

## Chapter 14 / Example 16

### Estimating parameters for the binomial distribution

In this example, instructions for performing the  $\chi^2$  goodness-of-fit test are not provided.

An archer fires five arrows at a target, aiming for the “bullseye” in the centre. She feels that she has an equal chance of hitting the bullseye with each shot, that each shot is independent of the ones that have gone before and so the binomial distribution is a good model to use.

To test this belief she looks back over her records and notes the number of times she has hit the bullseye in the last 150 sets of five arrows fired. These results are recorded in the table below.

Number of bullseyes	0	1	2	3	4	5
Frequency	5	22	28	45	40	10

Perform a  $\chi^2$  goodness-of-fit test to test the following hypotheses.

H0: The number of bullseyes follows a binomial distribution.

H1: The number of bullseyes does not follow a binomial distribution.

Open a new document and add a Lists & Spreadsheet page.

Type 'n' in the first cell.

Type the number of bullseyes in the first column.

Press **enter** or **▼** after each number to move to the next cell.

A	n	B	C	D
1	0			
2	1			
3	2			
4	3			
5	4			

Type 'f' in the cell to the right of 'obs'

Enter the frequencies in the second column.

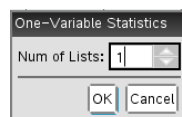
Use the **▲ ▼ ► ◀** keys on the touchpad to navigate the spreadsheet.

A	n	B	f	C	D
2	1	22			
3	2	28			
4	3	45			
5	4	40			
6	5	10			

To calculate summary statistics of the data.

Press **menu** 4:Statistics | 1:Stat Calculations | 1:One-Variable Statistics...

Click the touchpad on OK or press **enter**.



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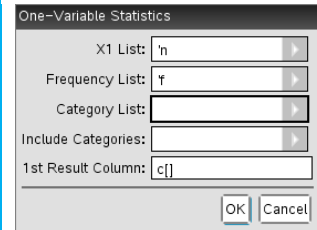
Open the drop down list with **►** and select using **▼** and **enter**.

Choose 'n' for X1 List and 'f' for Frequency List.

The remaining choices remain empty.

The 1st Result Column can remain as c[] as this next empty column in the spreadsheet.

Press **enter** or use the touchpad to click OK.



The GDC displays a list of statistics for the data.

The results show that the mean ( $\bar{x}$ ) number of messages is 2.82.

A	n	B	f	C	D
=					=OneVar(
2	1	22	$\bar{x}$		2.82
3	2	28	$\Sigma x$		423.
4	3	45	$\Sigma x^2$		1429.
5	4	40	$s_x := s_{n-1}$		1.2589
6	5	10	$\sigma_x := \sigma_{n-1}$		1.2547
D2	=2.82				

In the second cell from the top of the next column type = 150 ×

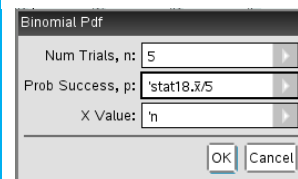
Press **menu** 4:Statistics | 2:Distributions | A:Binomial Pdf...

Enter 5 as the number of trials.

In Prob Success open the drop down list with **►** and select  $\text{stat. } \bar{x}$  using **▼**, type  $\div 5$  and press **enter**.

Choose X value n from the drop-down list.

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



Press **enter**.

The GDC displays the expected values.

B	f	C	D	E
=				=OneVar( =150*bino
1	5	Title	One-Va...	2.36333
2	22	$\bar{x}$	2.82	15.2857
3	28	$\Sigma x$	423.	39.5466
4	45	$\Sigma x^2$	1429.	51.1566
5	40	$s_x := s_{n-1}$	1.2589	33.0875
E				

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Since  $2.36 < 5$ , the first two rows are combined.

Number of bullseyes	0, 1	2	3	4	5
Observed	27	28	45	40	10
Expected	17.649	39.547	51.157	33.088	8.560

Using these values calculate the  $p$ -value using a  $\chi^2$  goodness-of-fit test with  $df = 3$ .

$p$ -value = 0.0131 < 0.05

The result is significant at the 5% significance level so we reject the null hypothesis that the data follows a binomial distribution.

A	B	C	D
=			= $\chi^2$ GOF(a
2	28	39.547	$\chi^2$ 10.7531
3	45	51.157	PVal 0.013138
4	40	33.088	df 3.
5	10	8.56	Complis... (4.95445...
6			
D2 =10.753137061973			