Sum of Squares

Calculations

CHARLES STURT UNIVERSITY

Learning Skills

Introduction:

A sum of squares is a value that is used in calculating a variance and standard deviation for a set of scores. You will also find it used in several other formulae you may come across.

This sheet will teach you to:

- Familiarise with some mathematical symbols
- Calculate a sum of squares for a data set

1. The symbols to be used

As the name suggests a sum of squares requires adding together some scores. When required to add together scores a shorthand maths symbol Σ (reads as sigma) followed by the name of the set of scores to be added is used. In this worksheet the data set will be called *X*.

There are two different sums that need to be calculated to find a sum of squares:

The sum of the scores – shown as ΣX

The sum of each score that has been squared – shown as ΣX^2 *(*reads as sigma *X* squared)

The notation that is given to a sum of squares is SS_X

The number of scores in the data set is shown as *n*

2. Calculating a sum of squares

Consider the ten scores:

X = 6 3 4 2 6 5 1 2 5 6

To find SS_x the following formula is used

$$SS_X = \sum X^2 - \frac{(\sum X)^2}{n}$$

(the sum of the squares of the scores minus the sum of scores squared divided by the number of the scores)

There are a couple of different ways of obtaining the sum of squares for a data set. The computational method, that is shown here, however, is probably the easiest.

1. find $\sum X$

$$\sum X = 6+3+4+2+6+5+1+2+5+6 = 40$$

2. Now square this total to find $(\sum X)^2$

(this reads as sigma X all squared)

$$(\sum X)^2 = 40^2 = 40 \times 40 = 1600$$

3. Add together the squares of each score to find $\sum X^2$

$$\begin{aligned}\sum X^2 &= 6^2+3^2+4^2+2^2+6^2+5^2+1^2+2^2+5^2+6^2 \\ &= 36+9+16+4+36+25+1+4+25+36 \\ &= 192\end{aligned}$$

4. Now apply the formula

$$SS_X = \sum X^2 - \frac{(\sum X)^2}{n}$$

$$SS_X = 192 - \frac{1600}{10}$$

$$SS_X = 192 - 160$$

$$SS_X = 32$$

In the second last line (192 – 160) the second number should be smaller than the first, but not hugely smaller than. This provides a check for you. If the second number is bigger or the numbers are a lot different to each other for instance 192 and 45 then your calculations should be checked.

3. Exercises to try

1. Find the sum of squares of X = 10, 15, 16, 18, 20, 22
2. Find the sum of squares of X = 102, 110, 132, 145

4. Solutions

1. $\Sigma X = 101$, $(\Sigma X)^2 = 101 \times 101 = 10201$, $\Sigma X^2 = 10^2 + \ldots = 1789$, $n = 6$

$SS_X = 1789 - (10201 \div 6) = 1789 - 1700.17 = 88.83$

2. $\Sigma X = 489$, $(\Sigma X)^2 = 489 \times 489 = 239\,121$, $\Sigma X^2 = 102^2 + \ldots = 60\,953$, $n = 4$

$SS_X = 60953 - (239121 \div 4) = 60953 - 59780.25 = 1172.75$

5. For more information

Visit our Learning Skills website at http://www.csu.edu.au/division/studserv/maths/index.htm