μ

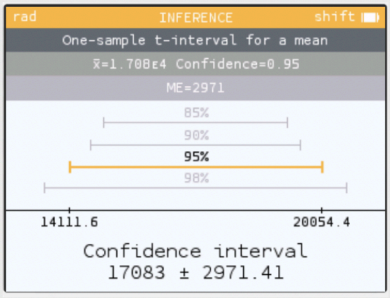
The data set `loan50`, introduced in Chapter 1, contains information on randomly sampled loans. Download the `loan50` CSV file from openintro.org/data. Open it and calculate a 95% confidence interval for the true mean of `loan_amount`. Also find the test statistic, df, and p-value for a test with the alternative hypothesis that the true mean is less than $20,000.

NUMWORKS: 1-SAMPLE T-INTERVAL.

Use OK or EXE to make a selection.

1. From the home screen, select Inference, then Intervals, then One mean, then t-interval. If these options do not appear, click the ↩ button in the upper right as many times as needed.
2. Choose Input statistics or Use a dataset and enter the needed values. Then use the down arrow and choose Next.
3. Note the quantities returned. Press the down arrow and choose Next.
4. In addition to seeing the confidence interval displayed in two ways, you can press the up and down arrows to quickly change the confidence level and see the resulting interval and margin of error.

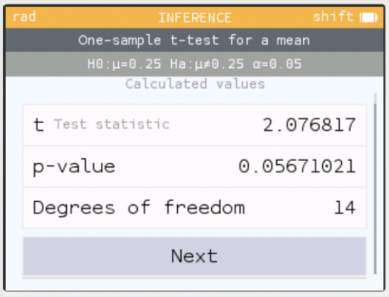


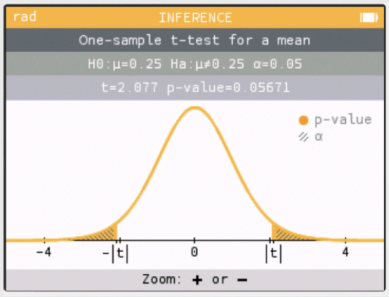


NUMWORKS: 1-SAMPLE T-TEST

Use OK or EXE to make a selection.

1. From the home screen, select Inference, then Tests, then One mean, then t-test. If these options do not appear, click the ↩ button in the upper right as many times as needed.
2. Enter the value of the hypothesized mean for the Null hypothesis. Press the down arrow. Press OK and choose <, ≠ , or > for the Alternative hypothesis. Press the down arrow and choose Next.
3. Choose Input statistics or Use a dataset and enter the needed values. Then use the down arrow and choose Next.
4. Note the quantities returned. Click the down arrow and choose Next.
5. On this screen, the p-value and alpha are shaded on the t-distribution and can be visually compared.





4.6.4 Technology: the two-sample t-interval and t-test for $\mu_1 - \mu_2$

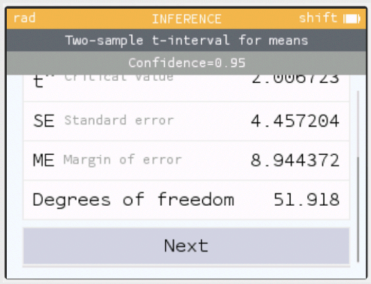
Use technology to find a 95% confidence interval for a difference in true average scores between Version A and Version B of the exam, as described in Example 4.5.4. Also find the test statistic and p-value for a two-sided test to evaluate whether there is evidence that the true means differ. Conditions were verified to be met.

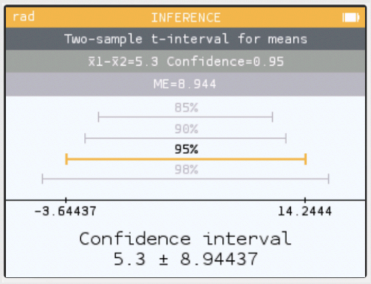
Version	n	$\bar{x}$	s	min	max
A	30	79.4	14	45	100
B	30	74.1	20	32	100

NUMWORKS: 2-SAMPLE T-INTERVAL.

Use OK or EXE to make a selection.

1. From the home screen, select Inference, then Intervals, then Two means, then t-interval. If these options do not appear, click the ↩ button in the upper right as many times as needed.
2. Choose Input statistics or Use a dataset and enter the needed values. Then use the down arrow and choose Next.
3. Note the quantities returned. Press the down arrow and choose Next.
4. In addition to seeing the confidence interval displayed in two ways, you can press the up and down arrows to quickly change confidence level and see the resulting interval and margin of error.

