# Hypothesis testing I

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## LEVEL

High school or university students with basic knowledge in Mathematics and elements of Statistics.

## OBJECTIVES

To use the calculator's built-in spreadsheet tool to make elementary statistical evaluations for real-life problems.

## Corresponding eActivity

S04TEST.g1e (for Activity1), S04MOBIL.g1e (for Activity2)

## OVERVIEW

Hypothesis testing allows verifying a hypothesis about a large set of data based on data measured on its subset. The reliability of the conclusion(s) is discussed.

## EXPLORATORY ACTIVITIES

[Note]
We shall use small letter *x* instead of capital X as shown on the calculator throughout the paper.

Here we describe two activities. For their mathematical background refer for example to [LM], page 257-290.

**Activity 1 (S04TEST.g1e):**

(a) (Refer to New players) The average height of a hockey team's player is 182 cm with the standard deviation 4.1 cm; the average weight is 77 kg with the standard deviation 3.5 kg. A hockey team has recently hired 10 new players. Their data are in the table.

 

| SHEE | A | B | C | D |
|---|---|---|---|---|
| 1 | Name | Height | Weight | |
| 2 | Dan | 191 | 86 | |
| 3 | Ed | 178 | 80 | |
| 4 | Frank | 188 | 79 | |
| 5 | Hugo | 180 | 74 | |
| 6 | Lynn | 180 | 79 | |
| 7 | Nick | 193 | 91 | |
| 8 | Paul | 176 | 77 | |
| 9 | Peter | 185 | 79 | |
| 10 | Rod | 190 | 82 | |
| 11 | Vic | 178 | 73 | |

The trainer presumes the present mean values are optimal for his game strategy. He knows that his assistant is skilled in Statistics so he asks him to estimate whether the new players' average values fit to the current figures.

## EXERCISES A

***Exercise 1***.
Help the assistant to formulate the null hypothesis on the players' height.

***Exercise 2***.
Is the test one-tailed or two-tailed?

***Exercise 3***.
The test is two-tailed. Assuming the 0.05 level of significance, what critical value(s) will we use?

**SOLUTIONS to EXERCISES A**

***Exercise 1***.
There is no significant difference between the height of the already hired players and of the new ones.

***Exercise 2***.
The problem is two-tailed. We are in any difference – both taller and shorter mean of players is assumed to cause problems.
One-tailed problems presume that a certain difference is important, the other not. (For example, the trainer does not want to have *lighter* players, but do not care about *heavier* ones.

***Exercise 3***.
-1.96 to +1.96 is the region of non-rejection of the null hypothesis.

(b) (Refer to <u>Test statistics</u>) A null hypothesis sounds like: "*There is no significant difference between the height of average players and that of the new hired ones*".
We decided to use the 0.05 level of significance for its acceptance/rejection. Now, the test statistics $z$ is calculated. Its formula is

 

$$z = \frac{\bar{X} - \mu}{\sigma / \sqrt{n}}$$

where $\bar{X}$ is the sample mean (i.e. the mean height of the new players), $\mu$ is the population mean (i.e. 182 cm), $\sigma$ is the standard deviation of (players') population (i.e 4.1), and $n$ is the number of players in our discussed sample (i.e. 10).

Let us calculate $z$ in the spreadsheet using the entered data. First, we calculate the mean height of the new players in B12. After activating the cell, press [SHIFT] [•] (i.e. =), then [F5] (CELL) and then [F3] (CellMean). Enter the range B2:B11, enter the closing parenthesis and [EXE]. The mean is 183.9.

The value of z can be calculated in B13.

| SHEE | A | B | C | D |
|---|---|---|---|---|
| 10 | Rod | 190 | 82 | |
| 11 | Vic | 178 | 73 | |
| 12 | Mean | 183.9 | | |
| 13 | z | 1.4654 | | |
| 14 | | | | |

=(B12−182)÷(4.1÷√10)

## EXERCISES A

***Exercise 4***.
The value of z is 1.4654. Interpret the result.

***Exercise 5***.
Formulate the null hypothesis on the players' weight. Is the problem one-tailed or two-tailed?

**SOLUTIONS to EXERCISES A**

***Exercise 4***.
The value of y is between -1.96 and 1.96. The null hypothesis is accepted – the difference in heights is not significant.

***Exercise 5***.
There is no significant difference between the average weight of already hired players and new ones.

(g) (Refer to <u>Z for weight</u>) Using the spreadsheet data, calculate the test statistics for the players' weight. As said above, the average player's weight is 77 kg with the standard deviation 3.5 kg.

 

## EXERCISES A

***Exercise 6***.
z = 2.7105. Interpret the result.

***Exercise 7***.
After hearing the latest result, the trainer says: "I need tough men. I would only mind, if they are lighter." Interpret his words in statistical terms.

**SOLUTIONS to EXERCISES A**

***Exercise 6***.
The null hypothesis must be rejected. There is a significant difference between weight of old and new players.

***Exercise 7***.
The problem has been changed to one-tailed test. The hypothesis is now: "The mean weight of new players is not significantly lower than that of the all players". The critical value for its rejection is -1.645.

**Activity 2 (S04MOBIL.g1e):**

A mobile phone manufacturer claims that 96% of its mobile phones (with 5% standard deviation) will function regularly after falling from the altitude of 2 meters. To demonstrate this, they invited the representatives of dealers and randomly selected 100 new mobile phones from the production line. All have been dropped from a 2 meter high cupboard to the floor. Five of them (i.e. 5 per cent) did not function after the fall.
Can the producer's claim still be accepted?

## EXERCISES B

***Exercise 1***.
Formulate the null hypothesis.

***Exercise 2***.
Is the crash test one-tailed or two-tailed?

***Exercise 3***.
Specify the input values for calculating the test statistics (*z*).

**SOLUTIONS to EXERCISES B**

***Exercise 1***.
The number of broken mobile phones does not significantly differ from 4 percent.

***Exercise 2***.
The test is one tailed. We are only interested in worse test results, not the positive ones. Thus its critical value is 1.645.

***Exercise 3***.
Specify the input values for calculating the test statistics (*z*).

 

(a) (Refer to Calculation) Using $\bar{X}$ = 95, $\mu$ = 96, $\sigma$ = 5, and n = 100, calculate the test statistics.

$$z = \frac{\bar{X} - \mu}{\sigma / \sqrt{n}}$$

## EXERCISES B

***Exercise 4***.

Make your conclusion: *Can the producer's claim still be accepted?* Explain why do you think so.

**SOLUTIONS to EXERCISES B**

***Exercise 4***.

No, the claim must be rejected. The critical value for one-tailed test is 1.645. The test statistics shows z=2. The value falls to the region of rejection.

## REFERENCE

[LM] Douglas A. Lind and Robert D. Mason, *Basic Statistics for Business and Economics*, Irwin/McGraw-Hill, 1997. ISBN 0-256-19408-4

 