

# Chapter 14 / Example 15

## Estimating parameters

The lengths of fish caught in a lake are thought to be normally distributed. To test this belief 200 fish were caught and measured and the results are shown in the table below.

Length ( $x$ cm)	$0 < x < 10$	$10 < x < 15$	$15 < x < 20$	$20 < x < 25$	$25 < x < 30$	$30 < x < 40$
Number of fish	45	55	38	27	25	10

Using estimates of the mean and standard deviation of the population taken from the sample data, test the hypothesis at the 5% level that the lengths of the fish are normally distributed.

Press **[stat]** 1:Edit and press **[enter]****[format]**

Type the mid-interval values: 5, 12.5, 17.5, 22.5, 27.5, 35 in the first column.

Press  or  after each number to move to the next cell.

L1	L2	L3	L4	L5
5	-----	-----	-----	-----
12.5				
17.5				
22.5				
27.5				
35				
-----				

L1(?)=

Press  to move to the next column.

Enter the frequencies in the second column.

L1	L2	L3	L4	L5
5	45	-----	-----	-----
12.5	55			
17.5	38			
22.5	27			
27.5	25			
35	10			
-----	-----			

L2(7)=

To find the summary statistics

Press **[stat]** and **[▶]** to access the CALC menu.

Select 1:1-Var Stats and press **enter**.

Enter  $L_2$  as the FreqList by pressing  $\boxed{2\text{nd}} \boxed{2} \boxed{[L_2]}$ .

Navigate to Calculate and press **enter**.

**1-Var Stats**  
List:L1  
FreqList:L2  
Calculate

The GDC displays a list of statistics for the data.

From the sample

$$\bar{x} = 16.1 \text{ cm}, S_x = 8.46 \text{ cm}.$$

$H_0$ : The fish in the lake have an  $N(16.1, 8.46^2)$  distribution.

$H_1$ : The fish in the lake do not have an  $N(16.1, 8.46^2)$  distribution.

**1-Var Stats**  
 $\bar{x}=16.1125$   
 $\Sigma x=3222.5$   
 $\Sigma x^2=66181.25$   
 $Sx=8.464741757$   
 $\sigma x=8.443553384$   
 $n=200$   
 $\min X=5$   
 $\downarrow Q_1=12.5$

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Calculate the expected values directly in the table.

Press  $\rightarrow$  to move to the next column.

Press  $2^{nd}$   $vars$   $[distr]$  2:normalcdf(.

Leave lower as  $-1E99$  and type 10 for upper.

For  $\mu$  press  $vars$  5:Statistics... 2:  $\bar{x}$  and press  $\text{enter}$ .

For  $\sigma$  press  $vars$  5:Statistics... 3:  $Sx$  and press  $\text{enter}$ .

Navigate down to Paste and press  $\text{enter}$  when complete.

```
normalcdf
lower: -1E99
upper: 10
 $\mu$ :  $\bar{x}$ 
 $\sigma$ :  $Sx$ 
Paste
```

The probability is entered directly in the table.

Repeat for the remainder of the column, using the boundaries:

10-15, 15-20, 20-25, 25-30 and 30-9E99

To enter  $E$  ( $\times 10^{\square}$ ) press  $2^{nd}$   $,$   $[EE]$  [format]

L1	L2	L3	L4	L5	3
5	45	.23511			
12.5	55				
17.5	38				
22.5	27				
27.5	25				
35	10				

$L3(1)=\text{normalcdf}(-1E99,10,\bar{x},Sx).$

The template will remember the values from the previous calculation which makes entering the values much easier.

Now press  $\rightarrow$  to move to the next column and  $\uparrow$  to move up to the top cell.

Type  $L_3 \times 200$  and press  $\text{enter}$ .

L1	L2	L3	L4	L5	3
5	45	.23511			
12.5	55	.21261			
17.5	38	.22926			
22.5	27	.17615			
27.5	25	.09643			
35	10	.05044			

$L3(7)=$

The GDC calculates the expected values which are shown in  $L_4$ .

L1	L2	L3	L4	L5	4
5	45	.23511	47.022		
12.5	55	.21261	42.521		
17.5	38	.22926	45.851		
22.5	27	.17615	35.23		
27.5	25	.09643	19.287		
35	10	.05044	10.087		

$L4(1)=47.022486194362$

You are now ready to conduct the  $\chi^2$  test.

Press  $\text{stat}$  and  $\rightarrow$   $\rightarrow$  to access the TESTS menu and select

D:  $\chi^2$ GOF-Test...

Select Observed  $L_2$  and Expected  $L_4$ .

Since the mean and standard deviation were both estimated, the number of degrees of freedom is  $6 - 1 - 1 - 1 = 3$ .

Navigate down to Calculate and press  $\text{enter}$ .

```
 $\chi^2$ GOF-Test
Observed:L2
Expected:L4
df:3
Color: BLUE
Calculate Draw
```

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# Estimating parameters

p-value = 0.0334.

$0.0334 < 0.05$ , the result is not significant so there is insufficient evidence to reject the null hypothesis that the lengths of fish in the lake follow a normal distribution.

```
χ²GOF-Test
χ²=8.709413439
p=.0334145987
df=3
CNTRB={.0869892415 3.662...
```