

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.

Press **[2nd]** **[x<sup>-1</sup>]** **[MATRIX]**. Press **[▶]** **[▶]** to access the EDIT menu.

Select 1:[A] and edit the dimensions of the matrix so that they read 2 × 4.

MATRIX[A] 2 × 4

0	0	0	0
0	0	0	0

[A](1,1)= 0

Enter the data into the matrix. (Not the totals). Press **[ENTER]** after each item.

MATRIX[A] 2 × 4

18	9	3	8
22	6	7	7

[A](1,1)= 18

Press **[STAT]**. Press **[▶]** **[▶]** to access the TESTS menu.

Select C:  $\chi^2$ -Test.

You should be able to leave the entries in the template unchanged.

Use **[▼]** to navigate down to Calculate. Press **[ENTER]**.

**$\chi^2$ -Test**

Observed:[A]  
Expected:[B]  
Color: BLUE  
Calculate Draw

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.

```

χ²-Test
χ²=2.472848789
p=.480217905
df=3

```

Press **2nd** **[QUIT]** to enter the home screen.

Press **2nd** **[x⁻¹]** **[MATRIX]**. From the NAMES menu select 2:[B] and 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)

```

[B]
[19 7.125 4.75 7.125]
[21 7.875 5.25 7.875]

```

Press **2nd** **[x⁻¹]** **[MATRIX]**. Press **▶ ▶** to access the EDIT menu.

Select 2:[C] and edit the dimensions of the matrix so that they read 2 × 3.

Enter the values for the matrix with combined columns.

```

MATRIX[C] 2 × 3
[ 18  9 11 ]
[ 22  6 14 ]

[C](1,1)= 18

```

Press **[STAT]**. Press **▶ ▶** to access the TESTS menu.

Select C:  $\chi^2$ -Test.

Change the Observed and Expected matrices to [C] and [D] by pressing **2nd** **[x⁻¹]** **[MATRIX]**, selecting 3:[C] and 4:[D] from the NAMES menu and pressing **ENTER**.

Use **▼** to navigate down to Calculate. Press **ENTER**.

```

χ²-Test
Observed:[C]
Expected:[D]
Color: BLUE
Calculate Draw

```

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.

```

χ²-Test
χ²=1.162907268
p=.5590850705
df=2

```

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

Press **[2nd]** **[QUIT]** to enter the home screen.

Press **[2nd]** **[ $x^{-1}$ ]** **[MATRIX]**. From the NAMES menu select 4:[D] and press **[ENTER]**.

These are the expected values.

This time all expected values are all greater than 5.

```
[B]
[19 7.125 4.75 7.125]
[21 7.875 5.25 7.875]
[D]
[19 7.125 11.875]
[21 7.875 13.125]
```

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.

```
 $\chi^2$ -Test
 $\chi^2=1.162907268$ 
 $p=.5590850705$ 
df=2
```