

Chapter 14 / **Example 11** $\chi^2$  test for independence

A randomly selected group of 80 people were asked what their favourite genre of music was: pop, classical, folk or jazz. The results are in the table below.

	Pop	Classical	Folk	Jazz	Total
Male	18	9	3	8	38
Female	22	6	7	7	42
Total	40	15	10	15	80

A  $\chi^2$  test was carried out at the 10% significance level.

- Write down the null and alternative hypotheses.
- Show that the expected value for a female liking pop is 21.
- Find the full table of expected values.
- Combine two columns so that all expected values are greater than 5 and write down the new observed and expected tables.
- Write down the degrees of freedom for the new table.
- Use your GDC to find the  $\chi^2$  test statistic and the  $p$ -value for this test.
- Determine whether the null hypothesis is accepted or not.

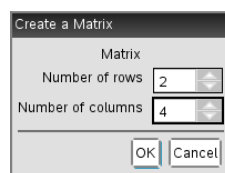
First you will enter the observed frequencies in a matrix. This is an array of numbers, in this case two rows by 4 columns. The row and column totals are not included in the matrix.

Open a new document and add a Calculator page.

Press **menu** 7:Matrix & Vector | 1: Create | 1:Matrix...

Select 2 rows and 4 columns.

Press **enter** or click on OK with the touchpad.

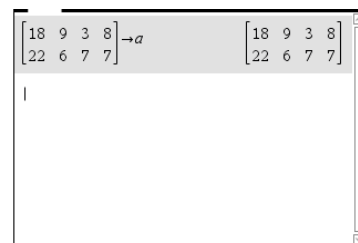


Enter the data into the matrix. (Not the totals). Press **tab** after each item.

Press **ctrl** **var** (**sto→**) and type A.

Press **enter** when you have finished.

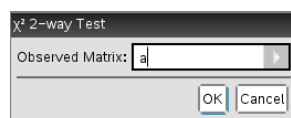
The matrix you create is stored as a variable  $a$ .



Press **menu** 6:Statistics | 7:Stat Tests | 8:  $\chi^2$  2-way Test...

Select  $a$  as the Observed Matrix.

Press **enter** or click on OK with the touchpad.



Chapter 14 / **Example 11** $\chi^2$  test for independence

The  $\chi^2$  statistic is 2.47, the  $p$ -value is 0.480 and the number of degrees of freedom is 3.

However, before using these results, check whether any columns need to be combined.

$\chi^2$  2way a: stat.results

"Title"	" $\chi^2$ 2-way Test"
" $\chi^2$ "	2.47285
"PVal"	0.480218
"df"	3.
"ExpMatrix"	"[...]"
"CompMatrix"	"[...]"

Press **var** and select `stst.expmatrix`.

Press **enter**.

These are the expected values.

The expected value for a female liking pop is 21.

Combine the Folk column with Jazz (or Classical)

stat.ExpMatrix

19.	7.125	4.75	7.125
21.	7.875	5.25	7.875

Press **menu** 7:Matrix & Vector | 1: Create | 1:Matrix...

Select 2 rows and 3 columns.

Press **enter** or click on OK with the touchpad.

Create a Matrix

Matrix

Number of rows: 2

Number of columns: 3

OK Cancel

Enter the values for the matrix with combined columns.

Press **ctrl** **var** (**sto→**) and type B.

Press **enter** when you have finished.

The matrix you create is stored as a variable  $b$ .

stat.ExpMatrix

19.	7.125	4.75	7.125
21.	7.875	5.25	7.875

18 9 11 → b

18	9	11
22	6	14

Press **menu** 6:Statistics | 7:Stat Tests | 8:  $\chi^2$ 2-way Test...

Select  $b$  as the Observed Matrix.

Press **enter** or click on OK with the touchpad.

$\chi^2$  2-way Test

Observed Matrix: b

OK Cancel

The  $\chi^2$  statistic is 1.16, the  $p$ -value is 0.559 and the number of degrees of freedom is 2.

However, before using these results, check again whether any columns need to be combined.

$\chi^2$  2way b: stat.results

"Title"	" $\chi^2$ 2-way Test"
" $\chi^2$ "	1.16291
"PVal"	0.559085
"df"	2.
"ExpMatrix"	"[...]"
"CompMatrix"	"[...]"

Chapter 14 / **Example 11** $\chi^2$  test for independence

Press **var** and select `stst.expmatrix`.

Press **enter**.

This time all expected values are all greater than 5.

The degrees of freedom is 2.

$\chi^2 = 1.1629...$  and  $p = 0.559...$   $0.559 > 0.10$  and so the result is not significant and there is no reason to reject the null hypothesis that favourite genre of music is independent of gender.

"Title"	" $\chi^2$ 2-way Test"
" $\chi^2$ "	1.16291
"PVal"	0.559085
"df"	2.
"ExpMatrix"	"[...]"
"CompMatrix"	"[...]"

<i>stat.ExpMatrix</i>	$\begin{bmatrix} 19. & 7.125 & 11.875 \\ 21. & 7.875 & 13.125 \end{bmatrix}$
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