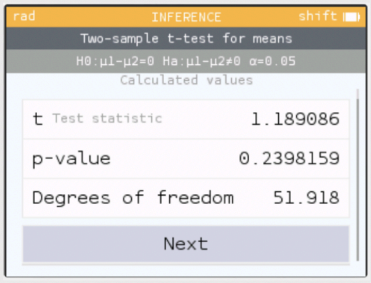


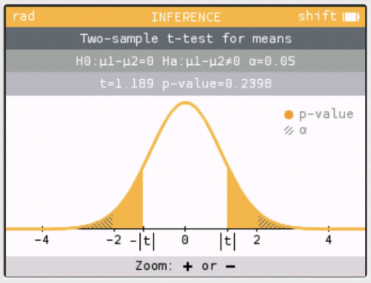


NUMWORKS: 2-SAMPLE T-TEST

Use OK or EXE to make a selection.

1. From the home screen, select Inference, then Tests, then Two means, then t-test. If these options do not appear, click the ↩ button in the upper right as many times as needed.
2. Enter the hypothesized difference for the Null hypothesis. Usually this will be 0. Press the down arrow. Press OK and choose <, ≠ , or > for the Alternative hypothesis. Press the down arrow and choose Next.
3. Choose Input statistics or Use a dataset and enter the needed values. Then use the down arrow and choose Next.
4. Note the quantities returned. Click the down arrow and choose Next.
5. On this screen, the p-value and alpha are shaded on the t-distribution and can be visually compared.





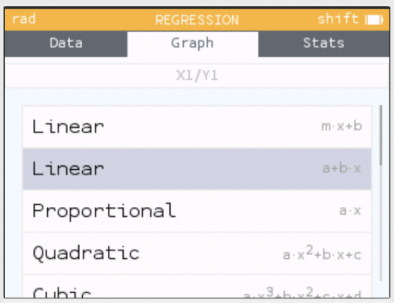
5.3.5 Technology: Scatterplots and regression analysis

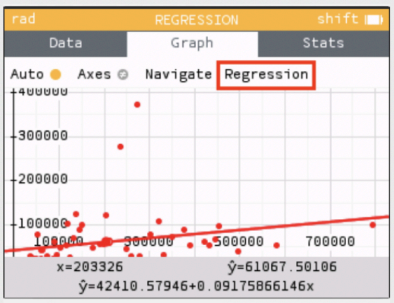
The data set `loan50`, introduced in Chapter 1, contains information on randomly sampled loans. Download the `loan50` CSV file from openintro.org/data. Open it and perform linear regression analysis for predicting `total_credit_utilized` from `total_credit_limit`.

NUMWORKS: REGRESSION

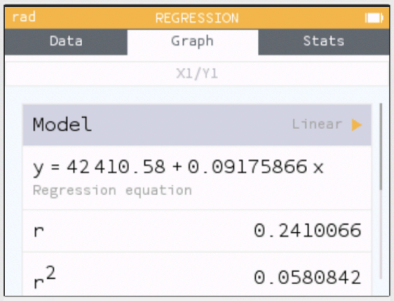
Use `OK` or `EXE` to make a selection.

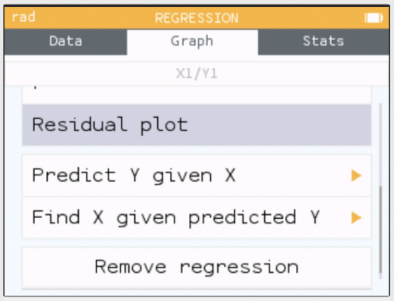
1. Click the yellow Home button (above the black Power button) to get to the home screen.
2. Select `Regression` and enter the x and y values.
3. Use the up and right arrow and select `Graph`. This will show you the scatterplot. Use the left and right arrow to toggle among the data points.
4. Press the up arrow and the right arrow to select `Regression`. Here you can choose Linear a+bx format or choose a nonlinear regression. This will draw the regression onto the scatterplot.





5. Press the up arrow and the right arrow to select `Regression` again. Here you will see the regression output. Press the down arrow to see more options, including `Residual plot`.





6. On the residual plot, use the left and right arrows to select individual points and see their corresponding residual.
7. Use the arrows to choose `Stats` at the top to see the summary statistics for x and y. Press the right arrow to see the y summary statistics. Press down arrow to see more summary statistics.